# Graphical User Interfaces as Educational Tools

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## Abstract

There are many aspects to consider when designing an application. Requiring extra attention is usability (the efficiency with which a user can perform required tasks). Educational tools must be designed not to give the impression that the user does not have the required knowledge, yet the application cannot be too simple otherwise nothing is learned. The appropriate level of usability for educational applications varies on the age of the intended user. Elementary school students require a higher level of usability that higher education students.

This paper will discuss the design of a GUI controlling a computer animated movie generator Surveys of middle school aged students will be used to guide the design. The goal is to determine a level of usability to aid in the design of future educational applications to provide meaningful experiences for the intended users.

## I. Introduction

The popularity of Computer Science as a major has dropped significantly in the past few years. As freshmen interest levels are an indication of the number of degrees granted four or five years later, it is likely that there will be a sharp decline in the number of Computer Science bachelor's degrees granted in the coming decade [Vegso]. Yet, computers have become integrated into most human activity and because of this, computer science education, and the improvement thereof, has become much more important [Halstead]. We must find a mechanism to attract students into and keep students. One such approach is via the use of educational software and it is the focus of this paper to evaluate the graphical user interface (GUI) design of one such application.

The goal of any user interface is to bridge the gap between the user and the application they are using. Many aspects of the user interface can be enhanced through the use of graphical techniques [Mackinlay]. This can be done to improve the presentation of the application as well as its usability. When designing an educational application, it is important to make the computer system more satisfying and easier to learn [Mackinlay]. However, designing a GUI can be as difficult as designing non-graphical interfaces. There are many choices available due to advances in technology and it is important for the designer to have a deep understanding of the choices available as well as how to incorporate them.

Educational applications must have a level of usability appropriate to the goal user. For instance, an application designed to educate cannot be so simple that they lose interest. Similarly, the application cannot be too challenging that the user is unable to learn at a satisfying rate, again losing interest. There is a delicate balance in this regard. The usability level that seems the most vague to determine is that of middle school students. Compared to previous generations, this level of student has a much better grasp on the use of computer software as computer software has always been available to these students. They have also been exposed to and influenced by highly advanced computer and console games, which are themselves exemplary teachers [Gentile]. As such, the application's GUI needs to be designed such that the student does not lose interest in learning what is intended to be taught.The obvious way to adjust the usability of an application is through its GUI. By adjusting aspects of the GUI, the difficulty of use of the application can be adjusted. This can be done on a meta scale by adding and removing parts of the GUI or on a micro scale by manipulating existing parts of the GUI.

Finally, A key challenge that prevents many computing educators from researching and gaining such an understanding is isolation. This can result from existing in an environment in which educational research is not considered to be real research [Alstrum]. Another problem is avoiding the temptation to re-invent the wheel [Alstrum]. As technology is constantly improving and changing, we are constantly trying to alter our approaches to teaching it.


## II. Initial Design

In this study, an application that will manipulate a robot through a scene with buildings in the background has been designed to educate middle school students on some of the major aspects of computer generated movies. During the study the application will be modified many times in an attempt to find what aspects of the GUI improve the usability for this age group. Each modification will be made after having a group of participants test the application. The participants of the study will then rate different aspects of the application based on ease of use. From this analysis, appropriate changes will be made.

What the application itself does is not important when analyzing the GUI and only the important aspects of an animation process have been included. These are as follows:

- Personal Information Entry – The user will enter some personal information which will be used to identify them when the animation is generated.
- Robot Customization – The user may alter the appearance of the robot by changing its coloring.  This is included to give the user a sense of ownership of this robot.
- Camera Control – The camera location can be modified so that the scene can be viewed from a different location.
- Lighting Control – The lighting can be moved so that the user can see how the position of the light affects the shadows. Also, the color of the light source can be modified so that the scene may appear to be at a different time of day.
- Robot Control – The robot's movements can be controlled by the user so that each user can have a unique experience.

Figure 1 shows the initial GUI design of the application. The design is very simple in an attempt to ensure that the usability level is not too difficult from the start.  It is easier to increase this level than it is to decrease it.
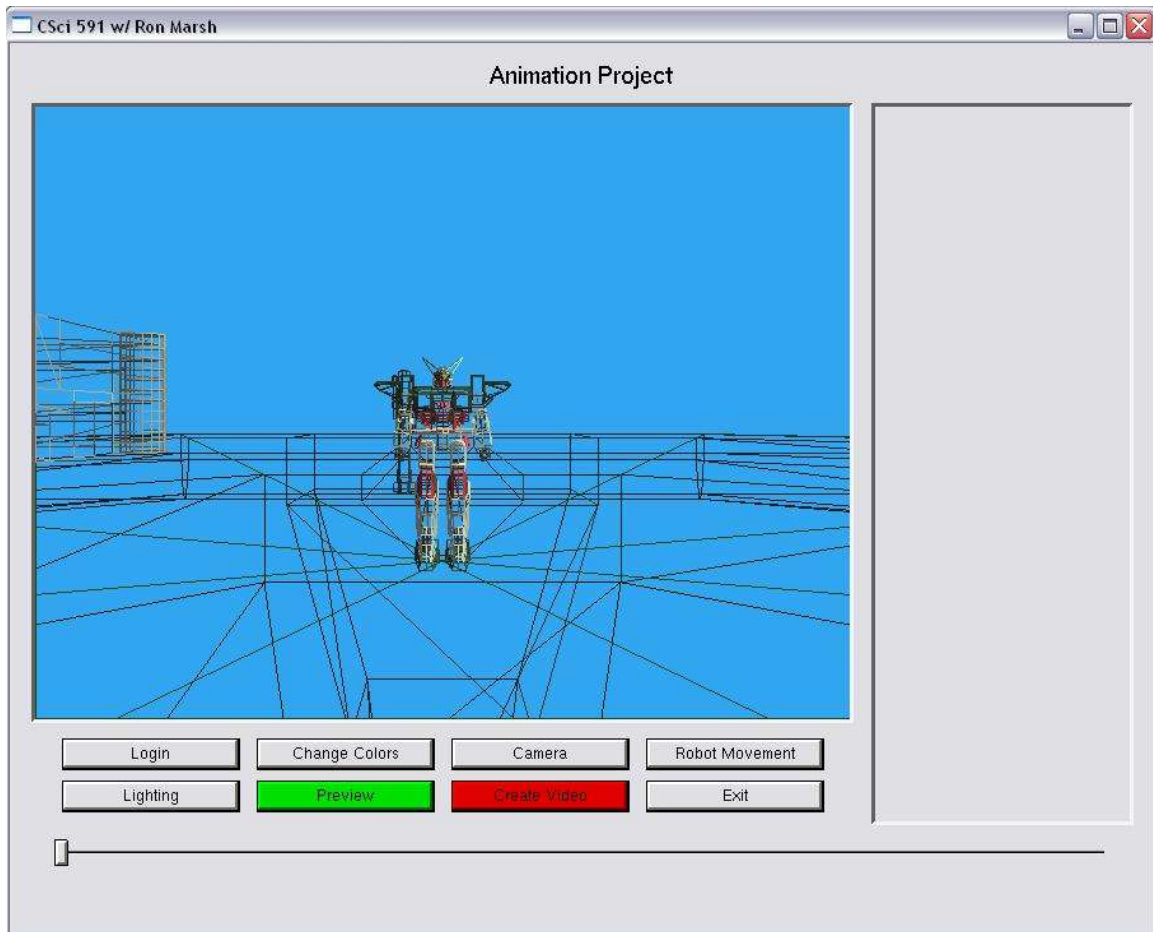


Figure 1. Initial Design of the GUI.

The amount of control that the user will have over each of these aspects (the 8 GUI buttons) will be modified over the course of the study based on user feedback. However, we do have some criteria:

- No aspect of the application can be too simple or too complex.
- The users must remain interested in the application throughout its use. It is possible that the controls are at the correct usability level, but the user loses interest due to lack of options.
- Each of the buttons in the main display will bring up specific controls. For example, the "Login" button brings up a control window to the right which asks for the user's personal information.

Finally, please note that for this study, the actual video will not be generated. This study will only analyze how the GUI affects the usability of the application.


# III. Current Revisions

Figure 2 shows the GUI after the user has clicked on the "Change Colors" button to customize the robot's colors.
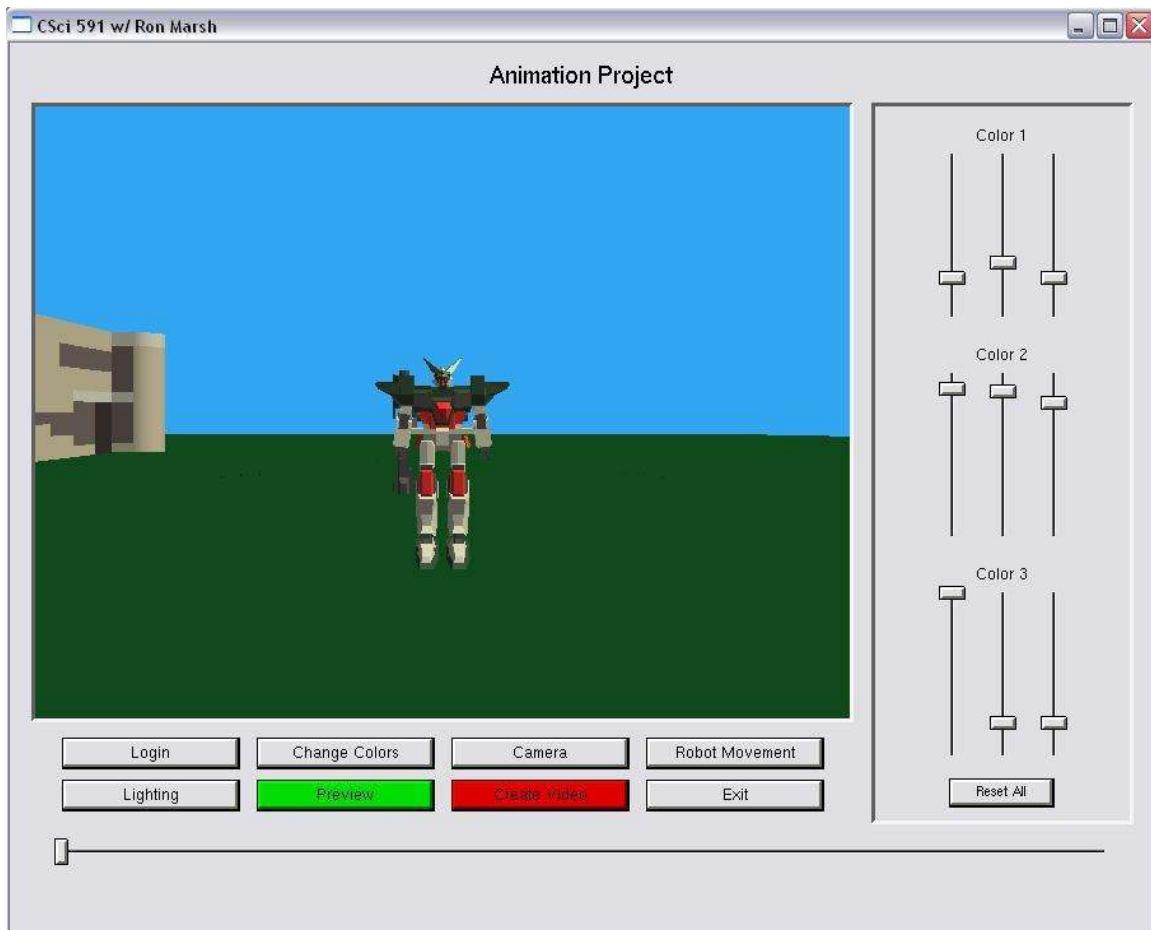
Figure 2. Initial Design of the "Change Colors" panel.

Based on feedback from adults, some preliminary changes have already been made, including:

- The first change is to the "Change Colors" panel were the sliders have been colored corresponding to the red-green-blue (RGB) color band of the robot that each controls.
- The second change was to the "Lighting" panel were the sliders have also been colored corresponding to the red-green-blue (RGB) color band of the lighting that each controls.
- The third change is the location of the "Exit" button. Though this seems of no importance, it is necessary to ensure that the user does not accidentally leave the application. Likewise, the standard minimize, restore, and close buttons may eventually be removed.
- The fourth change was to replace the "Preview" and "Create Video" buttons by the more familiar setup of a VCR or DVD player control. The user has options for playing, pausing, and stopping their preview. Also, they are able to move forward or backward through the robot's movements. All of these controls are based on the movements which have been chosen for the robot.
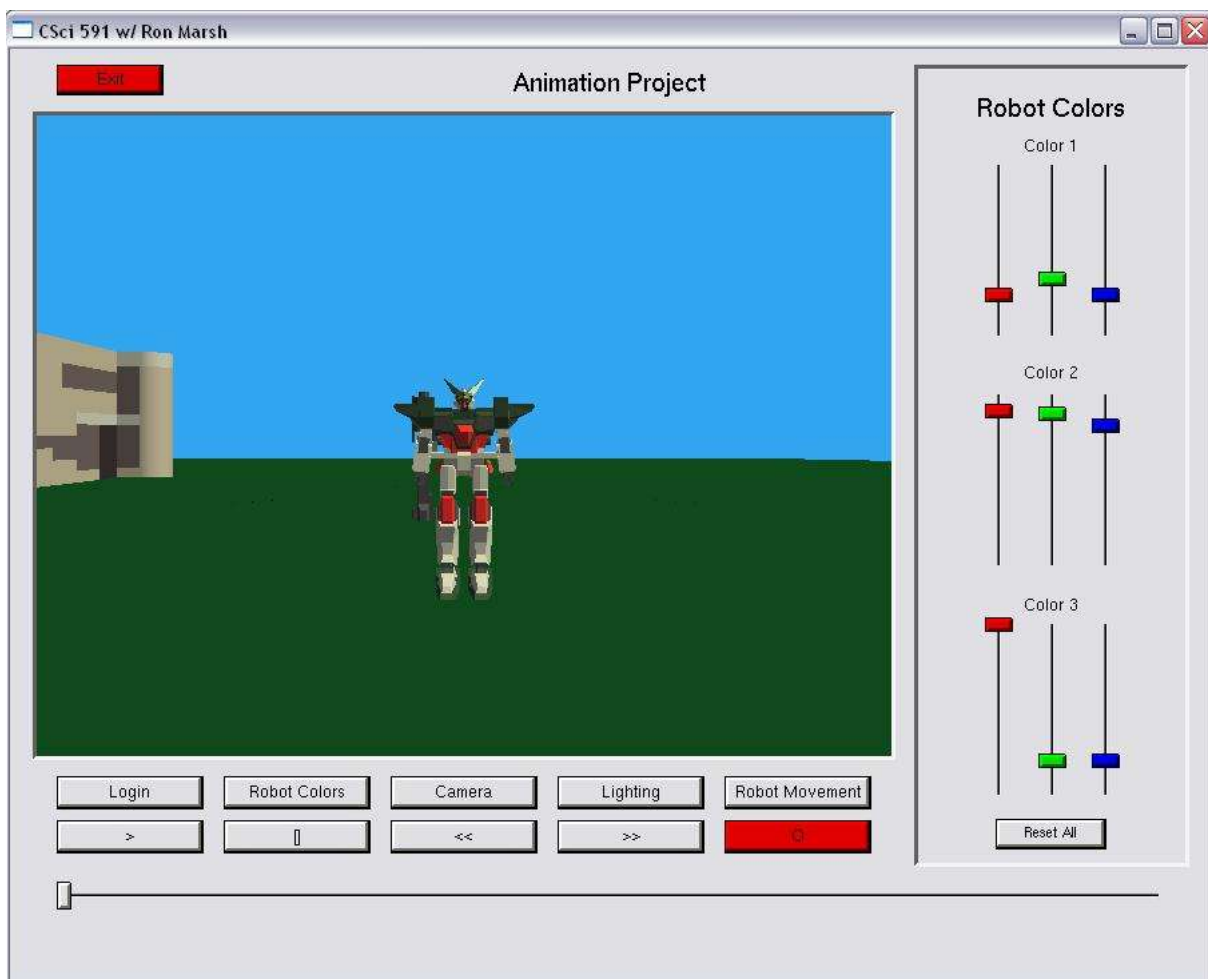
Figure 3 shows the revised GUI.

Figure 3. GUI after first round of modifications.

Based on a second round of feedback from adults, additional changes have been made, including:

- The wording on some of the controls has been changed. It is extremely important to remember that the target age group for this application is junior high level, or approximately age 11 to 15 and though it may seem obvious to some that the "Reset" button for the coloring sliders will reset the settings to the original default settings, it may not be obvious to others.  Especially when considering the target age level of the users. Thus the "Reset" button has been relabeled as "Back to Default". Similar changes have been made to the wording of other buttons and controls throughout the application.
- The initial camera settings did not show the user a complete view of the scene. Therefore, this setting has been changed so that the camera is further back. The initial camera setting now gives the user a full view of the buildings in the scene as well as the robot.
- Another setting of the camera that was necessary to change was its location when editing the robot's coloring. It is very difficult to tell what is being changed on the robot when the camera is a large distance away. For this reason, when customizing these colors, the camera location has been moved to closer to the robot. When other aspects of the animation are being edited, the camera location returns to its previous location.
- One of the most important changes to the interface is the addition of headings to each of the control panels.  Previously, the controls would appear, but the user could not be certain that the control window they were using was for the appropriate options. This was particularly true when adjusting the "Robot Colors" or the "Lighting."

Figure 4 shows the current GUI. The GUI that will be used for student evaluations.
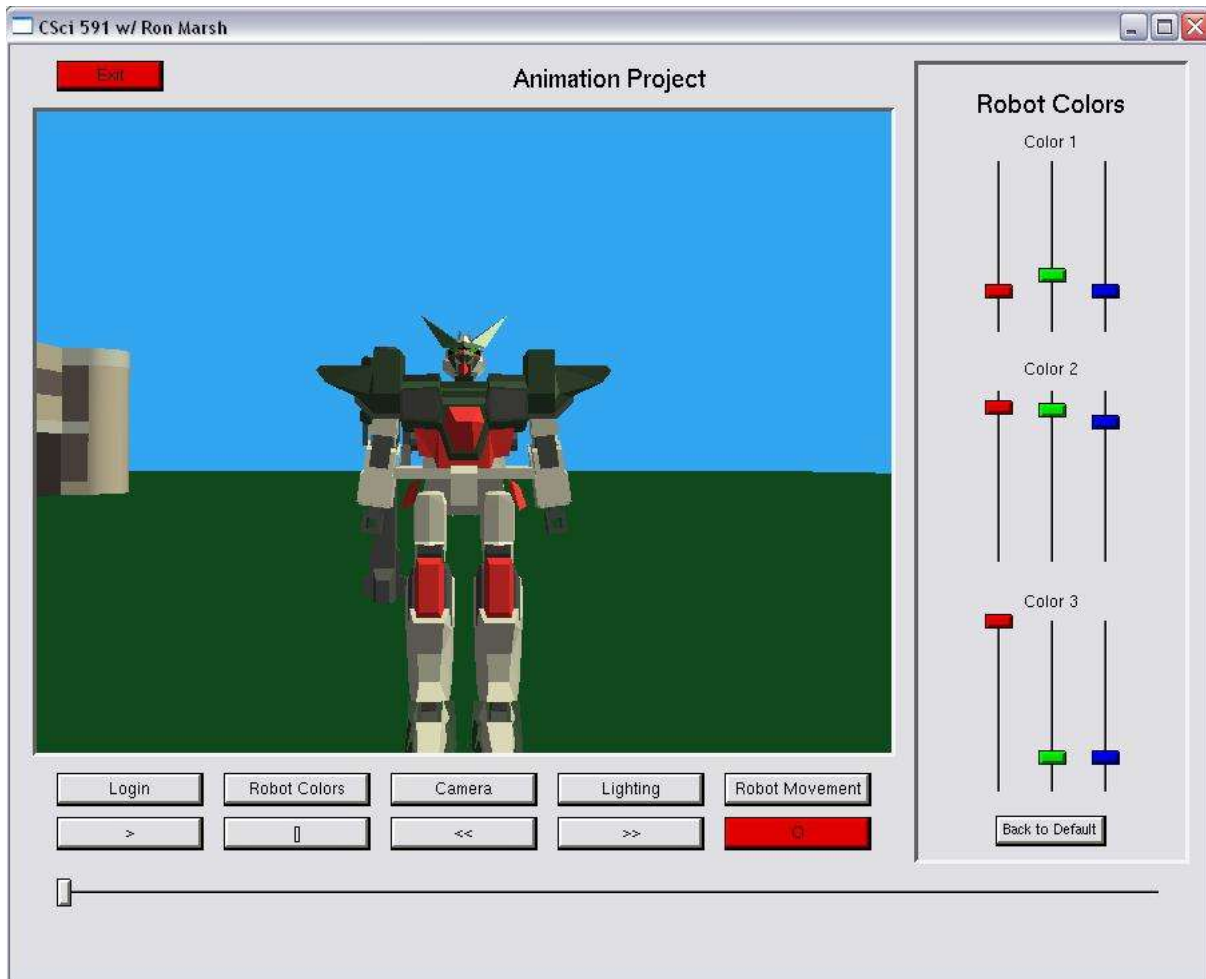
Figure 4. Current state of the GUI.

# IV. Conclusion

It has become obvious, through these preliminary modifications, that there is much to consider when designing the GUI of such an application. It is expected that GUI aspects will be better understood once a proper assessment has been made by student participants. However, it has not yet been possible to have student participants test the application and rate its usability as we have just recently received Institutional Review Board (IRB) approval to conduct this portion of the study.

During the student evaluations, the application will be tested on at least three groups of students. Each time it is tested, the group of students will be completely different to ensure that previous experience with the application does not improve their use of it. It is important to receive feedback from the target user group to determine the usability of the application. Without this feedback, we can only guess that we are making improvements to the design.

Once the design of the user interface has been properly revised, the remainder of the application may be completed. For an educational application, not only is usability important, but the functionality of the application is important as well. Once the project is completed, the goal is that users of the target junior high school age population will be able to use the application with little instruction. Once they have manipulated the robot and created an animation, they will be able to generate a short (thirty-second) clip which will be rendered using the Persistence of Vision Raytracer (POVray) ray-tracing application. The conversion between this OpenGL application and POV-Ray is being done by another UND CS graduate student at this time. However, these components will be combined in the future to form an application which can be used to generate further interest in Computer Science.

Finally, this application is in itself only a small part of a larger program being developed at UND including a kids robotics programming summer camp and a proposal to the NSF's Broadening Participation in Computing (BPC) program. Like the NSF's BPC program, UND's goals are to increase the number of U.S. citizens and permanent residents receiving post secondary degrees in the computing disciplines.

# References

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