A game that scales

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Introduction

We posit that visual scale is an important aspect of any video game, and that any changes made to the size of the screen on which the game is played influences the *playability* of the game for better or worse. We define *playability* as a measure of how well the developers intentions of the "experience" that the game should provide are interpreted by the player.

When we make games we wish to allow the player to experience through our stories and our interfaces something that is both engaging and enjoyable. Today, there are many different devices with which people can experience games and as game developers, it is a challenge to give users across a variety of platforms homogeneous experience of our games.

This "change" if you will of the how the game is presented with respect to screen size is not a trivial consideration. If we think for instance about just some of the factors that would come into play when trying to play a game of Solitaire on the screen the size of football field as compared to on a 24" screen. What kind of interface would one be using? A mouse? Touchscreen? How would this affect how the game is played? What kind of things would have to change in order to preserve the "experience" of the game of Solitaire regardless of the size of the screen it was played on? It is these sorts of questions about considerations that form the focus of this paper.

In this paper, we hope to bring to the reader's attention, many of the considerations that must be taken into account in order to develop *a game that scales well*. We use the game *Plants vs. Zombies* by PopCap Games as our case study and analyze the changes in the game across a multitude of screen sizes discussing some of the plausible reasoning behind why such changes were made. The reader should, by the end of this paper, should know what to look for judging a game with respect to *scalability* and some of the key considerations that must be taken when developing a game to scale.

Scale for scaling sake

In considering the same title on different platforms (i.e. screen sizes) we want to make a difference between games that have been adapted for different screen sizes via straight scaling of game elements as opposed to discernible differences made between versions informed by research. Just scaling up from a smaller sized incarnation of a game to a larger one or vice versa won't necessarily preserve the playability of said game.

Maximizing this playability is the most important thing and therefore the decisions made in scaling should not be informed by *just* needing to have a game for a particular screen size or to fill some area of the market but should be related to producing excellent representations of the game across a variety of screen sizes.

Separation of concerns

First and foremost, in trying to differentiate between what *makes up* a game, the most obvious choice to make was between the menus and other interface elements that one navigates through to actually play the game and of course the game play itself.

We can tentatively call these two aspects, "interface" and "gameplay" concerns.

In making this decision however, another problem arises. "Which way to go?". If we think about games across a variety of visual scales then it is intuitive to think of their differences as being represented along a straight horizontal line.

Small screens ←————————————→ Large screens

Initially, we felt that we needed to decide which *screen size* to base our analysis on so that we can have something to compare further analyses to. In the world of web development recently, there has been much discussion about a move from thinking about desktop and larger screen sizes first, towards contemplating mobile and smaller screens first in the design process. While this is a point of view we think is beneficial in the design process, we posit that in order to develop games that scale, the most important aspects to be isolated are what the "experience" is supposed to be like.

However in order to drill down changes, we needed a starting point. We have *generated* if you will, a pool of data about the features in the largest incarnation of the game, and then take it from there identifying which elements related to our two concerns have been changed and of course why. It's reasonable to think that this method makes any change feel much more stark. Stark is a good thing and one of the hallmarks of well done games is that *"starkness"*.

Pre-game Menus

Typically, the menus that are available are:

- Selection of game mode
- Settings
- Achievements
- Leaderboards
- Online Shop
- Links to more games

UI

Plants vs. Zombies (PvZ) has a few gameplay elements that are present throughout each iteration of the game and without which, the experience of the game would be too drastically different to be comparable.

They are the:

1. Zombie progress bar
2. Seed inventory
3. Shovel
4. Sunshine gauge
5. Money indicator
6. Pause button
7. 6x9 grid of grass on which seeds can be planted.

The game provides the user with a house to protect. The only way in which houses can be protected is via the planting of *seeds* from the *Boom and Doom Seed Company* that attack the zombies who wish to "eat your brains". The decision to use PvZ as our game for analysis of course was not made trivially, as it turns out that *PvZ* is an excellent choice for a variety of reasons.

- The game is available on a variety of platforms, mobile, console and personal computer. that is, Xbox 360, PS3, Android, iPhone/iPad/iPod Touch, Blackberry Tablet OS, Blackberry, PS Vita, Nintendo DS/DSi, Mac and PC.

- There are easily identifiable (stark) differences in the different versions of the game
- There are subtle differences in the different versions of the game

An important concept to grasp here is that saying "they made a different version" isn't as important as quantifying the changes made to the different versions.

Regarding this concern, we can further classify changes made on the gameplay side into some set categories.

- Changes made to viewport
- Music and SFX changes
- In-game menu changes
- Image/rendering changes

We may have a variety of different platforms to consider and therefore we must be vigilant in trying to find groupings in order to keep our data concise. It is rare that console versions will be different beyond the obvious differences in button mapping and *some* menu items (mostly related to online services). similarly, iPhone and iPod touch versions are normally share many similarities, whereas iPad and comparable tablets will also share similarities as well.

We have to decide what to group by. Screen size, graphical power, method of interaction (whether touch, controller, stylus etc.). We have to consider the category that allows us the most control over our groups and since our main interest is visual scale that is what the groupings will be primarily based on, with special mentions for method of interaction.

This allows us to group by *console*, *tablet*, *touchscreen mobile*, *handheld* and *PC*.

** we have to decide what it is in a screen that decides how a game is going to go, what i mean by that is, is it the pixel density, size... ?

Console

All the console versions of course utilize the buttons and joysticks available in order to play the game.

- You collect sun via moving the on screen cursor to where the sun is (the sun is then collected automatically).
- You are allowed a selection of a maximum 10 seeds.
- The game space is very large, that is, you have a full view of the house, lawnmowers and other visual elements.
- The fence is obscured by the game bar, which contains of course your sun meter and selectable seeds. the shovel is displayed inline as well.
- The seeds are displayed in PLF with images representative of the plants the seeds grow into, their sun cost and the sun icon.
- Money is displayed BLH.
- The fence is obscured by the game bar.
- The progress bar is very small and BRH, it also has the text "LEVEL PROGRESS" superimposed on it.
- When selecting a seed, you have a shadowed outline that shows where the seed will be planted.
- The pause menu is in the shape of a tombstone

- When a level ends, the new item screen takes up the entire screen, the background is textured, and the main information is displayed in PLF.
- When digging up plants, you have a progress bar and about a 1 second turnover before it gets uprooted.
- When you defeat a zombie, you can see exposed bone.

Tablet

The tablet versions make use of the screen real estate and the increase in dexterity available because of it to implement multi-touch features.

- You use your finger to tap on sun to collect it
- You have a maximum of 9 selectable seeds
- Menu button and shovel are both square like
- Seed choice is given in a 8x6 grid at any given time
- Shop and almanac buttons are BRH
- There is a "LETŚ ROCK" button to press when you've finished selecting seeds.
- You tap to select a seed, a grid then appears to help you place the seed.
- You can use multi-touch to plant seeds and collect sun.
- The progress bar no longer has it's text, and it has been made larger w.r.t to the gameplay
- The fence is still obscured, but not as much as in the console version.
- The game bar is left aligned and takes up most of the top of the screen.
- When you've used a seed, there is an animation to show it "filling back up" so to speak.
- Money in BLH, only displayed when there is money to be collected.
- There are no hover effects on devices that used touch input, however hover effects can be simulated via tap effects.

Touchscreen Mobile

The mobile, i.e. iPhone/iPod Touch/Windows Mobile/Android/PS Vita versions, share many of their features. The biggest difference is the viewport, what you can actually see in the games.

- All the mobile versions place the seed select to the LHS of the screen.
- The seed icons have been shrunk and placed in LLF, the sun bar, menu and shovel has likewise been shrunk and placed in LLF. The mobile versions utilize a much more rectangular shape.
- There is no more tombstone in the pause menu, it has been changed to a simple rectangle.
- Fence is still obscured.
- You have a maximum 9 plants.

Hand-held

The Nintendo DS/DSi versions in particular are illustrative of why *PvZ* is such an excellent game for analysis. PopCap has leveraged the DS/DSi's stylus and seeds are now planted via drag and drop among a plethora of other changes made to the game.

- You are allows 9 plants at a time, all of which are displayed in a row at the top of the screen, once again obscuring the gate.
- There is a quite appreciable drop in graphical fidelity, the resolution of the backgrounds have been lowered and all of the game components have been *8-bitified*.
- The sound fidelity has also been reduced.
- Collected sun is TLH.
- The seeds now only have a caricature of the planted form, the sun cost and a small progress bar.
- There are not as many zombie animations as is present in the other versions. e.g. There are no animations for zombie death
- Strangely, sunflowers have an extra animation to show how long it is until they release sun.
- Seeds have a progress bar to show how far they are away from being replenished.
- The shovel has been placed BRH.
- The zombie progress bar is displayed in the DSs' upper screen.
- Pause menu preserves the tombstone.
- The visibility of the elements in the pause menu is poor (a direct relationship with the quality of colour reproduction in the screen)
- Money is BLH, and is a simple text representation.
- The game ends on killing the last zombie, there is no requirement to select the dropped item at the end of the game.

PC

We're going to take further differentiate this category into *browser* iterations of the game as opposed to *native* iterations of the game.

Note on hover effects

The method of interface is point and click using a mouse, because of this, there are hover effects. They deliver extra information about seeds recharging, telling you that you don't have enough sun to plant a particular seed and also a description of the seed on hover. This of course is only possible because of this interface.

Browser

The game is run in a sandbox, and does not utilize the entire screen. It is almost identical to the native version.

- In order plant seeds, it's one click to select and one click to place.
- There is no BGM in the browser version, only SFX.

Native

In the native version, it runs full screen.

- The menu button has returned to being rectangular.
- The seeds are larger and in a PLF. There is extra information given about the seeds, that is, that they are manufactured by the "Boom and Doom Seed Company".
- Seed selection is drag and drop.
- The viewport is smaller than you would expect.

Analysis

Having listed the differences in each of the different versions, we can now take some of these differences in isolation and have a discussion about the motivations behind them.

PopCap and the "experience" of gaming

The hypothesis is that PopCap has an "experience" if you will that every incarnation of the game should allow the user to feel. We can say that the "experience" of PvZ is that

Select seeds, plant them, prevent zombies from reaching your house.

We'll examine the differences relative to this "experience". We believe that it is important to differentiate between changes that had to be made because of hardware limitations or the lack thereof across devices and other differences that we made simply because it "looks better".

0.0.1 The Nintendo DS problem

When considering the DS version the concessions made in the gameplay due to hardware considerations are important but at the same time could be argued to be straightforward and on some level intuitive. However, when dealing with devices where graphical fidelity (given the standard *game fidelity*) is not an issue, it is here that real "visual scale" decisions are apparent.

Just considering the size of the gameplay elements. Say from the Nintendo DS and mobile versions towards the larger iPad and console versions. We can see that from a hardware perspective, the DS cannot render the complex graphical elements while keeping the gameplay the same. The developers prioritised the "experience" and as a result of that, scaled down the graphical fidelity of the game. The gameplay itself hasn't changed and anyone familiar with the game in other media will recognize instantly that the "experience" is the same.

Hardware limitations on the DS, also required that some elements to be rendered took priority over others. A good example of that is how money is displayed on the DS versions as compared to any other version. This is most likely also the reason for there being a change in how selectable seeds are displayed.

Hardware considerations also play a role here in the sound fidelity which has been scaled down to be more MIDI-like and reminiscent of arcade games from generations past. Hardware considerations are also responsible for the poor visibility of the elements in the pause menu, simply due to the DS bottom screen's poor pixel density.

The game itself ends differently in comparison to its other device brethren editions, ending as soon as the last zombie is killed. This most likely owes to the extra game fidelity that would have been needed to animate the new seed as is customary in the other versions. In this version, the developers prioritised the player being able to see the lawn, that is, the main gameplay area which of course "makes sense" given the hardware limitations.

Given the lack of screen real estate the developers utilize the DS' second screen to display the zombie gauge.

We want to spend our time speaking about the differences in screen size as much as possible, however it is difficult to take the DS version of PvZ independently of it hardware limitations because of the obvious bottlenecks that the loss in graphical fidelity causes.

However, we now move onto larger screens with more homogeneous game fidelity which allows us to speak more readily about the changes made to the different versions because of visual scale. We will return to the DS intermittently whenever we discuss interesting aspects about the game that are related to it.

** It would be interesting to analyse if there was a relationship between size of screen size and limited hardware capability **

Fit

The maximum number of seeds that the player is alloted is directly related to the size of the screen. The "normal" maximum number of seeds available is 9 seeds. However, the console version and the PC-native version both allow up to 10 seeds. The sizes and shapes of seeds to be selected has changes quite noticeably w.r.t the different screens. This is in tandem with the size and shape of the shovel and the size and shape of the menu button. However, in every other iteration of the game not console or PC-native, the shrinkage of the items that could have been done to make 10 plants "fit" was deemed detrimental to the "experience" and hence abandoned.

We can possibly see reasoning for this in *Fitts' law*. Paul Fitts (1954) discovered that pointing time is a function of the distance and the width. Fitts' law and its extensions deal with *time for precision pointing*, which is derived as a result of *index of difficulty* and *time to point*. This refers to how deftly the player could strike the intended target consistently even in high pressure situations (e.g. an increase in game difficulty).

Indeed, it would seem that many of the changes w.r.t visual scale come as consequence of Fitts' law. On smaller screens, it is not unconventional to see that gameplay elements have been scaled down. The smaller screen enforces that only whatever is necessary for understanding and comprehension be displayed. In other words, leave out ALL information that does not hinder the users' experience of the game. In the case of the DS for example, the new plant representations and small, square-like and pixelated. They are difficult to select via touch and if they were due to the size of the screen it would be difficult to say with certainty that you always selected what it is you had hoped for. However, the DS comes with a stylus whose edge is pointed and therefore these issues are unimportant and the stylus gives tremendous control of the selection of minute objects. This reasoning extends to the shovel as it is represented on the DS as well.

A word on aspect ratio

In the rundown of differences earlier, the acronyms PLF and LLF were used. PLF meaning *portrait-like fashion* and LLF meaning *landscape-like fashion* respectively. This LLF and PLF correspond directly to aspect-ratio. Aspect-ratio seems to be a very important factor in considering how PvZ is scaled. UI elements are "scaled" in line with the preservation of the aspect-ratio of the screen. Especially given the size of the screens on say touchscreen mobile devices, in preserving the aspect-ratio, it allows the developers to preserve their game fidelity while at the same time maximizing the amount of screen real-estate that can be directed to actual gameplay-elements themselves.

The iPhone 5 for example has an aspect ratio of 16:9 and as a result of that, all the UI elements are based around the accommodation of that aspect-ratio as well. Similarly due to the size of the screen, UI elements have to be rearranged so that they remain useful and do not hinder the "experience". In the touchscreen mobile versions, this has resulted in the *zombie progress bar* being moved to the top, the re-arrangement of the seeds to the LHS of the screen and the scaling of the sun meter and now rectangular shovel open space that is taken advantage of by the zombie progress bar.

The white-picket fence at the top of the screen in PvZ seems to be the most unimportant aspect of what the developers would *rather have you see* in the gameplay. The console and tablet versions obscure the white-picket fence with the sun meter and seed inventory, while using the 4:3 aspect ratio and the large screens to display more of the background images. That is, in the case of the first few levels, the house, bicycles, BBQ grills, clouds in the distance (which are in the shape of plants). The grid itself hasn't changed but the ambient assets of the game are much more noticeable. These *extras* have been eliminated in the touchscreen mobile versions.

The 4:3 aspect ratio also much like the 16:9 changes how UI elements are scaled. The PC versions and the console version augment the seed inventory with more information about the "Boom and Doom Seed Company", while the tablet versions have new icons for plants, which increase the size of the images showing what seeds will look like when planted. The sheer size of the tablet version icons make sense if you think about the method of interaction with touch devices. Using your hands and fingers across such a large screen, having larger icons makes sense w.r.t to gameplay.

Priority

The icons themselves provide further insight into what we feel is one of the most important tenets of scaling. That of "priority", i.e. prioritizing what it is a UI element or a game element is supposed to communicate first and in scaling it as long as that communication remains intact there will be no problems later on. The icons in PvZ only need to have a representation of what the plant will look like once planted and a value for how much sun is necessary. We can see here how "strikable" visual representations as opposed to say text are easier to use in tight situations.

The grid on which the game is played is independent of the UI elements the most important part of the game. It is the only aspect of the game that remains unchanged across all screen sizes, and it's obvious that the priority is making sure that this interactive space is easy to navigate.

Seeds can be planted, dug up and the players can see the approach of the zombies.

This results in the other UI elements having to fight for space and sometimes whole UI elements are left out, if only temporarily. For example, the money gauge only shows when money has been collected.

Other considerations

There are other elements of the games that change from platform to platform that are independent of visual scale. For example, in the game zombies are killed in stages, after getting attacked by plants, different parts of the zombie are damaged until eventually the zombie is defeated and disappears. This normally results in seeing body parts fall off and with that exposed bone and in some cases what could be considered as blood. However, in the Nintendo DS version of the game, possibly due to parental concerns, there are no exposed bones etc.