

# One-handed interface for multitouch-enabled real-time strategy games

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## ABSTRACT

Historically, real-time strategy video games, such as *Starcraft* (Blizzard Entertainment, 1999) and *Command and Conquer* (Westwood Studios, 1995), were intended to be played on desktop or laptop computers, with interfaces that afford the user dozens of keys and key combinations, mouse gestures including clicking and dragging, and several mouse buttons to further complicate the interface while allowing customization and a wide range of possibilities for the user. On a mobile multi-touch platform, there are constraints of limited visual real estate, shared with the touch command interface. Further constraints are presented when considering accessibility for players desiring one-handed operation. Game accessibility is a topic with a growing need, as those with disabilities are often unable to use commercially-available games due to user interface restrictions. To date, there has not been a significant commercial effort to enhance the usability of strategy games' touch interfaces by removing redundancies and tailoring the game commands to these multi-touch devices – especially for use with only one hand. In this paper, we present a rapidly-prototyped user-centered design in a ten-week project of a real-time strategy user interface native on the iPad. The contributions of this project are the ability of the user to use one hand to interact with the system, a multi-touch interface design, and the ability to cancel orders. We confirm the effectiveness of the user interface using one hand with a pilot study. Although we hoped to create a universally accessible user interface for a real-time strategy game for the iPad, we found that it is impossible to separate the user interface from a polished game with real features.

## Categories and Subject Descriptors

H.5.2 [Information interfaces and presentation]: [User interfaces]; K.8.0 [General]: [Games]

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## General Terms

Games

## Keywords

accessibility, games, interaction, touch-screen, HCI

## 1. INTRODUCTION

The idea of a one-handed input device is not new. The one-handed keyboard has been around for over two decades [4, 5]. However, little research has been done in recent years leveraging the newly-available popular mobile computer—by which we mean the iPad—for use with one hand. We take inspiration from games like *Game Over!*, designed to be the world's most inaccessible game with a new challenge each level [2].

User studies on mobile computers suggest that larger devices are inappropriate for use with a single hand because of the amount of touchable area outside of the reach of the thumb [3]. Our research contradicts this finding, showing instead ten users that were able to interact with our user interface with just one hand.

Real-time strategy games afford the player many complicated instructions for adding or modifying domain objects; as such, the user interface for real-time strategy games is a nontrivial problem [6]. This problem is compounded when screen real estate is small and the input device is limited to the fingers of one hand rather than a full keyboard and mouse.

On many mobile platforms, multiple compelling games and applications have sprung to life, but the user interface design still has not taken full advantage of the touch surface. In this project, the real-time strategy (RTS) game menu interface has been redesigned to use several intuitive gestures so it will run natively on the Apple iPad. We theorize that the multi-touch surface of the iPad will allow users to play RTS games more quickly and more accurately because gestures use more area and require less targeting precision than traditional buttons.

Current iPad RTS user interfaces are direct translations from their desktop counterparts, and do not take into account the unique requirements of the multi-touch user environment. Existing interfaces present the user with small buttons, or exhibit major design flaws such as the inability to cancel a selected function. This project's design draws on the experience of users who use play RTS games on iPad, and incorporates these users' comments into the design and

implementation of the interface. The goal of this project is to implement a new and innovative touch-based interface to give the users a new way to experience RTS game play.

## 2. DESIGN DECISIONS

The iOS human interface usability guidelines [1] proposed by Apple were our starting points in designing the system. In particular, our goal was to embrace the platform by making full use of the touch-screen interface, a detail ignored (in favor of ease of portability) by currently-available real-time strategy games.

The major contributions of this work to the field of mobile real-time strategy gaming include the following items.

*Pop-up bubble menu.* In our domain research, we found that real-time strategy games for the iPad simply port functionality from RTS games intended for a desktop PC with mouse and full keyboard affordances, thereby reusing interface paradigms incongruent with a larger, portable touch-screen device. Porting the user interface led to several design-level inefficiencies that hampered the usability of the games. For example, in *Command and Conquer* for iPad, a menu hides much of the screen real estate and essentially blocks access to that part of the screen. To address the issue of screen real-estate, we designed a pop-up menu that could be universally accessed in-game and which adapts available functions to specific units.

*One-handed optimization.* In our design, we were careful to accommodate players with disabilities, as well as those who prefer to use the device with one hand. We implemented selection with one finger drag, which can be achieved by drawing a circle around a set of units. Furthermore, this meant that two finger drag became the screen-drag function. As discussed below, users found this preferable to the commonly-available mappings in other games.

*Trash can.* In *Starcraft II* (Blizzard Entertainment, 2010), buildings appear as a holographic image, called a blueprint, under the cursor to indicate where the building will be and if it can be built at a certain location. We wanted to give this kind of feedback to the user, but have also decided to improve this in two ways: *a)* the buildings that appear are simply blueprints and do not require a worker to exist, and *b)* they come from either the universal bubble menu or an individual worker unit menu. When creating one of these blueprints, the user must drag the finger to the desired location, so canceling a blueprint is simplified by the availability of a trashcan.

## 3. RAPID PROTOTYPING

This project progressed from concept to user-tested deliverable in 10 weeks. This progression is described below.

*Concept.* Figure 1 shows the layout of the game screen. The minimap can be tapped to see different areas of the map quickly; control group add/set buttons are toggle-able functions that allows the user to add units to a control group and set units as a control group. By default, it is toggled to *add*.

*Low-fidelity prototyping.* The low-fidelity prototype shown in Figure 2 was created with paper cut-outs for the various parts of the menu, an iPad screen sized print-out, and various colored shapes for the representation of buildings and units. The menu system was designed based on interviews with seven users, most of whom were intermediate to ex-

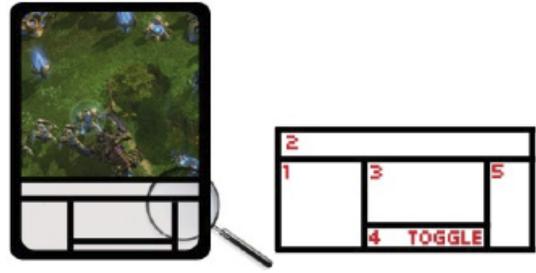


Figure 1: Layout of the screen, with (1) Minimap, (2) control group buttons, (3) unit or building features and statistics, (4) control group add/set buttons, and (5) resources and supply cap

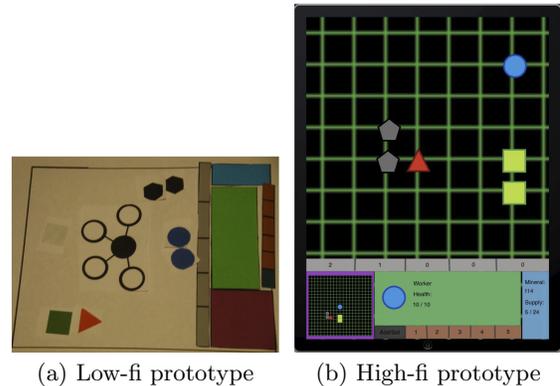


Figure 2: Low-fidelity paper prototype (with bubble menu) and high-fidelity prototype of the user interface and sample game. The blue circle (selected) shows a worker at full health.

perienced RTS game players. We tested the prototype with five users. To interact with the prototype, the user would act as if it was a real touch interface, and use all gestures available on the iPad platform. Then, a group member would be responsible for updating the state of the prototype as the user progressed.

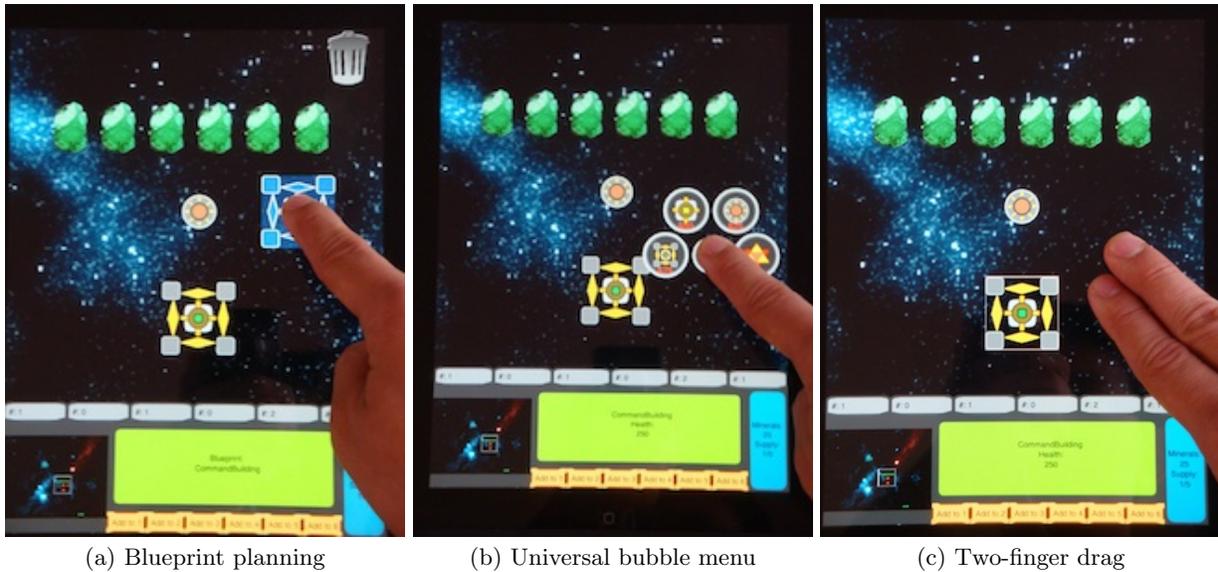
*High-fidelity prototyping.* The high-fidelity prototype was created in iOS developer suite for the iPad. A screen capture is shown in Figure 2. The sample game uses geometric shapes in the place of sprites to indicate buildings and units. The red triangle indicates an offensive unit; the blue circle is a worker; the grey pentagon is a supply building; and the yellow square is a barrack.

Heuristic evaluation with a modified Nielsen’s heuristic list [7] showed minor to critical usability, playability, and mobility flaws in our design.

*Final system.* The final system is shown in Figure 3. The player can place a blueprint prior to committing to build a building; bring up a bubble menu; move the screen with the two-finger drag; select, assign, and add to control groups; create units or buildings; and build workers and offensive units and have them perform basic functions (move, attack, mine for minerals).

## 4. USER TESTING

The user interface was tested with ten participants, all



(a) Blueprint planning

(b) Universal bubble menu

(c) Two-finger drag

Figure 3: Blueprint planning allows the player to consider placing a building before expending the resources to actually build it. The universal bubble menu brings up a menu of actions anywhere on the screen. The two-finger drag was preferred by the users to the one-finger drag in other games.

of whom have had some experience with real-time strategy games. The reason domain experts were selected as users was we wished to stress the importance of our novel user interface rather than the underlying game mechanics. The system was compared against the iPad versions of *Command and Conquer* (2010) and *Land Air Sea Warfare* (2010). A within-subjects design with randomized game order ensured there would be no biasing effects, and gave participants equal grounds for comparison with two different known systems. Qualitative and quantitative approaches were used to glean the most information about the system given the small number of pilot participants.

#### 4.1 Participants

We recruited a convenience sampling of 10 participants, ages 18 to 28 (mean: 21). There were two women and eight men in the sample, all of whom were University students from a variety of majors (anthropology, life sciences, business, cognitive science, computer fields, english, psychology, and art). All participants had played RTS games and used touch-screen interfaces; five participants self-rated as somewhat experienced in RTS games, two said they were very experienced, and three were veteran RTS players.

#### 4.2 Method

Each participant experienced all three games. After each game, we administered a follow up survey consisting of both open-ended and Likert-scaled questions. Participants were also asked a series of questions following the question-asking protocol while playing each game: After performing a certain event, participants were asked to explain what had just happened to determine understanding of the current game state and gesture-function mapping. Participants were randomly assigned the order in which they experienced each user interface. Each participant met with the experimenter(s) in a noise-free environment to minimize distractions.

#### 4.3 Results

The findings from this experiment show no significant difference in ease-of-use or enjoyment between our iPad RTS interface and other RTS games that are already available on the iPad. However, these results may be somewhat skewed. Many of the participants mentioned in their assessment surveys as well as their question-asking answers that the lack of an actual “game” for the iPad RTS made “playing” it less enjoyable. The prototype did not spawn enemy units, so users who built mass fleets of offensive units were unable to use them. This skewed most of the information received from participants, as they focused mostly on the game aspects, rather than the usability aspects. The surveys provided us with valuable information on what stereotypical users look for in a game and features that they would like to have incorporated in games for iPad.

The question-asking portion of the experiment revealed that overall, participants were able to correctly assess what happened after performing certain tasks (e.g., sending a worker to mine a mineral, setting a control group, sending an offensive unit to fight an enemy unit, etc.) for all games that were played, including our sample game.

*How enjoyable was it for you to play this game?* The options were ranked on a 5-point Likert scale, from extremely boring (1) to extremely enjoyable (5). The means and standard deviations for the Likert responses were as follows. *Land Air Sea Warfare*: mean 3.40, sd 0.84; *Command and Conquer*: mean 3.10, sd 1.29; Prototype system: mean 2.80, sd 0.79.

Pearson correlation showed that participants that enjoy playing *Command and Conquer* also enjoyed playing the demo system’s user interface ( $r = 0.788$ ,  $p < 0.01$ , two-tailed). This speaks to the adaptability of our system and the ease with which its interface can be learned. Experience with real-time strategy games was negatively correlated with a more enjoyable playing experience on the demo game

( $r = -0.674$ ,  $p < 0.05$ , two-tailed), indicating that our user interface was likely to be enjoyed by less experienced players.

*How easy were the controls of this game to pick up for you?* The options were ranked on a 5-point Likert scale, from extremely difficult (1) to extremely easy (5). Results for this question were not statistically significant. The means and standard deviations for the Likert responses were as follows. *Land Air Sea Warfare*: mean 3.00, sd 1.25; *Command and Conquer*: mean 3.70, sd 1.25; Prototype system: mean 2.90, sd 1.10.

Most interesting were our results from the qualitative portion of the user study. Participants preferred several user interface features to those of our competitors, including the two-finger drag to move the screen to a specified spot on the mini-map. One participant said, “I really liked the two-finger scrolling rather than the one-finger,” because it prevented him from accidentally moving the screen when he meant to select a unit or building. Both competitor games use one-finger drag for the same effect.

Our system was found to be preferable to *Command and Conquer* in selecting units because the latter requires the player to either press a toggle button to begin the selection process, or use three finger selection. Our test found both undesirable: Players had trouble positioning their fingers naturally without contorting their hands. Three finger selection encouraged some players to use two hands to solve the problem. Because selection is the most frequently-used function in RTS games, it should be mapped to simple gestures rather than two-step or complicated ones. Hence, our system performed better as selection was accomplished with a single touch and using a single hand.

#### 4.4 Usability Flaws

We found several issues as a result of our user study.

*Inability to select a group of units on screen without adding them to control groups.* This was a serious usability problem because selecting groups of units was important for the strategy aspects of the game being played. This feature will be implemented in future work.

*Lack of enemy units.* While this was not relevant to the user interface, it was relevant to how users perceive the interface. Attack commands and functions would need to be incorporated to fully assess what users think of the interface.

*Graphics to denote when things are being built, mined, etc.* Most other games have animation showing an action in progress; as this was just a prototype, we did not implement progress animation.

*Course plotting on mini-map.* This feature was not allowable, as clicking on the mini-map would move the player to that area of the map. The importance of this feature is debatable, as one would not want to accidentally send units when trying to move the map.

*Radial menu only appears on buildings/units.* The appearance of the menu was debated; however, based on participant input, the radial menu will be changed to appear only for buildings and units with functions.

#### 4.5 One-handed Use

We instructed participants to use only one hand when playing our demo user interface. We found that not only did participants have no trouble interacting with our user interface, participants expressed that it was easy to do so. The gestures mapped well to one-handed use. All ten par-

ticipants placed the device on the table and used one hand to navigate the demo game.

On the other hand, both *Command & Conquer* and *Land Air Sea Warfare* had gestures that lent themselves better to two-handed use. One such gesture, in *Command & Conquer*, is “select groups of units within an area,” in which the user should tap simultaneously three points on the map. The units within the triangle created by the tapped points are selected. Without being instructed to do so, one participant, noting that the fingers do not create an area large enough to his liking, used two hands—thumb and forefinger on one hand and forefinger on the other hand—to select the area.

Another gesture, available in *Land Air Sea Warfare*, is “build in a line,” in which the user must touch two endpoints of a line so that the user interface can iteratively build units along the line. Again, we noticed that one participant used the forefinger of each hand to accomplish this task.

### 5. CONCLUSION

Our system was a proof of concept, demonstrating *a*) the possibility of a positive one-handed experience on a mobile device (specifically, the iPad); *b*) the benefit of a trash can feature for command issuing; and *c*) the necessity of a user interface specifically aimed at touchscreen interfaces (rather than a direct port from a non-touchscreen interface). We hope to continue this work as explained below.

### 6. FUTURE WORK

Future work on this project includes adding greater game functionality, as many of our pilot participants expressed frustration that the game was limited or incomplete. Given positive results in our pilot testing regarding one-handed use, we plan to recruit a larger sample, including those with limited use of a limb, to test our system.

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