Making Games By Demonstration

Executive Summary

Richard G. McDaniel

The objective of this experiment is to understand how computer users would use a programming-by-demonstration (PBD) system to build interactive software like video games. Five non-programming CMU students who like games will be recruited to perform game building tasks using a paper prototype mock-up of a computer interface. The results will be used to improve the design of the system when it is later implemented. The experiment will last a maximum of 2 hours and the participants will be paid $10 for their time.

The goal is to find subjects who enjoy playing games and who might want to design games for the computer. Also, these people should be nonprogrammers as that is the target audience for the final system. People who do not meet these criteria will be rejected from the study.

The experimental procedure involves having the subject use a paper mock-up of the proposed computer interface to perform game building tasks. The experimenter plays the role of the computer and acts out the responses the computer would make. The subject's actions will be recorded on videotape. The subject will be asked to follow a "think-aloud" protocol, where his or her thoughts and intentions are spoken aloud. The tasks consist of constructing common game behaviors most of which should be familiar to the subject.

The videotape recording constitutes the entire data of the session. From this recording we will find the parts of the interface which were too difficult for the subject to use or understand. The kinds of information for which we will look include:

- Whether the subject completes the tasks.
- How much time the subject spent in certain portions of the tasks.
- Which tasks were easy or more difficult.
- Specific interface problems that made a task more difficult.

The goal of this study is to obtain qualitative insights into the problems users would have with the project's interface rather than achieve statistical results. The results will be used to improve the design of the interface. Therefore, we will likely change the tasks slightly and modify the prototype's interface as we discover and correct problems in the interface design.

Making Games By Demonstration

Richard G. McDaniel

1.0 Purpose

The purpose of this experiment is to understand how computer users would use a programming-by-demonstration (PBD) system to build interactive software like video games. The work is part of the author's Ph.D. thesis project called Gamut and is meant to help with the design of critical issues and techniques upon which Gamut will be based. In a PBD system, the computer user constructs software by *demonstrating* how the program behaves instead of writing out the behavior using a programming language. The techniques the user uses to communicate with a PBD system have heretofore been mostly conjectural. This experiment is designed to examine a number of possible PBD techniques and to see if they are understandable to users. The results from this study will be used directly in the design of the working system.

2.0 Environment

The basic experiment is composed of a paper-prototype [1] mock-up of the Gamut interface. A paper-prototype is a method for testing a user interface without actually writing the costly interface code with a computer. Interface components are constructed from paper and cardboard cutouts, and the experimenter manually arranges these cutouts as the computer would control its interface. Subjects will be asked to use the mock-up as though it were an actual computer interface (within reason) in order to accomplish a short set of tasks.

A video camera will be pointed at the interface mock-up to record the subject's actions as he or she manipulates the interface. The video will record only the hand movements and not the subject's face or expressions. The subjects will be asked to use a "think-aloud" protocol [3] where subjects state verbally any thoughts and intentions as they use the interface. These comments will also be recorded using the video camera.

The experiment will be conducted one-on-one with the experimenter and one subject at a time. In order to facilitate the think-aloud recording, sessions will be held in a quiet room. The room will have a large table to accommodate the paper prototype as well as other writings the subject may wish to make.

3.0 Materials

The major component for this experiment is the paper prototype mock-up. Pictures of all the various pieces of the mock-up are in Appendix G. Other materials include a video camera, extra paper, felt-tip markers, and pennies (part of the mock-up). A clock will be available in the room to keep track of time.

4.0 Participants

There will be about five participants. We are specifically recruiting subjects who enjoy making and playing games. Both computer game and board game players would be acceptable. Subjects should be familiar with game playing terminology and have at least some desire to make a game on their own. The subjects should also be computer users but not programmers. Specifically, the subjects may not program as part of their work or as a significant hobby. Though, it is expected that the subject know how to use a computer to perform basic commands and operations. Subjects will be asked whether they like games and whether they would like to construct some. They will also be asked about their computer experience and whether they can program. People who do not like games or creating games or are expert computer programmers will be rejected from the study.

Participants will be chosen among students at Carnegie Mellon University. A notice will be posted to attract subjects and the experimenter will try to recruit some subjects through word of mouth. Subjects will not be selected randomly. Participants will be paid $10 for their time which should not exceed 1.5 hours.

5.0 Procedure

My procedure is based on the techniques developed by Gommol [3] for conducting a user interface study. Subjects will first be asked to fill out the consent and survey forms (Appendix A and Appendix B). During that time the experimenter will discuss the reason and content of these forms and answer any questions the subject may have. After the subject finishes the forms, the experimenter will explain the experiment and what the subject will be expected to do (Appendix C).

There will be three possible tasks which a subject may be expected to work. A task consists of a written description of the work (Appendix D) and the mock-up interface components used for performing the work (Appendix G). To perform a task, the subject first reads aloud the task description and then proceeds.

The first task will be demonstrated by the experimenter in total to show how the subjects are supposed to carry out their tasks. The subject will then be asked to work through the remaining two tasks. The subject will not have prior knowledge about the other two tasks while the first is performed by the experimenter. The experimenter will be allowed to give the subject assistance during the second task if the subject is seen to be having difficulty understanding, but the subject is to be given no help on the third task. The order of the tasks will be different for each subject though not necessarily random. Subjects will not be required to complete either task. If the subject chooses to quit during the second task, the experimenter may choose to forego the third altogether.

When the tasks are completed or the subject chooses to quit, the subject will be asked to fill out a questionnaire (Appendix E) to gauge his or her experiences. The questionnaire is partly based on [2] and is meant to find out which aspects of the interface most suited the task, which aspects were difficult or poorly designed, and any general comments the subject may have. In addition, the subject will be given an information sheet explaining the goals of the experiment (Appendix F).

To make sure this test plan is reasonable and appropriate, I will run one or two voluntary pilot participants. This will be used to practice the dialog the experimenter will use and to make needed changes if the tasks take too long or are otherwise unwieldy.

6.0 Tasks

The tasks are designed to be games that a user may want to build using the actual programming tool. The games are simplified versions of real computer games with which most people will be familiar. Task 1 is based on a typical board game. It consists of making a pawn piece move around the board when dice are rolled. Task 2 is based on PacMan which is a simple maze game. Monster characters chase the player's piece around the maze. Task 3 is a space game where the player's ship attempts to shoot a moving flying saucer.

Each task is divided into sub-tasks that are used to demonstrate each behavior in the game. Sub-tasks will consist of specifying how objects in the game move, showing conditional behavior, and showing a behavior that requires a creative application of Gamut's techniques.

Subjects will be asked to specify the behaviors using the interface techniques the experimenter has demonstrated, but, if desired, will be allowed to design a new technique if it would help specify the behavior more easily. If the subject chooses to create a technique, the experimenter will decide if the technique is reasonable and could possibly be implemented on a computer. If the experimenter decides that the new technique is not feasible, the subject will be asked not to use it and try to use something else.

7.0 Evaluation

This study is informal and qualitative. We mean to investigate how users would react to the techniques of our programming system before we invest time in building the actual system. All data will be recorded in the videotape of the session. From this video, we will analyze how the subjects perform the tasks and then reason about how to make the techniques better for the next subject. The areas for potential problems that we will look for in the video include:

- Whether the subject can perform a sub-task.
- Whether the subject understands the interface's modes.
- Whether the subject can compose the interface's techniques into a behavior.
- The places where the subject spends the most time.

The videotape analysis will consist of mostly watching the tape and noting points when the user performs a significant action. These significant actions are points where the subject does something unexpected or subject's goals change. These data will be marked on paper while the videotape is viewed and the subject's identity will not be noted on the paper besides the subject number. These notes will be destroyed when the experiment is complete.

Since the study is informal, we will likely change the tasks between subjects in order to emphasize different aspects of the design. Furthermore, we will want to modify the interface as we discover and correct problems. If the subject wants, they will be allowed to design new interface components. When this happens we will analyze this new technique, and if we think it can be implemented, will include it in the design.

8.0 References

[1] M. Rettig. Prototyping for tiny fingers. *Communications of the ACM* 37, 4 (April 1994). pp. 21-27.

[2] Susannah J. Ravden and Graham I. Johnson. *Evaluating Usability of Human-Computer Interfaces: A Practical Method*. Ellis Horwood Limited, Chichester, West Sussex, England, 1989.

[3] Kathleen Gomoll. Some Techniques for Observing Users. In B. Laurel (Ed.), *The Art of Human-Computer Interface Design*. Addison-Wesley, Reading, MA, 1990. pp. 85-90.

Appendix A: Consent Form

Carnegie Mellon University
Consent Form

Project Title: Gamut
Conducted By: Richard G. McDaniel, Computer Science Department

I agree to participate in the observational research conducted by students or staff under the supervision of Dr. Brad Myers. I understand that the proposed research has been reviewed by the University's Institutional Review Board and that to the best of their ability they have determined that the observations involve no invasion of my rights and privacy, nor do they incorporate any procedure or requirements which may be found morally or ethically objectionable. I understand that my participation is voluntary and that if at any time I wish to terminate my participation in this study, I have the right to do so without penalty. I understand that I will be paid $10 for my participation when I have completed the experiment.

If you have any questions about this study, you should feel free to ask them now or anytime throughout the study by contacting:

Dr. Brad Myers
HCI Institute, School of Computer Science
412-268-5150
bam@cs.cmu.edu

You may report any objections to the study, either orally or in writing to:

Susan Burkett
Associate Provost
Carnegie Mellon University
412-268-8746

Purpose of the Study: I understand that I will be using a prototype interface of a game building tool. I know that the researchers are studying how people would use such a tool to build software. I realize that in the experiment, I will be asked to implement games using this interface for 1-2 hours. I am aware that I will be videotaped during the experiment so that the researchers can examine how I performed the tasks.

I understand that the following procedure will be used to maintain my anonymity in analysis and publication/presentation of any results. Each participant will be assigned a number, names will not be recorded. The researchers will save the data and videotape files by participant number, not by name. Only members of the research group will view the tapes in detail. No other researchers will have access to theses tapes.

I understand that in signing this consent form, I give Dr. Brad Myers, and his associates permission to present this work in written/oral form, without further permission from me.

______________________________	______________________________
Name	Signature
______________________________	______________________________
Telephone	Date

Optional Permission: I understand that the researchers may want to use a short portion of the videotape session for illustrative reasons in presentations of this work. I give my permission to do so provided that my name, face, and voice will not appear.

_________ YES   __________ NO   (Please initial here ___________)

Appendix B: Survey

Subject No.: ________ Age: ________ Sex: ________ Male ________ Female

Do you own a computer? ________ YES ________ NO

What do you use computers for?:

Do you use a computer in your work? ________ YES ________ NO

Can you program a computer? ________ YES ________ NO

Do you program computers regularly (as a profession or as a significant hobby)?
________ YES ________ NO

Do you use a computer to play games? ________ YES ________ NO

If so, what games do you like to play?

Do you play non-computer games like board games or puzzles? ________ YES ________ NO

If so, what non-computer games do you like to play?

If it were easy enough to do, would you write your own computer games?
________ YES ________ NO

If so, would you want to (check as many as you like):

________ Design original games.

________ Port non-computer games to the computer.

________ Other. Please specify:

Appendix C: Opening Statements, Directions

(The basic instructions below are based on instructions written by Kathleen Gomoll [3].)

Description of the observation:

- You are helping me by trying out a mock-up of a game building tool.
- I am testing the interface; I am not testing you.
- I am looking for places where the tool may be difficult to use.
- If you have trouble with some of the tasks, it is the tool's fault, not yours. Do not feel bad; that is exactly what I am looking for.
- If I can locate trouble spots, then I can build a better system for people to use.
- This is totally voluntary. Although I do not know of any reason for this to happen, if you become uncomfortable or find this objectionable in any way, feel free to quit at any time.

Demonstration of paper prototype:

- This is a mock-up of an actual computer interface.
- I will act as the computer and change the mock-up as if the computer were responding to your actions.
- You can manipulate the interface by pretending your finger is the mouse pointer.
- Please tell me when you're using your finger to click on a button or select a screen item. It is sometimes difficult to tell when I'm just watching.
- If you want to draw something or have the interface record a value, write it down on the paper with this marker.
- I have found that I get a great deal of information from these informal observations if I ask people to think-aloud as they work through the exercises.
- It may be a bit awkward at first, but it's really very easy once you get used to it.
- If you forget to think aloud, I'll remind you to keep talking.

Appendix D: Description of Tasks

Note: Tasks will be listed on separate sheets of paper with a larger font for the actual experiment.

Task 1: Pawn Race

- Make it so that when the dice are rolled, a pawn moves the dice's number of squares.
- Add another pawn and make the dice rolling work for two players.
- When one player's pawn lands on the other, the other player should be moved back to START.
- Make the game end when the first pawn makes a complete circuit of the board.

Task 2: Pacman

- Make the monster move through the maze.
- Make the monster chase the Pacman.
- When the monster touches the Pacman, make the player lose a life.
- When the player loses three lives, make the game end.

Task 3: Space Shooter

- Make the UFO move about randomly.
- Make the fire button cause the spaceship to shoot a bullet.
- When the bullet hits the UFO, make the UFO disappear, then reappear somewhere else.
- Have the player win when three UFO's are shot.

Appendix E: Questionnaire

Subject No.: ________

Which task did you find the easiest to do? What made the task easy?

Which task did you find the most difficult? Why was it difficult?

Did you experience problems with any of the following:
1. Understanding how to carry out the tasks (check one):

________ no problems ________ minor problems ________ major problems

Please explain:

2. Knowing what to do next (check one):

________ no problems ________ minor problems ________ major problems

Please explain:

What are the best aspects of Gamut for the user?

What are the worst aspects of Gamut for the user?

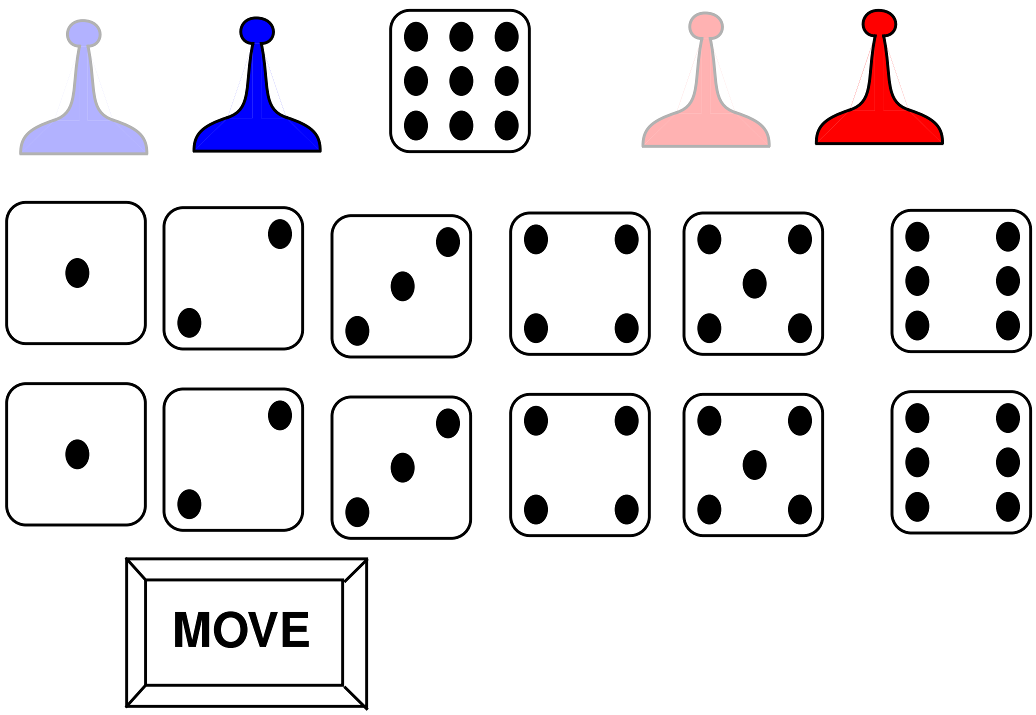
What changes should I make to improve Gamut so people can use it better?

Appendix F: Post-Experiment Information

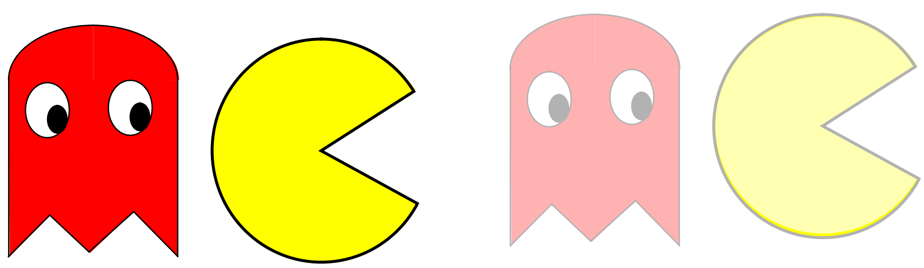
Thank you for participating in our experiment. The purpose of the experiment was to see whether nonprogrammers could use Gamut's new programming techniques to build games. We wanted to see which parts of the interface are confusing and difficult to use. We want to see how a person wanting to make a game uses and understands Gamut's techniques and see if they can be composed to build useful behavior. Gamut has not been implemented, yet, and your help will be used to make Gamut's interface better.

Appendix G: Components of Prototype Interface

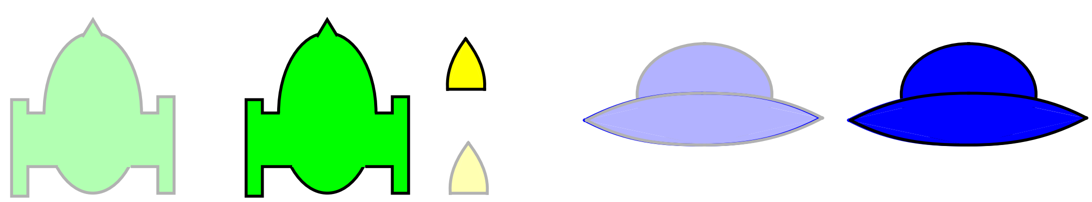
Task 1 Pieces



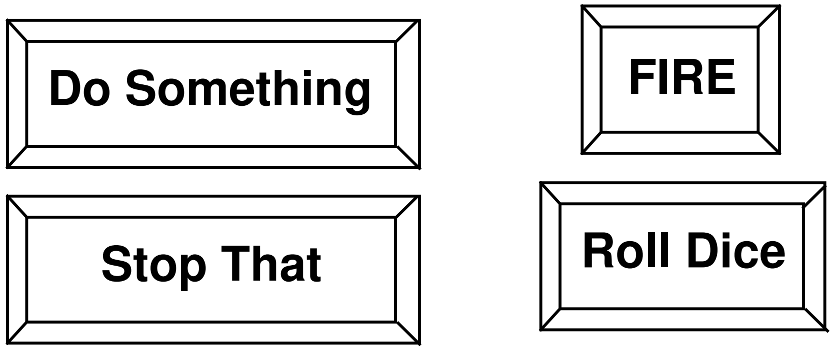
Task 2 Pieces

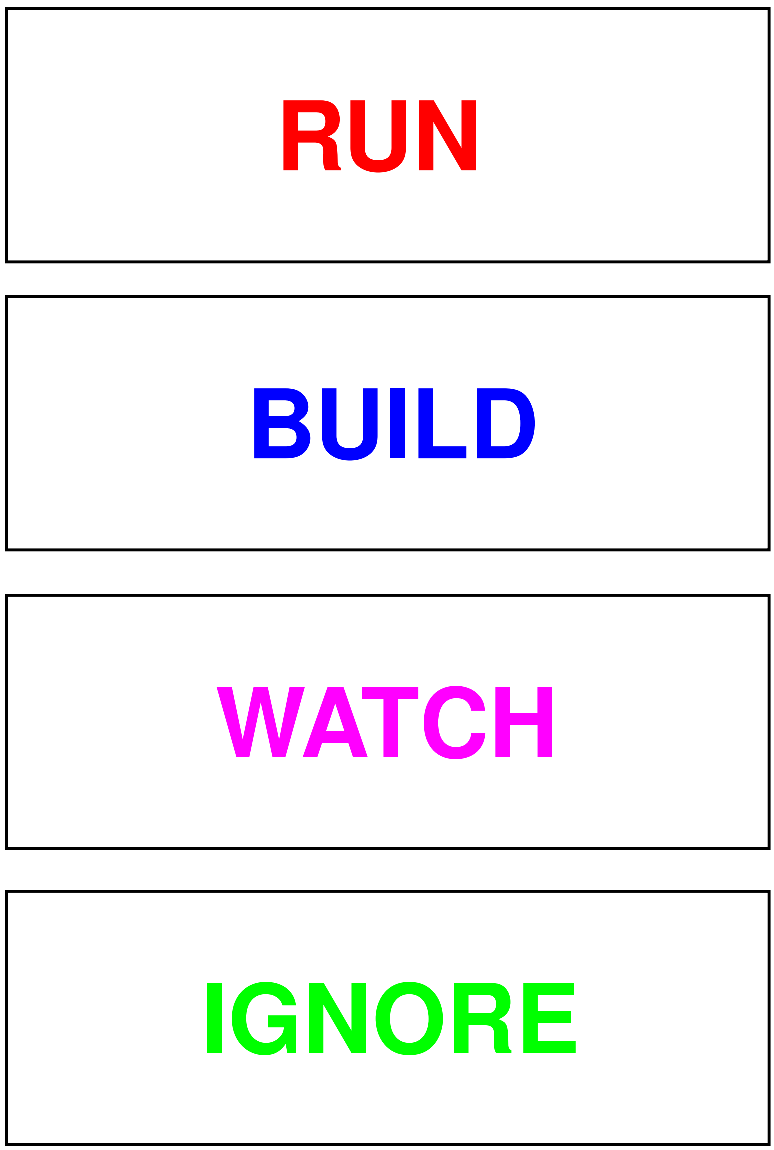


Task 3 Pieces

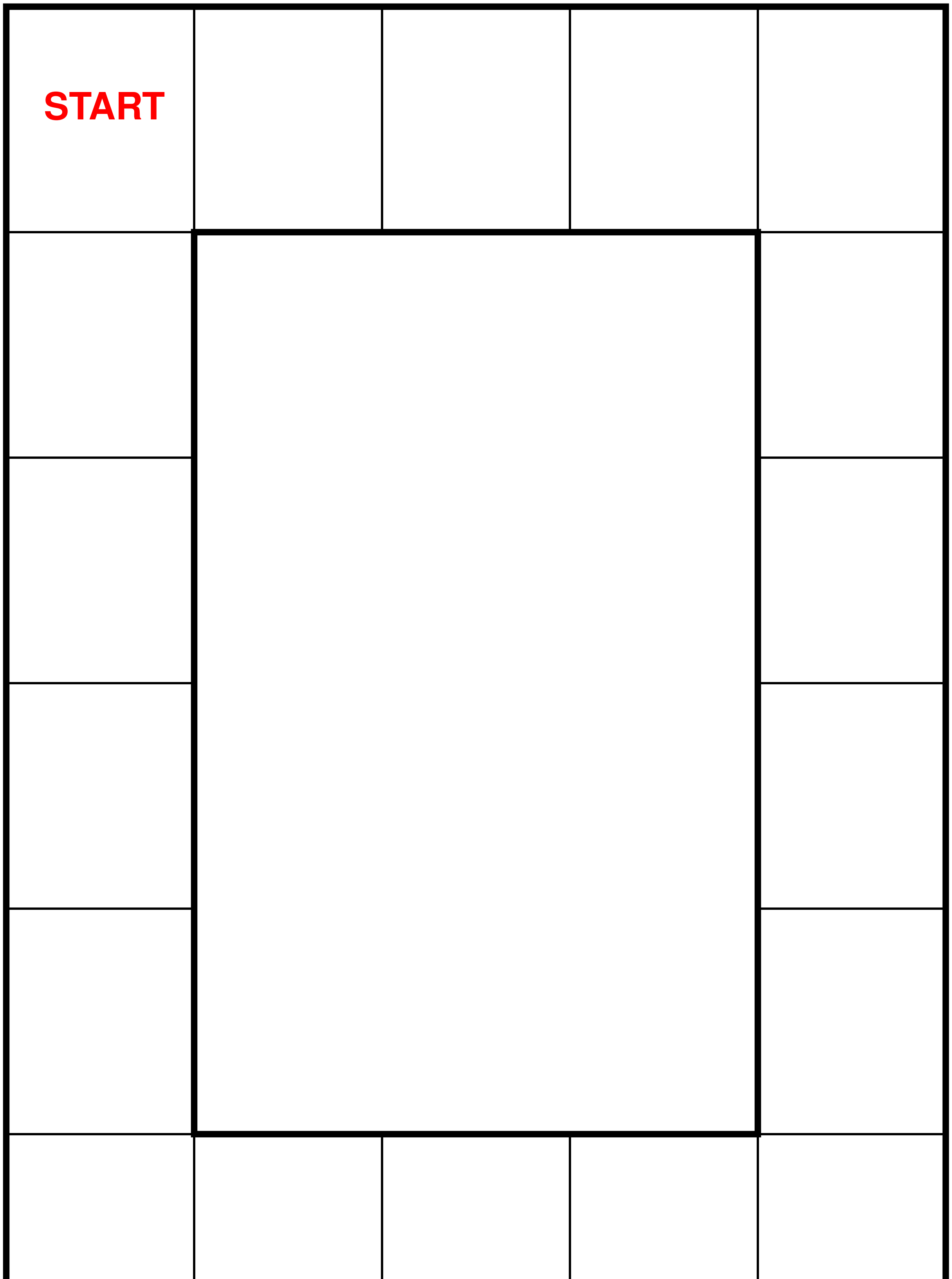


Buttons and Modes

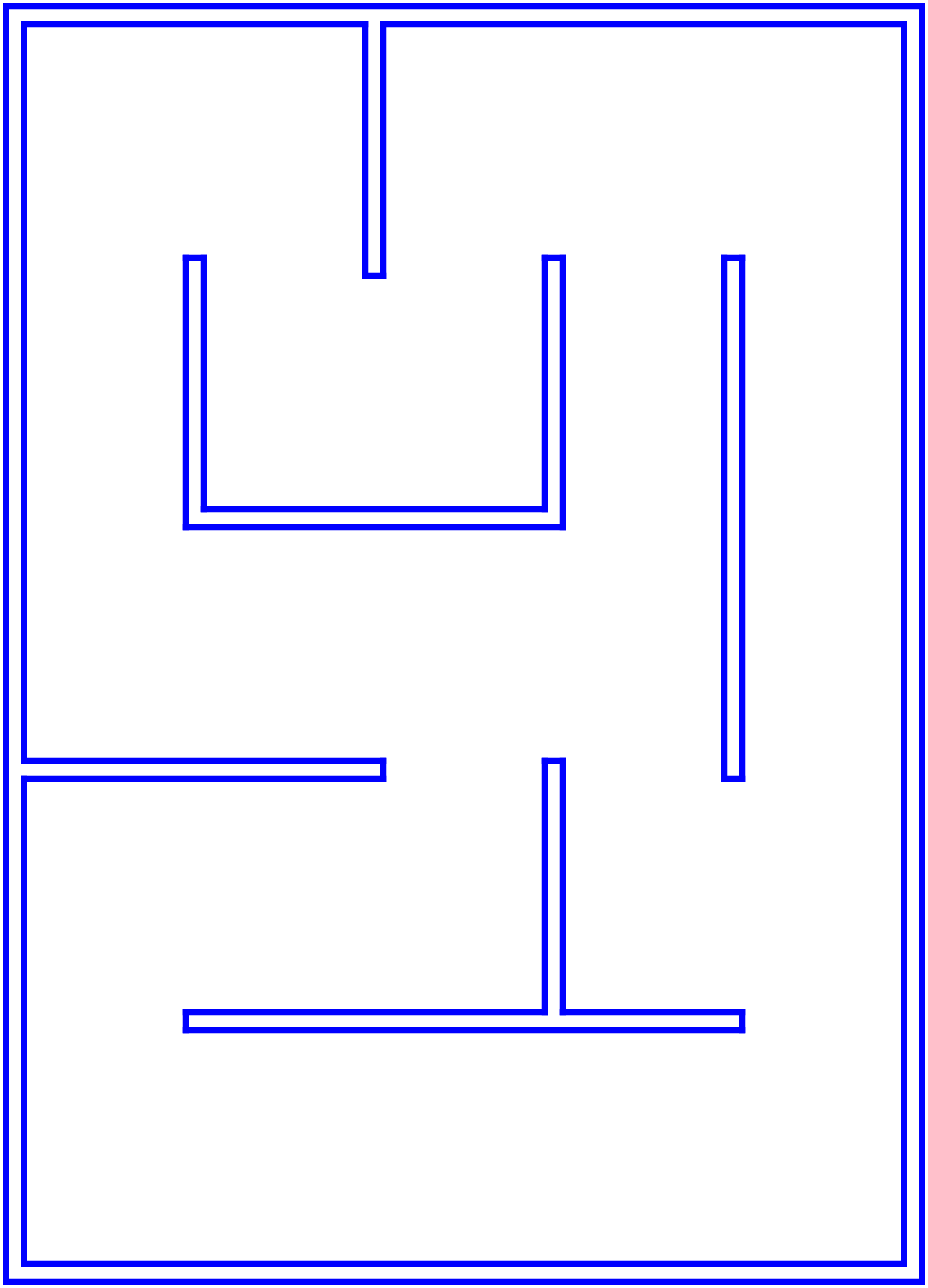




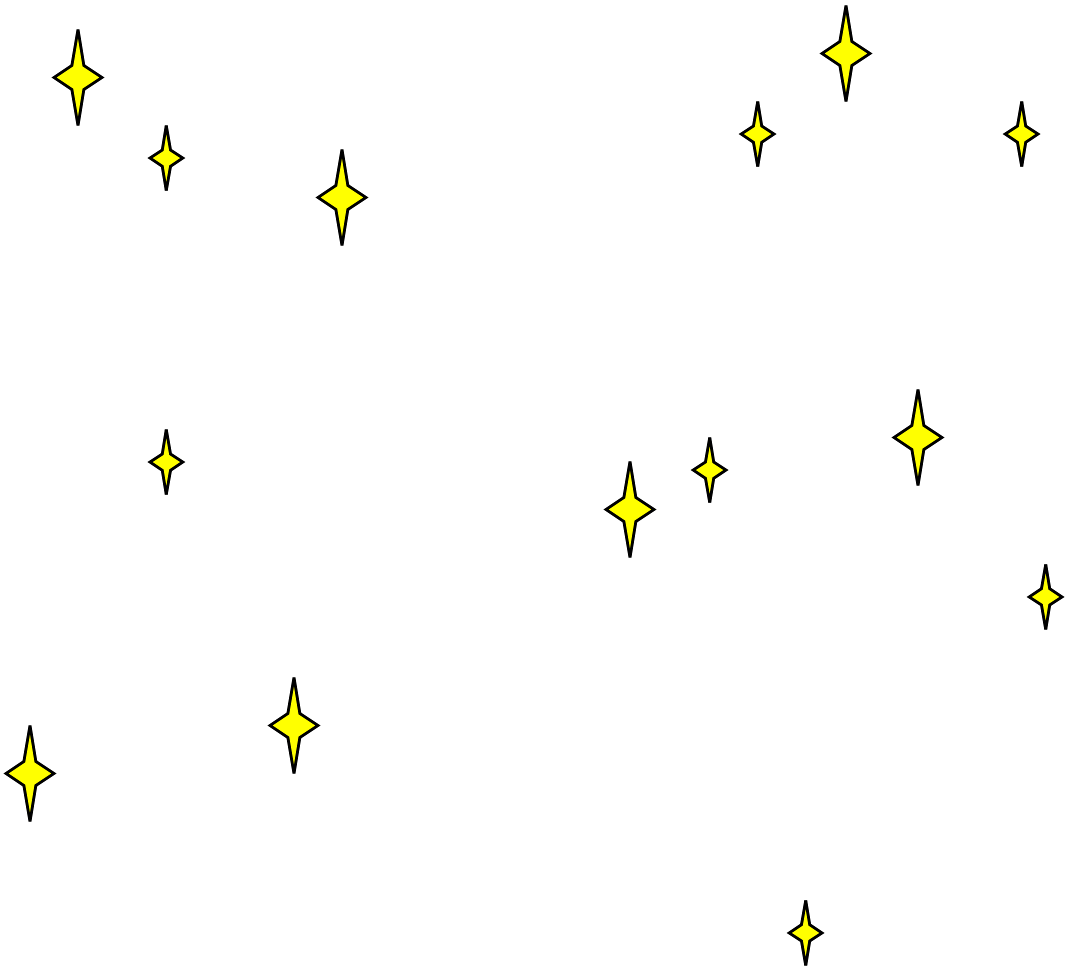
Task 1 Background



Task 2 Background



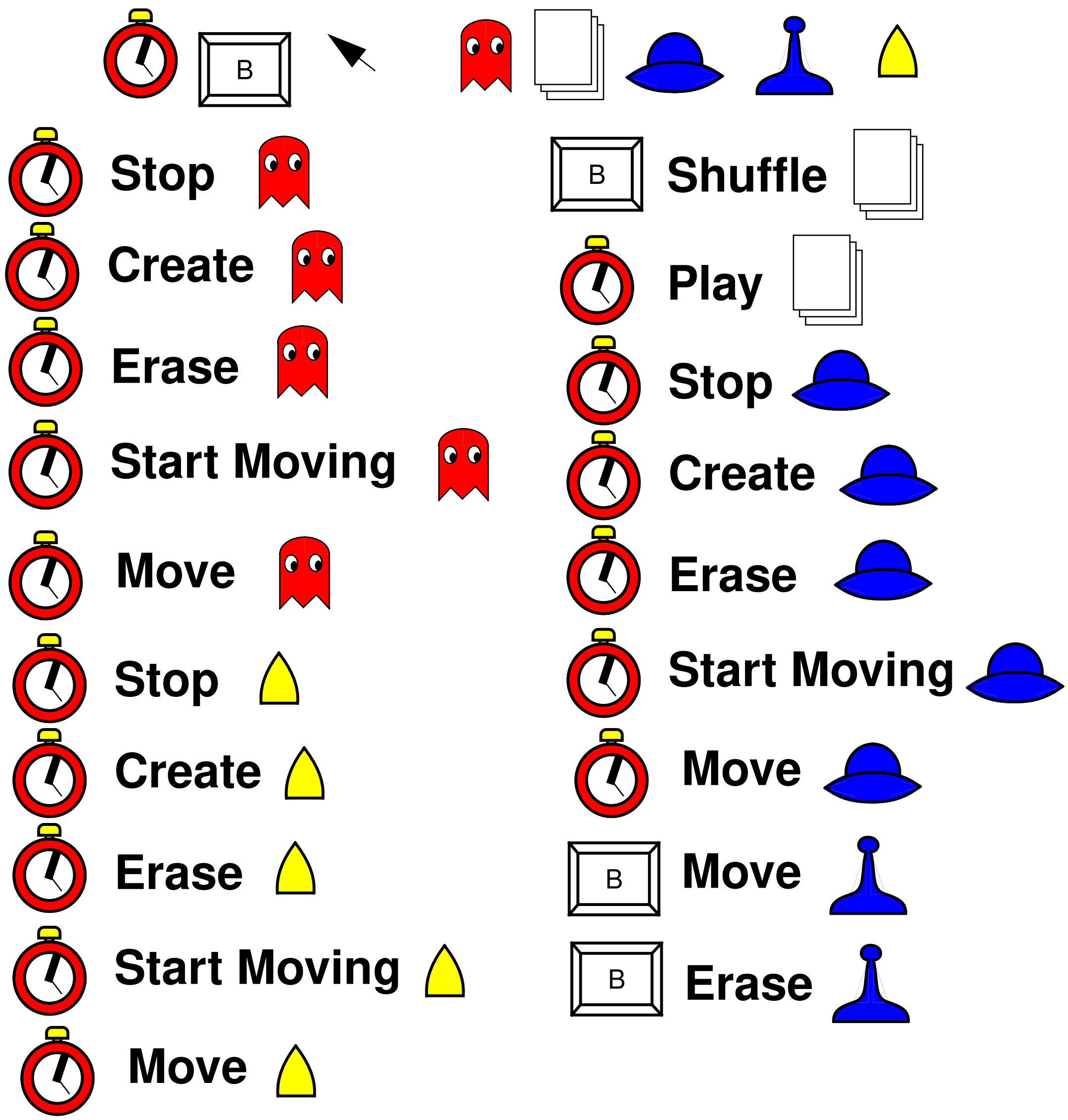
Task 3 Background

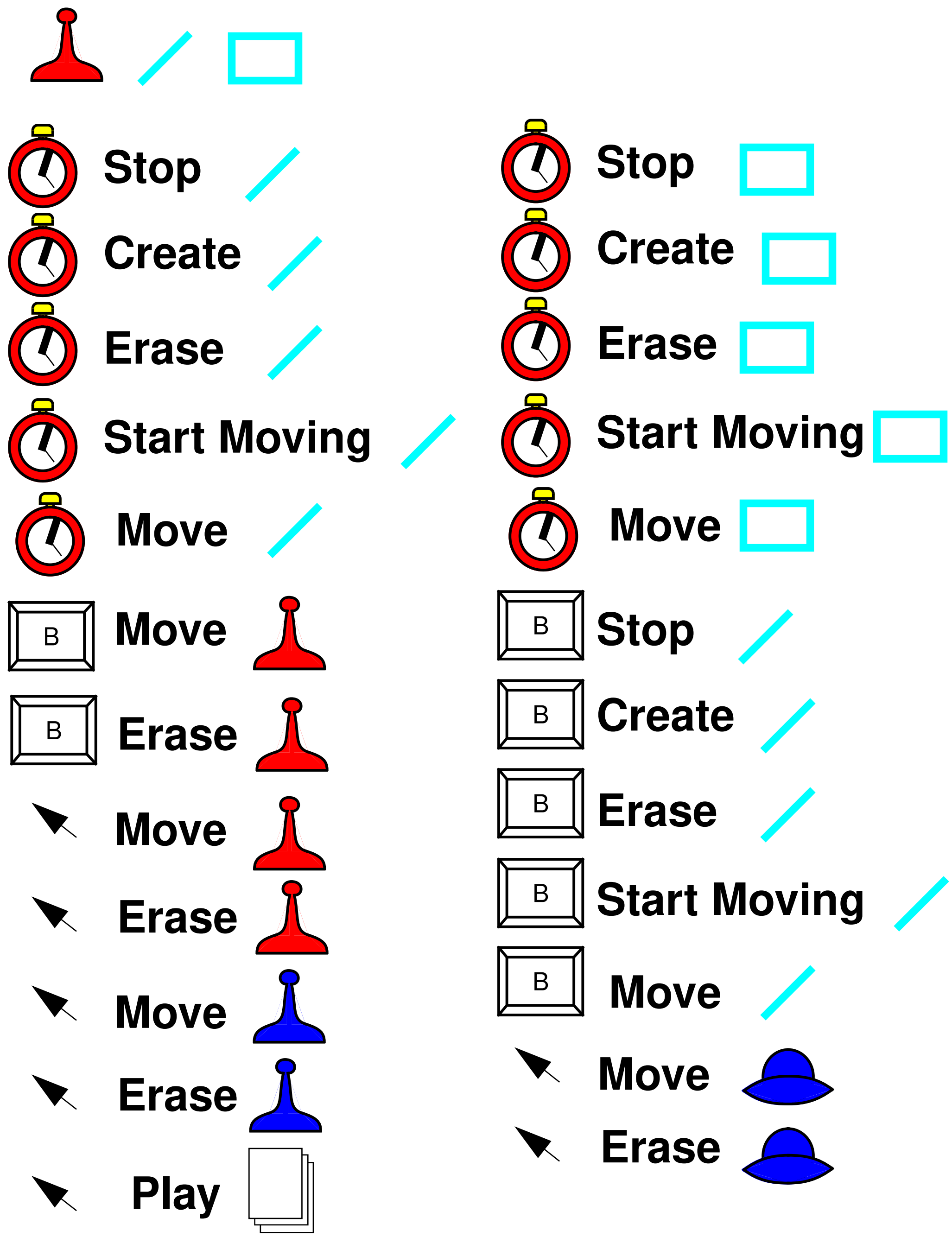


Time Line Dialog

Time Line

Time Line Contents




Stop
Create
Erase
Start Moving
Move
B
Move
B
Erase
Move
Erase
Move
Erase
Play
Stop
Create
Erase
Start Moving
Move
B
Stop
B
Create
B
Erase
B
Start Moving
B
Move
Move
Erase

Error Dialogs

What path is following?

Please highlight or draw the intended path.

Done Forget It

How does choose which branch to follow?

Please highlight or demonstrate how to choose a path branch.

Done Forget It

I do not understand where to put .

Please highlight or draw the intended position.

Done Forget It

I do not understand when to create .

Please highlight the thing that causes this to happen.

Done Forget It

I do not understand when to erase .

Please highlight the thing that causes this to happen.

Done Forget It

I do not understand when to move .

Please highlight the thing that causes this to happen.

Done Forget It

As far as I can tell, is identical to the way it was before. Please highlight the thing that makes this object different from before.

Done Forget It

I cannot tell what makes different from .

Please highlight the thing that sets this object apart.

Done Forget It

This behavior has changed from doing to doing this but I do not know why.

Please highlight the thing that makes this behavior act differently from before.

Done Forget It

Do Something

Select the object(s) that you want me to effect

or change the object(s) yourself and press “Done.”

Done **Forget It**

Do Something

I do not know what to do with .

Please modify it so that I can see what to do.

Done **Forget It**

Do Something

I have guessed how you want [ ] to change. You may keep my change or change [ ] yourself and press "Done."

Done | Forget It

Stop That

I have stopped [ ] . If you would like this object to do something else either press "Guess" to have me guess what to do or modify it yourself and press "Done." Otherwise, press "Done" to keep the object stopped.

Done | Guess | Forget It

I do not know why ☐ is special. Please highlight what makes it different from before or the item that selects it.

Done | Forget It

Stop That

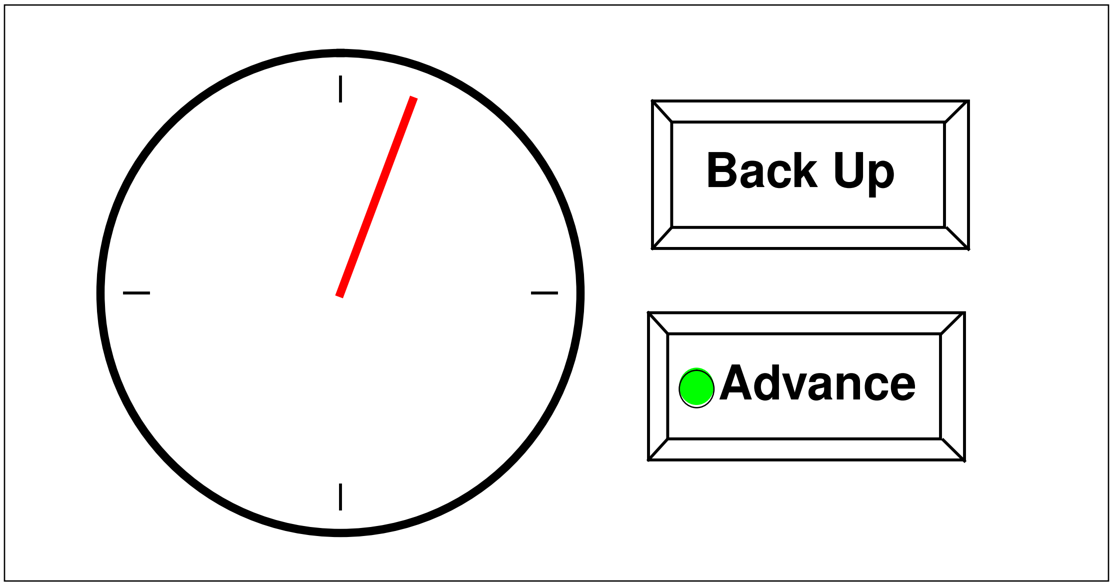
Please select the object(s) you wish to have stopped then press “Done.”

Done | Forget It

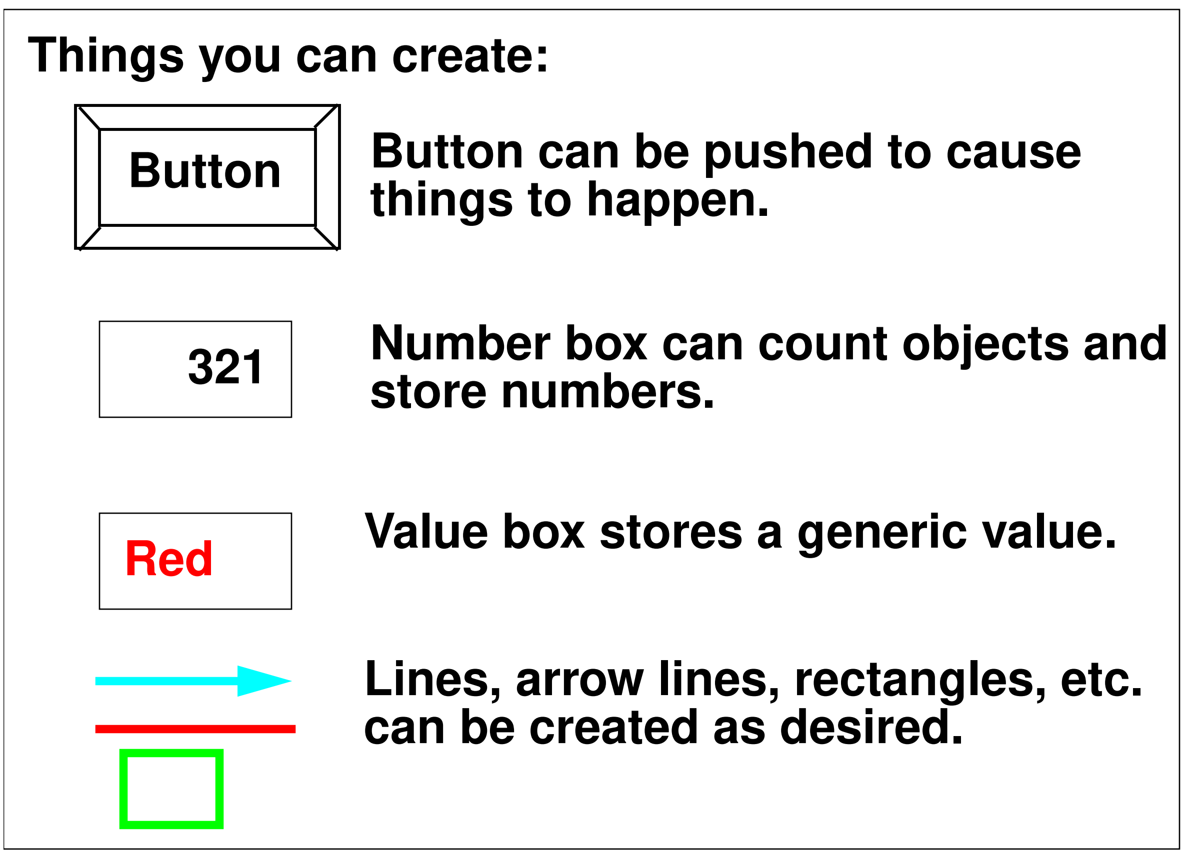
I do not understand when to stop ☐ . Please highlight the thing that causes this to happen.

Done | Forget It

Clock



Palette



Property Sheets

Properties of	
Position Color Custom:	

Things That You Can Highlight:

- **Objects**
- **Properties of Objects**
- **Actions in the Timeline**

Hints:

- **You can create new objects as needed.**
- **You can use properties to store object information (like numbers).**
- **Properties can also be stored in objects in the background. Write down the property and draw a box around it.)**
- **Lines make good paths for objects to follow.**

How Subjects Will Be Used

Our method of evaluation will be to run five subjects through a set of game creation tasks. The Gamut designer will be the experimenter for the test.

The session will begin with a general introduction, the experimenter will read aloud basic instructions (see Appendix C) and the subject will fill out forms including the consent form and a short survey (see Appendix A and B). Any participant who does not meet the criteria outlined in Section 4.0 will be rejected from the experiment.

The subject will then be given directions for completing the tasks by the experimenter demonstrating a completed task in total. After the demonstration is through, the subject will be asked to complete two tasks on his or her own. The tasks consist of creating a working game using the techniques provided in the Gamut software tool. The actual tasks will be performed using a paper and cardboard mock-up of the computer interface which the experimenter will manipulate to perform the role of the computer.

After the subject performs the remaining tasks, he or she will be asked to fill out a short questionnaire (see Appendix E). The questionnaire gauges whether or not the subject liked the interface design and to draw out useful criticisms. Finally, the participant is to be given an information sheet that explains the goals of the study (see Appendix F).

Data collection will consist of videotaping the session. Subjects will be asked to follow a "think-aloud" protocol [3] where the subject is told to verbalize all thoughts and decisions that he or she makes during the course of using the interface. Post session analysis will consist of watching the tape and identifying times when the subject has trouble using the interface. Kinds of mistakes will be categorized and tabulated to determine the most likely causes for the problems.

Since, this is an informal study, we will not be able to draw strict conclusions from the results. The purpose is to suggest a course of action for the design of the Gamut system, not to verify any quantifiable feature of the system. Because this is informal, we intend to modify the tasks slightly between subjects to accentuate different parts of the design as problems are discovered.

We will enforce a time limit on the experiment of 2 hours. The session is targeted to last 1.5 hours.

In order to verify that this test plan is appropriate, we will run two pilot participants and make changes that seem appropriate. The data in those runs will not be counted in the results and will likely not even be videotaped.

Carnegie Mellon University
Consent Form

Project Title: Gamut
Conducted By: Richard McDaniel, Computer Science Department

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I understand that the following procedure will be used to maintain my anonymity in analysis and publication/presentation of any results. Each participant will be assigned a number, names will not be recorded. The researchers will save the data and videotape files by participant number, not by name. Only members of the research group will view the tapes in detail. No other researchers will have access to theses tapes.

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Name	Signature
______________________________	______________________________
Telephone	Date

Optional Permission: I understand that the researchers may want to use a short portion of the videotape session for illustrative reasons in presentations of this work. I give my permission to do so provided that my name, face, and voice will not appear.

_________ YES __________ NO (Please initial here ___________)

How Confidentiality of Subjects Will Be Protected

The following procedure will be used to maintain the anonymity of subjects in analysis and publication/presentation of any results:

- Each participant will be assigned a number, names will not be recorded.
- The researchers will save the data and videotape files by participant number, not by name.
- The videotape will record only hand movements and sound. The subject's face will not be visible.
- Only members of the research group will view the tapes in detail.
- No other researchers will have access to these tapes.
- Presentations will use only short portions of the videotape footage if the subject gives permission.
- Sound recording of the subjects will not be played during any presentations.

Risk/Benefit Analysis

We anticipate no risks to the subjects who participate in this experiment. The subject will benefit from the experiment in two ways. First, they will be helping design a system that, when completed, will allow them to build game software without the need for advanced programming skills. The subjects will have demonstrated a desire to actually build game software in order to participate in the experiment suggesting that they would probably like to use this kind of tool. Second, the subjects will be helping to move Human-Computer Interaction (HCI) research forward if we can find results that help design this type of programming tool. These results would likely propagate to other software the subject will use. In addition, this will benefit all society by helping to make software easier to use.