

Effect of Display Size on a Player's Situational Awareness in  
Real-Time Strategy Games

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## **Abstract**

When it comes to computers and the display people use they typically want it to be as big as possible. This may not be the best thing to do when it comes to playing certain types of video games. For simple everyday use a bigger display is just fine, there is more screen real-estate to take advantage of allowing many windows to be open at once and they can be reorganized depending on what the user wants to focus on. This is not an option when it comes to video games specifically Real-Time Strategy (RTS) games. The purpose of this is to explore whether a bigger screen improves a player's situational awareness when playing RTS games. This will be determined by a user study in which participants will be placed in two groups to play an RTS game. Their ability to retrieve information and how well they play will be measured.

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Figure 1: Example of an RTS game screen, Warhammer 40,000: Dawn of War - Game of the Year Edition. Places where important information is displayed are highlighted in blue.

## 1 Introduction

If someone were to use a computer for everyday use such as checking email or writing papers or similar tasks they would do well to have a large display. They would be able to spread out their work so that they could see all of it at once instead of needing to switch between various pages. It is also easy to take whatever they are focusing on and put it in the middle of the display where it is easier to focus on it (Bi, Balakrishnan 2009). There also is very little penalty for taking slightly longer to determine what information is needed at any given time, for simple tasks like emailing or web surfing. This however is not the case when it comes to video games where almost none of these traits hold true. Since none of these traits apply the user's situational awareness can be very low when using a large display.

Real-Time Strategy games (RTS) are games that typically involve a player moving a large army across a map and destroying the opponent's army. The armies are composed of smaller characters referred to as units. The map is typically made up of varying terrain which either blocks units' paths or causes a decrease

in their mobility. There are many different ways to play these types of games: some people choose to build as many units as they can so that they overpower their opponents with sheer numbers, while others prefer to stick with smaller armies and micromanage their army, which requires individual attention to units in order to turn the tables on their opponent. While playing an RTS game the player is responsible for several things:

1. Selecting units
2. Moving units
3. Giving attack orders
4. Constructing buildings and units
5. Researching and upgrading units
6. Gathering resources
7. Knowing where the enemy is
8. Destroying the enemy

In RTS games there are several ways players can typically select units. The first way is that they can left-click and drag a box around the units they want to select, and the second is to individually select units. To move a unit a player must first select the unit and then right-click on a location to move them. Attack orders are similar to move orders but the player is right-clicking either an enemy structure or unit. The player must also construct buildings and units to make their army stronger. Buildings are used for either making your units more powerful with upgrades or creating more units. In addition to construction the player must also do research so they can get upgrades for their units so that they can become even more powerful. In order to construct buildings and units or do research the player must have the appropriate resources to do this, which is another thing the player must keep track of. While constructing units, doing research, and gathering resources the player must also keep track of where the enemy is. The enemy can be either a computer or another person and their goal is the same as the players. If the player loses track of the

enemy they may suddenly be right behind them and their base will be destroyed. In addition to destroying the opponent's army, the player wants to gather resources at strategic points. These allow for either more production credits or other perks. The production credits allow for the construction of more units. Because of this, resource points are highly contested for their high strategic value. RTS games happen in real time meaning that for every second that passes outside of the game, some amount of time greater than zero passes within the game.

## 1.1 Information distribution

When playing RTS games there is quite often a lot of important information that the player will need to keep track of. It is often the case that the player will need to make split second decisions based on some of this information. It is important to know what this information means and where it is located.

Figure 1 is a screen from an RTS game. In the upper left corner is the resource count for the current game. In the bottom left corner is a miniature version of the entire map (mini-map), which displays the terrain and the player's units location along with their opponent's units if they can see them. Then along the bottom is information about the currently selected units including their health, weapon information and other actions they can take. In the middle-upper-left there is information about hero units which are special more powerful units, and in the middle-lower-left there is information about events that have recently happened such as units being completed. Finally in the upper right there is information about the current game state including how many resources the player has and information about if the player is currently winning the game.

Figure 2 shows what part of the screen looks like when constructing units. The middle box shows the structure that is selected. The bottom left box shows the current health of the selected structure in green. The bottom middle box shows units and research that are queued and how close to completion they are. Only one unit can be constructed at a time, and the current one is at 1% completion with another queued behind it. The bottom right box shows the units that currently can be constructed in color, and ones that cannot be in black and white. If the player hovers the mouse over a unit, information about the unit will be displayed, including its name, abilities, and what it costs to build it. In the upper left corner the current



Figure 2: Example of construction. Places where important information is displayed are highlighted in blue.

resources the player has are displayed, if the player wants to construct a unit and they do not have enough resources they will be unable to construct the unit. The same goes for structures and research.

Figure 3 shows what part of the display looks like when a unit is selected. In the top left is the selected unit which is currently made up of four small characters. The bottom left box contains the unit's morale in blue, however no health statistics. If the morale statistic drops to zero the unit will stop doing what ever it is doing and retreat. This unit does not have a health bar because it is made up of several smaller characters each with their own health bar. To see each bar the player must hover over a specific character. The four in the upper right corner of this box is the current number of characters that are part of this unit. The middle left box contains information about the combat statistics of that unit. The top left red box contains the information on how much damage this unit does when it is in melee combat. The bottom left red box contains information on the damage the unit does in ranged combat. Next the middle upper box has information on how many characters will be in the unit after the queued upgrades are complete, along with the capacity of characters it can have. Below this is the number of special weapons currently equipped to the unit after the queue is complete, it also has the capacity of special weapons the unit can have. Finally





Figure 3: Example of selected unit. Places where important information is displayed are highlighted in blue. The smaller red boxes are subsections of the blue boxes.

the right red box has the type of unit it is either infantry, vehicle, or building. The middle blue box shows the queue for upgrades to the selected unit, upgrades can be canceled by clicking on them. Next the middle right blue box contains the possible upgrades for this unit. Box 1 allows more characters to be added to the unit. Box 2 allows a commander to be added to the unit which is a stronger character with the rally ability which boosts the unit's morale. Box 3 is a morale decreasing weapon. Box 4 is an anti-infantry weapon, however the unit must be stationary to use this weapon. Box 5 is a stronger standard rifle which can be fired while moving. Box 6 is an anti-structure and anti-vehicle weapon with a slow rate of fire. Here, like with building structures, if the player does not have the resources needed to finish an upgrade they are unable to do so. The bottom right blue box contains the actions that the selected unit can take. If more than one unit is selected the middle left blue box displays a list of currently selected units, with one highlighted allowing that unit to be upgraded with information on it displayed in the other boxes as shown in figure 4.

/subsection Situational awareness

Situational awareness refers to a player's ability to quickly retrieve information, along with their ability to know what is the most important thing to do at any given time. The ability to retrieve information quickly and knowing as much about the game at any given moment while playing a video game is critical. If the player takes too long to gather information about a situation it is possible that their army will quickly be



Figure 4: Example of multiple selected units. The difference between multiple and single selecting is boxed in.

destroyed. Due to the way information is displayed in RTS games and the fact that it cannot be repositioned it is possible that a large display will result in a longer retrieval time. In addition, knowing what is important to do at any given moment is also important and if the player cannot retrieve the information quickly enough they may not have all of the information that they would need to make an informed decision quickly.

Figure 5 shows a ranged unit fighting an enemy melee unit. A ranged unit is superior in combat at distance while a melee unit is superior when units are close together. This is a bad position for this unit to be in because it may be destroyed. Here there are several options of what the player could do. One, they could leave the unit to be destroyed, in which case they are down a unit and their enemy is still advancing upon them. Two, they could spend resources to try and reinforce the unit in the middle of the battle; however, they may not have the resources for it or it may simply take too long and the unit might be destroyed anyway. Three, retreat, the unit might survive but it also might be killed as it is trying to run away. Four, the player could look around and determine what other units are in the area and send a more suited unit to help. Five, a combination of these choices. Figure 6 shows a player having several ranged



Figure 5: Example of situational awareness being important

units in combat with several melee units in the red circle. The player has noticed that there is are friendly melee units nearby and has sent them to help; and while looking for friendly units they notice that they can afford to reinforce the endangered unit, so they begin to do that. The player noticed that the melee unit is nearby by either looking at the mini-map in the bottom left corner of the screen or by seeing it in the normal visualization of the screen that takes up most of it. The player realized that they had enough resources to reinforce the endangered unit by consulting the resource window in the top left corner of the screen. If the player hadn't been able to quickly identify the situation that they were in because of poor situational awareness they may not have been victorious in this instance, and it is possible that if a player has a larger screen because of the size of the display they may take too long to obtain all of the important information.

## 2 Background and Related Work

There has been some previous research done about how users interact with large displays. Bi and Balakrishnan[1] did work in which they had participants use a display that was 16' wide by 6' high made using multiple projectors. They had their participants come in and use the display for five hours a day for five consecutive days, they were asked to keep a log of what they spent their time doing. What they found is that participants overwhelmingly preferred the large display. They also found that when their users wanted to change their focus from one thing to another they would find their new focus and move that to the center



Figure 6: Player taking advantage of their situational awareness

of the screen. In RTS games moving information like this is not an option so this may result in a smaller display being preferred.

Tan, Gergle, Scupelli and Pausch [2] did an experiment in which they had participants navigate a 3D environment using a normal display and a large projector. The two screens were set up in such a way that they had a constant visual angle. Participants were lead through from point A to point B and then from B to point C. They were then asked to find their way back to point A from point C. They measured the error distance from point A. What they discovered is that when using a larger screen the error distance was smaller for the larger display than it was for the smaller display. This again shows that large displays again are better; however, again this is under the assumption that important information can be moved to the center of the screen, which in RTS games is not an option.

### 3 Design requirements

- Computer capable of playing Warhammer 40,000: Dawn of War
- Computer monitor



Figure 7: Example of screen size difference (Tan, Gergle, Scupelli, Pausch 2004)

- Projector and projector screen

## 4 Design

The first thing that is required is a computer that can play Warhammer 40,000: Dawn of War, along with a standard computer monitor and a projector and a surface to project on. Warhammer has been chosen because it is a good representative of average RTS games and it is fairly simple to learn the basics of it. Figure 7 shows the approximate size difference between the two display types. There will be two different testing groups; one will be using a projector display, the other will be using a standard display. The participants will be able to sit at the distance from the screen that they find to be comfortable. There are several other factors that will be held constant throughout both test groups. The difficulty of the non-human players will be kept constant, along with the resolution of the display, and the refresh rate of the display. Participants sit down in front of either a projector display or a standard computer monitor. They are given a short explanation of the controls and the various units they will have access to and a list of enemy units. Friendly units that the player will have access to are Space Marines which are ranged units, and Dreadnoughts which are armored vehicle units. Enemy units consists of Slugga boy squads which are melee units, TankBustaz squad which are anti vehicle units, and Killa Kans which are armored vehicle units. They are instructed to fully reinforce the friendly squad in the middle of the screen. Squads are made up of several individual units. Reinforceing





Figure 8: Initial setup

a unit it the act of calling in more units to join a squad. Reinforcing is the equivlance of healing. They will then be given time to become accustomed to the controls. They will then take part in defending one or more locations from enemy units with specified friendly units for four waves of enemies. The players situational awareness will be determined by if the player properly determines the most important things that need to be dealt with during the various rounds.

Figure 8a shows what the player will see when they start the game. Throughout the experiment the player will be defending either point A, or point B and C and the enemy will always be coming from the top right shown in Figure 8b. The map the experiment will take place on is Penal colony. The player will be given a monestary level Stronghold, a barracks, an armory, and a vehicle depot; all of this to be used only by the administrator to produce units.

#### 4.1 Wave 1

In the first wave the players will be given three space marine squads which have been fully reinforced to defend point A. The player may setup the units however they like though they are required to leave them close to the point they are told to defend. Once the player is ready the Administrator will start the wave by ordering three Ork Slugga squads; which are also fully reinforced, to move attack to just past point A.

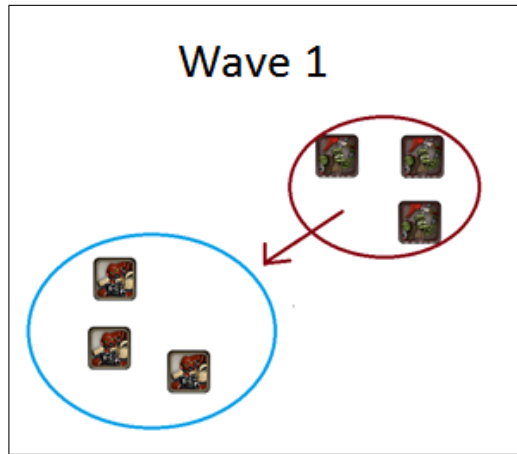


Figure 9

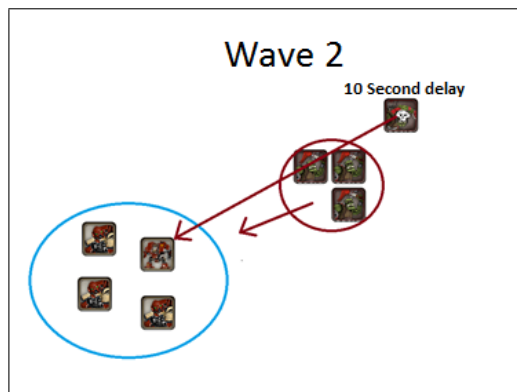


Figure 10

The administrator will only interfere with the units if they become idle. The purpose of this scenario is so that the player will lose the encounter. The hope is that the player will learn that they cannot just charge their army at the enemy and win.

## 4.2 Wave 2

In the second wave the players will be given three Space Marine squads which are fully reinforced and a Dreadnought to defend point A. Once the player is ready the Administrator will again attack with three fully reinforced Slugga squads. Then ten seconds after the wave has begun the Administrator attacks with a fully

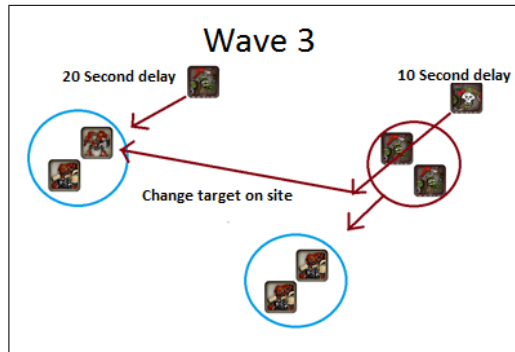


Figure 11

reinforced TankBustaz squad upgraded with rocket launchers specifically attacking the Dreadnought. The most important thing for the player to notice during this wave is that the TankBustaz squad is attacking the Dreadnought. The player should be able to infer that the TankBustaz is attacking the Dreadnought because there will be explosions that are targeting the Dreadnought. The player should be able to realize this is a threat if they have selected the Dreadnought and either look in the lower part of the screen to check its health or by mousing over it too see its health bar. After this they should be able to follow the trail of the rockets back to the source and realize that this is where they are coming from.

### 4.3 Wave 3

In the third wave the player is given three Space Marine squads, again fully upgraded and a Dreadnought to defend points B and C. Two of the Space Marines are to start defending point B, and the remaining Space Marine and the Dreadnought are defending point A. Again the player can organize the squads however they want but they must keep the squads near the points they are defending until the wave starts at which point they can move them where ever they want. Once the player is ready the administrator will have two Slugga squads attack point B, ten seconds later a TankBustaz squad, reinforced and upgraded will also attack point B. Then an additional ten seconds after that the Administrator will have one SLugga squad attack point C. Also while this is happening as soon as the Dreadnought comes into view the Tankbustaz change their target to the Dreadnought. The things that the player will notice if they have proper situational awareness is that the Tankbustaz have decided to attack the Dreadnought, and that the Slugga squad has attacked point C.



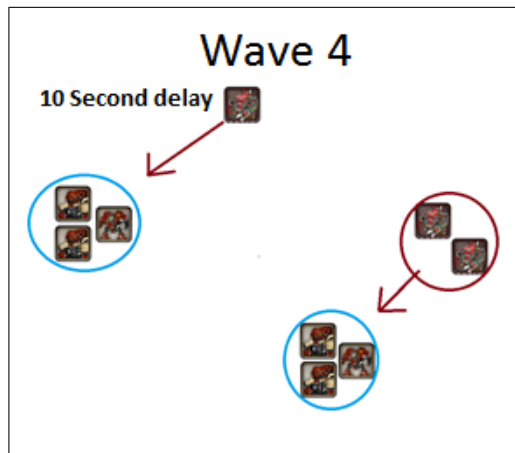


Figure 12

The player should be notice the Tankbustaz again by the explosions. They should also be able to notice that point C is being attacked because on the mini-map in the lower left corner there is a large red group of enemies moving towards point C and there will be a visual cue once their units are actually engaged that says that their units are under attack.

#### 4.4 Wave 4

In the fourth wave the player is given four Space Marine squads, and two Dreadnoughts to defend points B and C. Point B will be defended by two Space Marines and one Dreadnought, and point C also has two Space Marines and one Dreadnought. Once the player has organized their units the Administrator will attack point B with two Killa Kans, then ten seconds after this another Killa Kan will attack point C. In this situation the player would need to notice the Killa Kan attacking point C to have proper situational awareness. Here the player has only a few targets at point B to pay attention too, however at the same time they will get a smaller notification on the mini-map because instead of a squad of Orks it is a single vehicle attacking the point.

## 5 Results

The results of wave 2 is that of the four participants who used the large display none of them noticed that the Tankbustaz were attacking the Dreadnought. Meanwhile of the three participants who used the small display one of them noticed the Tankbustaz attacking the Dreadnoughts. During this wave almost six of the subjects either did not notice or ignored the fact that the Dreadnought had rockets being fired at it. Throughout all of the experiments the players had almost all of the units on the main screen for the duration of this wave. Two of the participants spent most of their time reinforcing the Space Marine squads than they did paying attention to most other things on the map for this wave, One of these participants had a large screen and the other had a small screen. The one subject who actually did notice this threat is the only participant who had actually had any experience with the game, and his thought process was that he recognized that there were explosions going off near the Dreadnought and realized that this was likely a threat to the Dreadnought and tried to withdraw it.

During wave 3 of the participants who used the large display half of them noticed the Tankbustaz and the Sluggas attacking point C. Of the two who noticed one of them didn't realize that point C was being attacked until the Tankbustaz had moved from point B to point C to attack the Dreadnought, this shows moderate situational awareness. The two who didn't notice at all spent most of their time trying to save point B and didn't notice point C until it was too late to do anything about it showing poor situational awareness. The results of the small display tests for wave 3 for the smaller display is that all of the participants noticed this information. Here on the smaller display one of the participants also didn't realize that point C was under attack until the Tankbustaz had moved from point B to point C, again this shows some situational awareness. The two who had noticed without assistance both had looked at the mini-map and had seen the large mass of red moving towards point C.

For wave 4 of the participants who used the large display three of them realized quickly enough that point C was being attacked off-screen. For one of the large screen participants only realized that point C had been attacked after the battle for point C had resolved itself. Two of the participants who did notice point C being attacked noticed that the small red dot was moving towards point C and reacted to that, and this shows strong situational awareness. As for the other participant who noticed they had basically finished

Wave	Vital Information	How many subjects noticed the information	How many subjects didn't notice the information
2	There are rocket units attacking the your tank unit	Large- 0 Small- 1	Large- 4 Small- 2
3	There are rockets attacking your tank unit and you are being attacked off screen	Large- 2 Small- 3	Large- 2 Small- 0
4	You are being attacked off screen	Large- 3 Small- 1	Large- 1 Small- 2

Figure 13: Results of experiment

up with defending point B and decided to look at point C and then it became under attack, this shows moderate situational awareness. Of the participants that used the small display only one of them noticed that they were being attacked off-screen. Atleast one of the small display participants who did not notice the off-screen situation, actually looked right at point C while it was being attacked and still didn't realize that there was any kind of problem. The one participant who had noticed on the small screen had noticed that point C was being attacked on the mini-map and then went and dealt with it showing strong situational awareness.

## 6 Validity threats

There are several validity threats to this experiment. First there is the fact that the sample size was very small. There were only seven participants. Another threat is that only one of the participants had any experience with the game. Then there is the fact that the computers that were used for the game had some difficulty running the game, which could cause the players to have more difficulty then they should have while playing the game. Another is that the distance the player will be from the display is not going to be controlled, and it is possible that this could have affected the outcome. If one group is better at multitasking and micromanaging they might get better results than the other group. This concern could be fixed by eliminating the two groups and having all of them use both displays. This creates its own problem though.

This will almost definitely result in the learning affect, and as the player gets farther into the experiment they will improve at the game, further skewing the results.

## 7 Future work

It would be good to perform the experiment again with a larger sample size. In addition it would be good to do the experiment with a game that more people have played, such as Starcraft II. It would also be good to perform the experiment using other genres of video games, perhaps either first person shooters, or role playing games. It would also be good to do the experiment with computers that can easily run the game. Performing the experiment so that the screen took up the same percentage of the players field-of-view would be also be good to do.

## 8 Conclusion

Based on the results of the experiment I can say that there doesn't appear to be an advantage to playing RTS games on a larger screen. Of the test waves for the large display in only 41% of them the participant noticed the vital information in the various waves. Meanwhile of the test waves for the small display 55% of the participants reacted to the vital information. Which makes it appear that the smaller screen might actually be better to play on. This experiment should be done again though it should be done with a more popular game, on computers that can run the game, and on screens that take up the same amount of a players field-of-view.

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