Capstone Proposal

Abstract

For my Capstone Project I propose developing game software designed to simulate the decision-making process of an emergency or ICU physician. This game will have implications in both the medical community and the educational community at large, as well as in the field of game development. It will serve as an example of how games can be used as a teaching tool and have value outside of the entertainment industry. The ultimate goal is to have such a game be a staple in a medical school curriculum.

I have been collaborating with two medical partners in the development of this game for the past year and propose to continue working on it for my senior Capstone. The game contains a database of patient types, each corresponding to a particular disease such as pneumonia, heart attack, or narcotic overdose. Each patient type is associated with a set of possible vital signs, physical exam signs, and a set of predetermined responses to player actions. These parameters are set for each patient based on current knowledge of the disease pathology.

The player is able to choose from a series of actions and investigations in response to the patient. The object of the game is to respond appropriately in a given timeframe to the vital signs and parameters. The proper actions that should be taken are determined by basic principles of pathophysiology, as well as current guidelines in resuscitation medicine.

In designing the game, particular attention has been paid to abstracting the graphical interface from the patient medical information so that I can quickly and easily update the patient database as needed. It is important that the focus is on accurate medical information rather than on realistic graphical rendering; the educational aspect of the game is emphasized so that, through gameplay, the basics of resuscitating critically ill patients can be learned. That being said, I have also put a great deal of time into enhancing game play so that the experience is engaging and encourages reusability.

Research Question and Significance

The question I intend to examine is whether computer/video games can be used to teach in an educational, engaging and easily accessible manner. The current usage of these games is mainly for entertainment purposes but there has been research in this field that suggests that the answer is yes. For instance, Jane McGonigal, the Director of Games Research and Development at Institute for the Future, does research on how games change the way we live our lives and how they can actually contribute to our “resilience and well-being”. She also creates games intended to address real world problems and help to solve those problems by teaching the necessary skills. While McGonigal’s games
address social problems, there are also games that aim to teach fundamental math and literary skills like spelling and arithmetic. Most of these games, however, are geared towards young kids and there are not many games outside the realm of entertainment for adults.

I want to explore the use of educational gaming in the medical field, where there is a need for simulated reality. Simulation games are an almost entirely new industry with a paucity of standard examples despite a great need for this type of product. Typically, simulations for medical purposes are taught in a simulation center with mannequins each attached to vital sign monitor and a computer operated by a simulation technician. The vital signs are manually manipulated by the simulation tech in response to how the student intervenes on the mannequin. Most, but not all, medical schools have a simulation program of some type. The advantage of such simulation is the sense of realism from dealing with three-dimensional, humanoid mannequins. The disadvantages, though, are significant; the two foremost being that simulation centers can only be used when a simulation tech is on duty and that the types of patients a student is able to practice on is limited to that which the simulation tech is able to input.

One recent advancement in solving the first issue is the collection of online computer simulations compiled by the American Heart Association. These simulations offer ten advanced cardiac life support scenarios. The player is able to choose interventions and drug therapeutics which with to respond to patients suffering cardiac arrest, stroke, and pulmonary failure. The AHA’s simulation engine can be used at any time by a subscriber. A subscription is bought by the individual and generally costs over $100 a year. These simulations only provide a limited number of patients. The interface is in three-dimensions and has a hyper-realistic quality to it with very complicated motions. As such, the code is incredible in depth and therefore not easily updated, especially considering the significant cost updates require. This means that the addition of new patients cannot be accomplished quickly whenever needed. The effort to display an ER room accurately has also forced players to sacrifice the ability to see what is happening clearly, which should be the goal of such a simulation in the first place.

Another attempt at a computer simulation is the mobile game CPR that has recently been released, which attempts to make a “game” of the task of running resuscitation. This simulation makes a few advancements, namely that it provides more than double the number of scenarios of the AHA simulation, that it costs much less than the AHA game, and is a mobile application. The application mirrors the AHA scenarios to a certain extent by offering a practical simulated environment that allows the player to follow the standard ACLS protocols, but it goes further to throw in practical issues that may arise while following these guidelines. However, these advantages provide no major evolution in medical simulation technology. As mentioned, the application is simply a somewhat updated version of the AHA computer-guided scenarios. Although it makes an attempt at creating a game environment, the gameplay itself is not more than a simulation; it requires the players to simply follow an exact list of actions that must be completed in time. Furthermore, if a player makes a mistake in following the order of the list, he gets no feedback until the simulation has run its course. This is both frustrating and unrealistic for the player, thereby taking away from the reusability of the application and again putting more emphasis on realistic graphics than realistic medical information.
My medical partners and I have studied these different simulation engines and have discovered that all are lacking in various ways. Most notably are the issues of dependence (on a simulation tech), updateability, extraneous information, and engagement. If a simulation can only be used when the simulation tech is available, it is limiting to a student who may want to practice on his own time. Secondly, it is important that a simulation be updated easily in respond to new knowledge discovered in the field. A significant factor to the difficulty of updating these simulations is the insistence on using three-dimensions and on realistic rendering. My partners and I concluded that these three-dimensional graphics are not necessary to impart the information and educate the user in an engaging manner. By abstracting the graphical component of the simulation, more time and effort can go into developing the patient information actually necessary to educate the user. Lastly, we have observed that the environment of a simulation results in less reusability as it is only used when a student is assigned or decides on their own to practice. Simulations are used on an as-needed basis, and lack an entertainment factor that draws one to use it of their own accord. This is what drew us to develop a game environment to provide this education support. The goal is to alleviate these issues and provide an educational environment that can be played at any time, updated at any time, has a more animated appearance that abstracts the graphics and focuses on the medical information is provides, and draws the player to engage in the environment on a regular basis.

Final Project Object

At the end of my Capstone Project I intend to have a player-ready, emergency room medical computer simulation game with approximately 60-70 patient types. With this game, I hope to show that educational gaming is a worthwhile endeavor applicable to a field, as prestigious and significant as medicine.

Project Design and Feasibility

The game offers on demand, probabilistically generated scenarios encompassing almost every type of life-threatening issue that can arise in the emergency room or hospital setting at one’s computer at any time, without a simulation technician or an instructor. It teaches the basic guidelines of how to stabilize such patients appropriately before they get definitive care, as well as how to generate the line of communication for the patient to get the type of definitive care that particular patient needs.

The game has been designed in such a way that modularizes the components of the game into the generation of patients and vitals, the graphical representation of the scenario, and the input options of the player. A probabilistic engine “throws” patients at the player in a distribution consistent with typical epidemiological patterns. Rather than having a set value for each parameter associated with each patient-type, these values are generated based on probabilistic distributions consistent with that of the patient-type’s underlying disease. As the player must respond to both the parameters generated as well as aspects of the underlying disease, the player may need to respond differently to two patients of the same type, consistent with real life.

The database of patient-types, the probabilistic methods that the game uses to choose a patient-type and the parameters of that particular instance of the patient-type, and the streamlined method for
creating new patient-types without affecting the other aspects of the game differentiates this simulation game from those simulations described above. During the term of this Project, the intent is to increase the number of patient types from 30 to approximately 60-70. The modularity of the game design allows adding in these new patients and to keep adding new patients as necessary.

The graphical look of the game was developed with significant thought as to what was essential to impart the necessary information. Initially the intention was to create a three-dimensional game, in the style of the simulations created before this one, but we quickly realized that the third dimensional was extraneous for our goals. The graphical displays created are evolved enough to clearly depict the clinical scenario but simple enough to be updated easily and quickly without interfering with the old code.

There are four types of graphics in the interface. The first is strictly informational graphics that display the information about the player and the patient. The patient’s vital information is not initially visible but can be turned on by the user. The informational graphics are simply drawn on the screen as they are.

The second type of graphics correlate to the actions the player can take in order to gain more information about the patient, for instance turning on the monitors to see the patient’s vitals. An informational-action is triggered by the user interacting with its corresponding graphical button, and the action itself has the ability to affect the graphics of the game only.

The player can also trigger intervening-actions in a similar way. Interacting with this third type of graphics will also affect the game’s interface, and in addition, has the ability to affect the patient’s state stored behind the scenes. An example of an intervening-action is putting an oxygen mask on the patient; this will update the graphics so that the mask is visibly on the patient and may cause the patient’s oxygen saturation to rise.

The last graphical category is the display of the patient. Each patient is represented by the same generic image that displays different physical symptoms based on the patient-type. Currently, this generic image depicts a male. One or two more generic images will be added to have gender-specific patient-types. The patient has a cartoon-like look to move farther aware from realistic rendering and separate the game from a simulation-feel in order to focus on the gameplay and educational aspects.

Much effort has been made to develop a simplistic, straight-forward way of presenting the information the game provides. Still, as the game is modified, additional effort will be made to rework the interface to optimize it for gameplay. I plan to consult with a few different professionals who have experience with representational graphics and game interfaces as part of my Capstone. I think it is important given the complexity of the game to ensure that the interface is as clear and streamlined as possible to help ease the learning curve of gameplay. Due to the separation of the different aspects of the game, I will be able to do so without interfering with the code that affects the other parts of the game.

The graphics are an important influence on the player’s actions during the game. The simplicity of the graphics allows for the visible display of physical symptoms of the patient. This gives the player the ability to enhance the crucial skill of using his eyes to access the patient. At least three-quarters of the
typical physical exam a doctor must perform on a patient can be accomplished in the game without clicking any buttons. Instead, the player must learn to use his eyes and past experience to determine how to respond appropriately to the patient.

Once the player has visually assessed the patient, he must determine what actions he wants to take. The set of actions a player can take is independent of the presented patient. This corresponds to real life scenarios in which one has the ability to respond to a patient using any of the medical tools available, though some may be helpful and others harmful. The player is presented with two types of actions to take: informational-actions and intervening-actions. As mentioned briefly above, informational-actions are used to provide the player with information that he was not presented with in the visual assessment and affect only the graphical interface.

Intervening-actions are those taken by the player to treat the patient once they have finished their assessment. These actions will affect the graphical interface and will also have an effect on the patient’s vitals stored behind the scenes. If the action affected the vitals displayed on the monitors and the corresponding monitor is on then these changes will be visible to the player on the monitors as well.

As more levels are added, the actions the player can take will become more complex and we will have the ability to add those in as needed. Again, because of the modularity of the different aspects of the game, this will be easily accomplished by first updating the graphics to include the new buttons corresponding to the new actions and then adding in the effects of the actions on the code.

The modularity of the code extends to the approach through which the game is designed. Each new addition to the game goes through a similar process and dialogue between my partners and myself. My partners first come up with the new pieces of medical information to add. Then we meet to discuss how we can translate the data into code and further, incorporate it into a successful gameplay. We then separate out the new pieces to code in into the different aspects of the game (patient information, graphical interface, and player actions) and I determine what I will need to code and where to insert it. Then I code in the different pieces, designing new graphics to add to the interface as necessary. Adding to the game in this modular way prevents the game creation from being an overwhelming task and allows changes to the big picture to be made as we work.

Lastly, this theme of modularity is extended to the gameplay in the various levels we’ve set up. The learning of correct patient response is separated into four different levels that each build upon the previous. This allows the player to have the ability to learn to play the game and to digest the medical information he is presented with simultaneously without feeling overwhelmed.

**Background and Overview of Goals within Context of Interdisciplinary Studies**

As mentioned above, I have been collaborating with two partners who both work in the medical field. This means that I am doing both the coding work and the design work on the project. My interdisciplinary background in computer science and architecture therefore is a vital asset to working on the game.
My education in computer science has taught me a lot about abstract thinking and creating algorithms for how to make applications work. When my partners and I first started conceptualizing the project, I had to bridge the gap between what we wanted to accomplish and what we could actually accomplish in code. As we continue to add features to the game, I continue in this role of translating the medical information to add into code.

Furthermore, as I mentioned previously, modularity is an important aspect of creating the game for the updateability that we consider an asset. My experience in working on coding assignments has taught me to keep my code clean and organized and to modular large chunks of code into smaller, more easily understood parts. As the complexity of the game, and therefore the code, grows, I am constantly working to re-modulate the code so that I do not let any one part of the code become indigestible.

My experience in architecture has helped enormously in terms of interface design and will become even more important as I rework the interface for optimal gameplay. The most useful lessons from architecture have not specifically been about buildings but rather regarding the design process and the art of representation.

The design process is useful for any creative endeavor, involving 1) identifying the problem at hand and the constraints it presents, 2) brainstorming possible solutions to the problem, 3) selecting a solution and trying it out by creating some sort of prototype, 4) evaluating the prototype, and 5) reevaluating the problem within the context of the chosen design and refining that design by repeating the process. I will employ this design process throughout my Capstone Project.

I am also proposing that while working on the game as my Capstone, that I reevaluate the design of the game’s graphical interface. This is where my education in (architectural) representation will be most useful. Although to the layman architecture is defined as the design on buildings, it is really about designing and representing spatial experiences. The buildings I design in architectural school are never actually built but I am still expected to conceptualize what it would be like to be in such spaces and to convey these experiences to my professors through some sort of visual representation. This representation can take the form of different types of models, such as site or conceptual models, drafts in plan, section, or elevation, photo-shopped images, or some form of rendering, including hand-drawn and from computer models. It is up to me as the student to decide upon the most efficient and concise way to express the concept I am trying to get across in his building design. Deciding on how to best represent a space that does not even exist is not an easy task; in fact, I would call it an art in itself (separate from the art of actually creating these representations).

Representation is highly significant to the design of the graphical interface of the game. I have been stressing the importance in our approach of abstracting the visual component from a realistic, three-dimensional display to a two-dimensional conceptual one. Brainstorming the best way to create this representation of the emergency room scenario parallels the art of architectural representation. In both cases, the goal is determining the optimal and most efficient way to get the concept across to the audience. In the case of working on the game the modes of representation are more limited but I think this will be advantageous because it will give me the opportunity to hone the approach.
I hope to collaborate with faculty in both architecture and game design to flesh out this new interface. In the design process, it is often useful to have outside feedback that suggests new approaches that have not been evident before. I think that this feedback will help not only with the graphical interface in isolation, but also the gameplay as a whole. The user experience of the game is heavily reliant on interaction with the interface so the more streamlined it is, the better the gameplay will be.

**Schedule** [email says month by month schedule??]

Here is my tentative schedule for what I hope to have accomplished by the end of each month:

**September:** Inclusion of all buttons necessary to make a demo video and the creation of that demo video

**October:** All code moved from Processing IDE to Eclipse IDE and re-modularized

**November:** New interface design determined and coding begun to work integrate it

**December:** New interface completed coded in

**January:** Level 1 completely coded in

**Spring Semester:** continue to add in levels and rework gameplay, begin testing with medical students, reach out to get backing from both the medical and gaming communities

**Feedback and Evaluation**

As I mentioned, I will be working with faculty in who have experience in both game design and representational arts. I hope to work with a game design professor on a weekly or ever-other-week basis so that we are working closely together on the best ways to both redesign the interface and to create engaging gameplay. While I am working on the interface, I also hope to collaborate with another person who has experience in representation to get yet another perspective on how to optimize the interface.

As the game is aimed towards the medical community, it is also important to obtain feedback and endorsement from colleagues of my partners’ in the medical field. To vindicate our software and its value, it is necessary to have this backing and to show that the game does work to educate medical students. Therefore, as I am working with professionals in my fields of study, my partners will simultaneously be collaborating with professionals in theirs.

**Dissemination of Knowledge**

We plan to present the game in a few different venues across various fields. Firstly, I will be presenting the game at Meeting of the Minds at CMU at the end of the year. Secondly, I will try to get backing from Jane McGonigal and/or others working in the field of educational gaming. We will also try to get backing from the medical community by posting about the games in medical journals and hopefully by licensing it to medical schools to be used in their simulation centers.