StreetDroids: Graphical Interface – Design Aspects*

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* This report is part of the *MobileHIVE'*s final report, section 3.4.2, about the design aspects applied to the *StreetDroids* Project, a context-aware mobile game developed for the Android Platform. The *MobileHIVE* is a one year project (2009/2010) combined between the Bremen University of Applied Sciences and the Bremerhaven University of Applied Sciences, immersed in the Digital Media Master Program, in Bremen, Germany. The additional author's parts are not included on this report.

3.4. Graphical interface

3.4.1. Technical aspects (by Hima Bindu Vudathu {HS-Bremen}, Felix Oey {HS-Bremerhaven})

3.4.2. - Design aspects

3.4.2.1 - Introduction

Recent advances in computer hardware have culminated in the so-called mobile smart phones. Such devices are nowadays an essential aspect of everyday-life for most of the world's population, with applications that range from simple communication applications like *texting* to highly specialized professional support, such as in the health care domain. In the *mobileHIVE*[1] project the ever-expanding use of mobile smart phones gaming industry was explored. The result from this project was the development of a context-aware mobile game for the Android platform, called *StreetDroids*. In this section it is discussed the aspects related to the design of the user interface for the game.

If on one hand current smart phones have computing power largely superior than high-end desktop computers of a couple of decades ago, on the other hand they are equipped with very small screens. Small screen size is, therefore, one of the major issues faced by designers of mobile applications. In this project, for example, mobile devices with 480x320 pixels of screen resolution was targeted. The main challenge was to find ways of displaying the needed information in a friendly manner, so that users have a pleasant experience while at the same time having complete access to the data and actions appropriate for a certain context. For this purpose, was applied concepts of Human-Computer Interaction (HCI) and Graphical User Interface (GUI) design to overcome usability issues and to explore the possible utilizations of the limited space at hand. The result was an iconographic and simple interface which was well received by the beta testers at the preliminary evaluation. It is possible to believe that the application of HCI and GUI theoretical design guidelines was essential to the development of a successful user-friendly interface with an intuitive navigation.

The remainder of this section is organized as follows: In section 3.4.2.2 (Design Consideration for Small Screens) was elaborated on the problems faced by designers of applications for mobile devices. In section 3.4.2.3 (Design Concept for the Game) presents the guidelines offered by HCI and GUI theories which were used to tackle the design problems. It it discussed the research for the design of icons, menus, game interface, navigation and characters, experiments with colors and present the final choices. In section 3.4.2.4 it is placed the final considerations.

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1   The m*obileHIVE* is a combined one year project (2009/2010) between the Bremen University of Applied Sciences and the Bremerhaven University of Applied Sciences, immersed in the Digital Media Master Program, in Bremen, Germany, which the outcome is the *StreetDroids'* game: a context-aware mobile game developed for Android Platform.

3.4.2.2 - Design Considerations for Small Screens

The interactive features present on smart phones, such as the touch interfaces found in increasingly affordable devices, give developers the opportunity to explore vast new possibilities. By using new technologies and devices (like the T-Mobile G1 Android[2]) , new features are being developed, like context and location-awareness – one of the *StreetDroids* characteristics - which can be used to make games that are more connected to the real world and to the community around the user.

> "As mobile phones move beyond telephony into areas as diverse as Internet access, personal entertainment, content creation, and interaction with so-called smart and pervasive computing environments, exciting new opportunities for intelligent auditory presentation behaviors arise. In recent pervasive-computing research, for instance, users intuitively navigated their way to undisclosed outdoor locations using a context-dependent, directionally adaptive auditory display (Etter & Specht, 2005). The underlying system uses global positioning data and a geographical information system to infer the mobile user's geographical context. Navigation cues are then rendered by adaptively panning and filtering music selected by the user to correspond with his or her direction of travel." [2, Pg 189]

The used approach to develop the design interface was based on HCI concepts since "*design, usability and interaction are recognized as the core issues in HCI*" [4, Pg XIV]. Furthermore, to work on small mobile screens is a challenging task. In order to enhance the interaction, studies on HCI and GUI were considered at the development process. For instance, the elements of the initial screen followed one of the principles of GUI design. According to Galitz [5], "*the array of alternatives available to the user is what is presented on the screen or what may be retrieved through what is presented on the screen - nothing less, nothing more*". From this principle, only what the user needs to know about the application and the available options should be presented on the screen, affecting how the design is developed.

Ronchi [6] pointed that a well-developed interaction design could serve as bridge to fill the gap between man and machine, enhancing the interaction between them:

> "The aim of interaction design is to close this gap (in man/machine communication) by bringing usability into the design process. This means developing interactive products that are easy, effective, and enjoyable to use from the users' perspective." [6]

However, there are no easy rules to define which solution is the best when displaying content on the screen. Attention must be paid to aspects like intuitive usability, easy navigation, clear information, nice layout, harmonious colors and internationalization, also respecting the values of HCI/GUI in a well developed perspective. That is the base of the design concepts for the *StreetDroids*' project.

StreetDroids was developed for Google's Android platform and, as mentioned, targets devices with 480x320 pixels screens. One of the features of the platform is the possibility of using the screen in a vertical or horizontal position. Some applications developed for Android can be used in both positions, which demands a flexible and adaptive design. That represents a change in the design paradigm since it is no longer possible to design for a single static position and view. It also makes it harder to predict patterns of user behavior because all the content might change according to the device's position. Taking this design challenge into consideration and looking for a solution that can clarify the structure of the game, the project fixed the vertical position for the game format. That choice considered also the most common position for handling a mobile phone. This decision not only facilitated the development, which was then carried out using a width of 320 pixels and height of 480 pixels, but turned the interactions clear and obvious for the user.

Once decided, it was necessary to keep in mind that the design for mobile requires special attention about the use and optimization for the small space available, where the choice of the displayed information is crucial for the navigation and performance. "*Designing for a mobile application is really quite a bit different than for desktop software. Limitations of the device itself, including screen real estate and user input methods, force us to make different choices.*" [7]

Another issue around screen usability is the visualization of elements and possibilities of navigation, where a minimum height and width should be considered. The displayed elements cannot be too small, considering that some users may have visual deficiencies. Also, the projected game has an outdoors context, which means that the lightness of the environment may interfere with the visualization as well. "*For small-screen interfaces, human factors designers face the challenge of displaying all the information they want to present, while making sure that what they present is not too small to be seen by the user.*" [2, Pg 324]

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2   The T-Mobile G1 was the chosen Android mobile device for the *StreetDroids*' Project. Further information about this device is available in its official website.[1]

> "While devices such as mobile telephones and MP3 players have continued to shrink, the problems with controlling and using these miniature devices have grown. From the physical ergonomics associated with using the systems to the navigation of tiny menus, the new systems have proven to be substantially different and more difficult, to use than their bigger brethren." [2, Pg 10]

These considerations were crucial for the design development of the mobile game. It is clear that the game could not be developed only by taking concepts of design of desktop applications and shrinking to a 320 x 480 pixels screen. It was sought to treat the mobile screen as an independent media, respecting its size limitations and exploring every pixel available in a user-friendly way.

The touch-screen feature is another factor that should be considered for screen design optimization, where the player uses fingers instead of a mouse or joystick. Fingers are less accurate and demand a larger area if compared to a pointer mouse.

> "(...)the finger is not a mouse . On the desktop, a user can use a variety of input devices — such as an Apple Mighty Mouse, a Logitech trackball, or a laptop touchpad. But, on screen, the mouse pointer for each of these pieces of hardware is always identical in shape, size, and behavior. (...) Additionally, finger input does not always correspond to a mouse input. A mouse has a left click, right click, scroll, and mouse move. In contrast, a finger has a tap, flick, drag, and pinch." [8]

Some Android devices have a "trackball" (as the mentioned T-Mobile G1 [1]) which works as a mouse. In the design process for the interactions, it was assumed that this hardware was not available, because not all mobile devices developed for the Android platform actually contain it. It was assumed users would use their fingers to interact with the game. In the next sections it is presented the solutions and concepts applied for the *StreetDroids*' game.

3.4.2.3 - Design Concept for the Game

Albert Einstein once suggested to "*make everything as simple as possible, but not simpler*" [3]. Evidently he was not referring to design for mobile screens, but this axiom can be perfectly applied for it. An intuitive and attractive user interface is usually a familiar user interface. [9]

> "When you design user interfaces, it's a good idea to keep two principles in mind:
> 1. Users don't have the manual, and if they did, they wouldn't read it.
> 2. In fact, users can't read anything, and if they could, they wouldn't want to.
> These are not, strictly speaking, facts, but you should act as if they are facts, for it will make your program easier and friendlier."[10]

These premises were applied when developing *StreetDroids* to support different types of open air scenarios. The main idea was to offer an intuitive interaction scheme. One of the features of the game is that users can create their own maps and characters through an on-line platform available at www.streetdroids.com. However, the design process started to be developed based on a default map and mission created using the "old city" of Bremen as scenario, with a historical emphasis. This map choice, together with the Master Project's name (*mobileHIVE*[3]), were the inspiration elements for the visual elements, always aiming the user-friendly interaction.

> "The audience must be captivated, but at the same time, delivered an easy-to-use, well-polished title. The aesthetics of the game are important, but the functionality is equally critical. The app must perform flawlessly, or your judges will call you out."[11]

Taking into consideration the aesthetics and functional aspects, the game starts with an iconographic main menu, where the user can access the main features and information about the game, such as Play Game, Language, Quit, Settings, Info/About and Help. The Figure 1 shows a screen-shot of the main menu, where the icons are followed by the message: "*Please select one of the buttons*". The logo of the game appears on top and disappears on the other screens when it is not needed, opening space for other elements.

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3   See "mobileHIVE" logo and description, at Appendix.

Figure 1: Initial screen with the main menu and logo.

3.4.2.3.1 - Icons and Menu

Each button in the main menu has a hive capsule format, originally created as reference to the Master Project's name and logo. The hexagon format of each button fits in a well-balanced distribution on the screen, surrounding a centered image which symbolizes a mobile irradiating information, as shown in Figure 1. To enhance the meaning behind each button, it was chosen the use of icons.

> "The universal nature of icons avoids the idiosyncrasies of different languages. They also speed up the rate of input by removing inferable constituents of communication, such as prepositions. These advantages have made icons pervasive in modern computing systems and ubiquitous in communication and assistive aids."[4, Pg 298]

The menu shows two types of options: ENABLED (with ON and OFF status) and DISABLED actions. In Figure 1 the "Language" and "Settings" were disabled (not implemented, for technical reasons, in the first moment), and the others enabled. After the user clicks in one of the enabled buttons, it changes to an ON status, with color and a centered white, bright icon, as shown in Figure 2.

The main navigation buttons were based on an iconographic concept, divided in three packages:

- Main menu icons (Figure 1 and 2).

- Puzzle icons (Figure 3). During a puzzle the user can ask for the Non-Player Character (NPC help), which will offer some options as hints, information about the puzzle and option to quit.

- Navigation icons (Figure 4). These icons are used to help the player during the game, giving the status feedback about her performance, such as collected coins and items, and also offering the NPC help and accessing the compass.
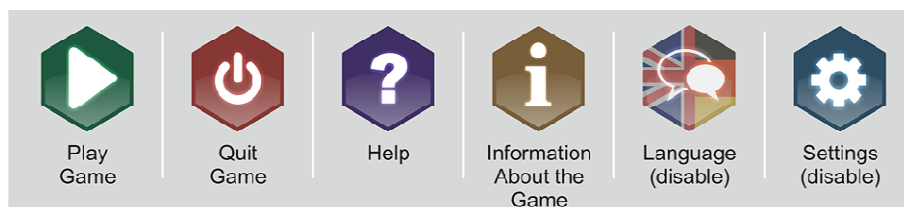
**Figure 2: Developed Icons for the Main Menu.**
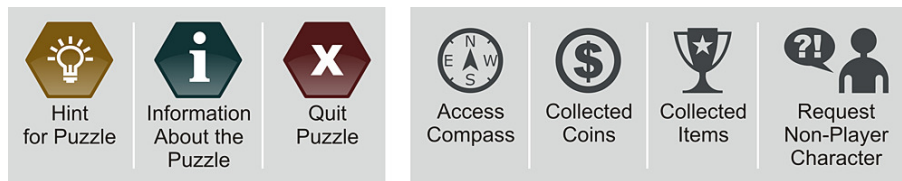
Figure 3: Icons accessed by the NPC during a puzzle. Figure 4: regular icons for the navigation during the game.

Some research on the appropriate symbols to use for the icons was made, in order to get the proper metaphor for each action, maintaining the visual consistency for each icon group. The idea was to use the most well known concept for those actions and metaphors, allowing a meaningful interpretation even in a multicultural environment. Also, the research went further and also it was considered the way in which players interact and navigate with the game using their fingers on the touch-screen:

> "User interface designs for touch screens must carefully consider the size of and spacing between touch-activated buttons and icons so that the user's inputs will be accurate. Usually, the larger the button, the easier it is for users to accurately point to it. But often, computer screen space is limited. Designs must trade off between button size and spacing that maximizes accuracy, and the ability to support the desired functionality for a given screen. (…) There was a significant difference among button/icon sizes. People performed best when it was equal to or bigger than 40*40 pixels."[12]

This rule about the size of buttons was observed. The navigation menu in the bottom of the screen was directly influenced for this touch-screen factor, where the available buttons followed the minimum height of 46 pixels, with width changing from 99 to 56 pixels, according to the game scenario, as shown at Figures 5 and 10.
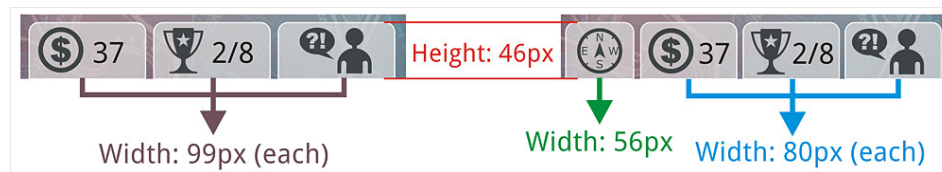
Figure 5: Bottom Menus used on Game, during a Puzzle and Map, respectively.
All buttons are above 40 x 40 pixels dimensions, improving the perception by the user.

3.4.2.3.2 - Colors

The composition of the design could be not considered complete without paying special attention to the selection of colors. The colors of the interface evoke answers and stimulation. *"One of the major challenges when working with color is finding a set of colors that work well together. When colors look good together, the effect is often referred to as color harmony"*[13, Pg 45]. Sir Isaac Newton invented the first color wheel. He split white sunlight into red, orange, yellow, green, cyan, and blue beams, and then joined the two ends of the color spectrum together to show the natural progression of colors. Newton associated each color with a note of a musical scale. A century after Newton, Johann Wolfgang Goethe began studying psychological effect of colors (Figure 6). Colors can be used to create illusions, sensations and luminosity in a layout, creating contrasts and harmonies in the screen. [14]
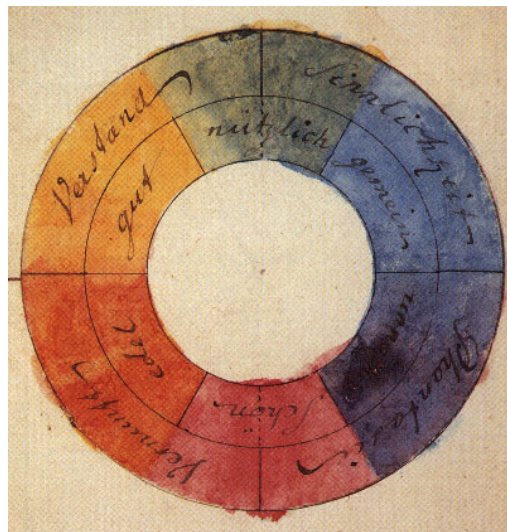
Figure 6: Goethe's Color Wheel. [15]

The color wheel served as basis for further studies about the use of colors. One interesting result is about the proper combinations of colors, which can be verified using the wheel. By positioning a square inside it, the corners will point 4 colors which after mixed will result in Grey. [13, Pg 48]. The Grey color can be considered as a neutral one, being ideal for background combinations. [16].

This balance of colors was used for the background colors at the *StreetDroids*' screen. This process is illustrated in Figures 7, 8 and 9. The square touches, in a clock-wise rotation, the orange, yellow-green, blue and red-violet areas. Extracting the tunes, they were applied in a soft version to the map that is the background of the game.
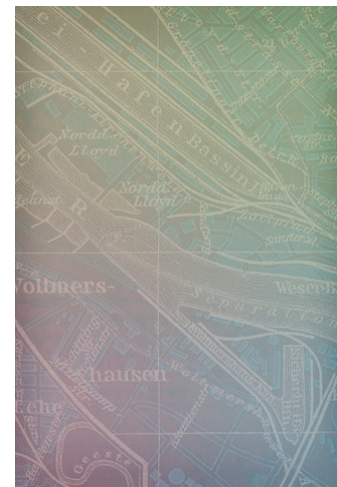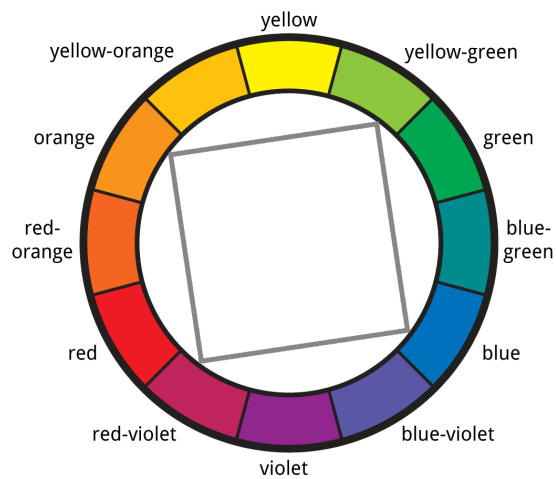
Figure 7: Selected Quadrant inside a Color Wheel. [4,]
Figure 8: Created color scheme based on the quadrant at Figure 7.
Figure 9: Game Background with the colors applied above map[5] layer with transparency property.

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4   Image modified from: Fox, B. 2005. [13, Pg 48]

5   The background image was taken from a selection on the map of the city of Bremen, dated from 1910, available at the online library of the University of Texas at Austin. [17]

3.4.2.3.3 - Game Interface

Optimization of space, simplicity, metaphorical icons and symbols, and direct navigation were the key elements that guided the development of the game interface.

"Typically, a graphical user interface draws on a user's environment to provide a metaphorical representation of the user's tasks. A metaphor provides an analogy to concepts already familiar to the user, from which the user can deduce the system's use and behavior. Icons can express the metaphor directly, as graphical representations of the metaphorical objects. They may also directly represent a physical object.

Icons are distinguished from other symbols on screens by the fact that they represent underlying system functions. Icons represent the objects, pointers, controls and tools making up the domain of an application and that users manipulate in doing their jobs. They can also represent status indicators used by the computer system to give information to the user and to mediate user interactions with software applications."[18]

The metaphorical elements were not exclusive for the navigation buttons, but also applied to the entire interface, including background, NPC and action feedback during the game. One example is how the NPC "talks" to the player using the metaphor of comics' bubbles (balloons), as shown in Figure 10. More than just offering a functionality, it is necessary to coordinate the graphic elements in order to provide a compatible and comprehensive visual rhetoric. In this way, the use of familiar elements helps to enhance the comprehension of the situation by the player. In this example, it is clear that the text displayed on comics' bubbles mean that the NPC is talking directly to the player. In Figure 11, on the other hand, the feedback uses a different approach, showing a gained item with its description.
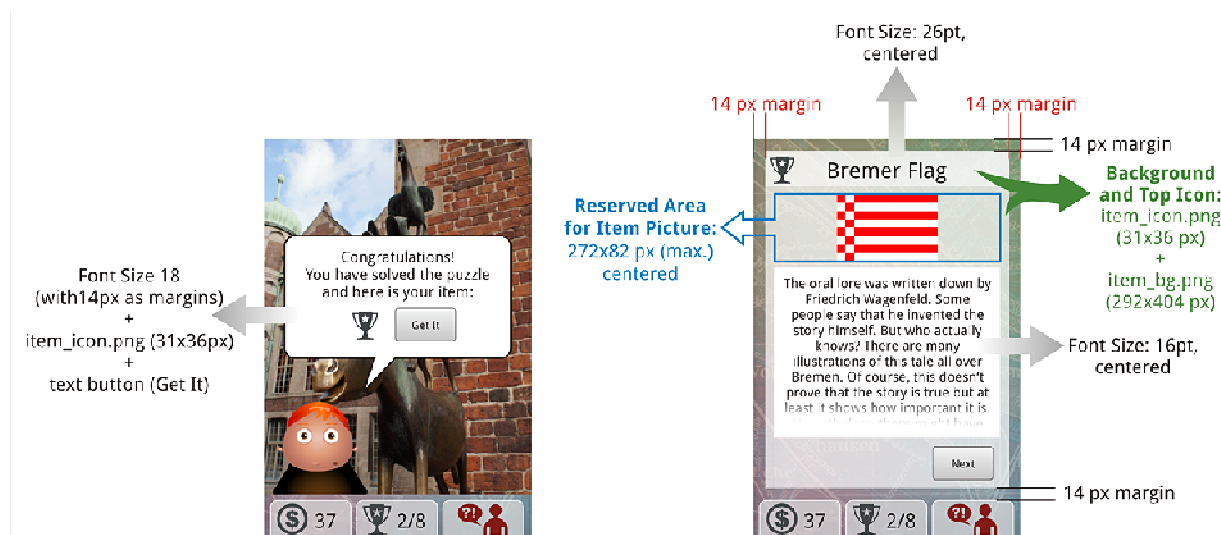
Figures 10 and 11: Tutorial example about navigation (and dimensions) for collecting and visualizing a gained item.

Scrollbars were avoided in the developed design. In some situations, however, they proved necessary, being introduced with a "fade out" effect, as shown at Figure 11. "*To create a better mobile experience, follow these guidelines: - Simplify everything. Use clear, short, simple words for links, buttons, and menus*"[19]. It is important to point that one of the fundamental ideas of space optimization is that all required information should be displayed at the screen whenever possible.

"A user interface without a scrollbar is the best experience for the user. However, if the information is more than the display area, a vertical scrollbar is acceptable. Always avoid horizontal scrollbars. These provide a bad user experience in a small device and can be avoided using 100 percent-width." [idem]

Despite the effort to provide meaningful items and other visual rhetoric components based on icons, text buttons are still necessary on the game interface. They are used for direct questions and actions, as shown in Figures 10 and 12.

"Labels. Button labels should be clearly spelled out, with meaningful descriptions of the actions they will cause to be performed. Choices should be composed of mixed-case single words. Multiple words are preferred, however, to single words lacking clarity in their intent. If multiple-word labels are used, capitalize the first letter of each word (headline style). Use the same size and style of font in all buttons.

The regular system font is preferred. Never change font style or size within buttons; these kinds of changes can be very distracting to the viewer. Center each label within the button borders, leaving at least two pixels between the text and the border."[5, Pg 408]

The text-buttons should use direct texts, expressing acts that could be easily understood by the player. Another reason to use simple and direct texts is the possibility to be translated in future language versions.
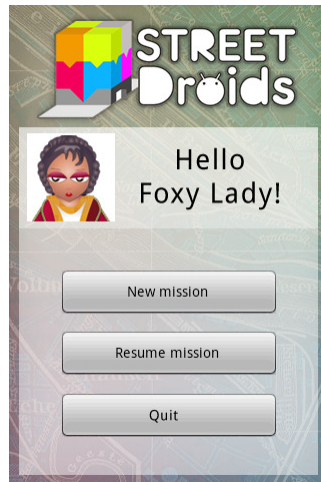

Figure 12: Text buttons

3.4.2.3.4 - Navigation Design and Immediate Feedback

The use of icons and visual feedback can support the player to become aware of actions and follow consequences. "*You can improve the flow of your application by helping your user more quickly ascertain the meaning of your controls*"[7, Pg 148]. One way to enhance the controlling aspect is using immediate feedback on the navigation. This feedback can be done by image, text and symbols, as shown in Figure 10 and in the following examples.

One example is when the player accesses the compass during the game in order to find out where the next puzzle to be solved is located. Once the player clicks on the "compass button" on bottom screen, it immediately changes its color, showing that the function is active and displaying the compass with the needed information, as seen in Figures 13 and 14.
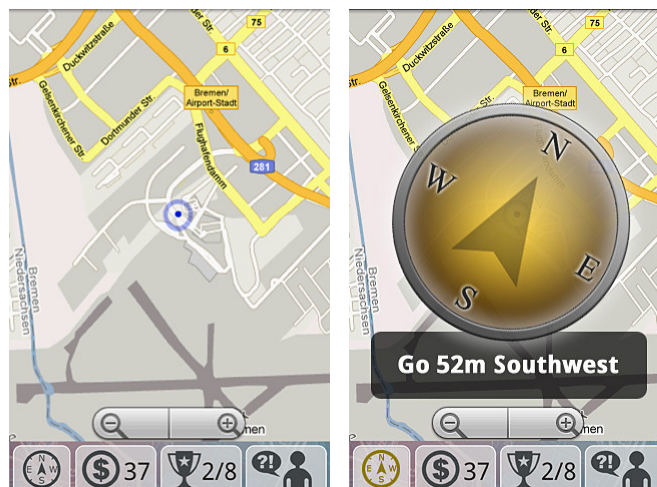
Figures 13 and 14: map during the navigation toward the next puzzle, and accessing the compass (with proper feedback)

Another subtle feedback is the color of the compass at the screen. It is available in three different colors: Green, when the user is close to the target of the puzzle (0 to 50 meters), Yellow if near (50 to 100 meters) and Red if far (above 100 meters), as shown in Figure 15.

Figure 15: the three stages of the compass, according with the distance from the next puzzle/target.

Another example of immediate feedback presented on the game interface is when the player asks for help to the NPC during a puzzle. The icon (button) changes its color, as seen in Figure 17, and after the choice is made, a floating-window shows up, describing the consequences of this choice and asking the user for confirmation.


Figure 16: accessing the NPC (Non-Player Character) during a puzzle
Figure 17: Feedback about the chosen action.

Another way to give immediate feedback regarding the main menu is including label on the buttons as soon as they are clicked by the user.

> "One common way to enhance menus is by using icons. Originally, on desktop systems, icons were used to visually represent an object, or function, of the operating system (e.g. an icon to denote a document). Icons were used in menu systems to replace, or augment, text descriptions of functions. Pure replacement of text is rare – it's hard to pick an icon that unambiguously represents a function. More commonly, icons and text are used together in menus to reinforce an idea."[20]

This concept was followed with the labels in the initial screen, where a help button explaining the game and the used symbols is also available.
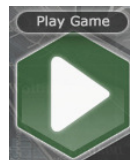
Figure 18: Play Game button with label

Observing the specific design developed for the *StreetDroids* as an academic learning process, it is evident that a careful theoretical review offered the proper support for efficient decisions. The iconographic navigation, allied with the immediate

feedback, can be a powerful combination for usability and friendly navigation.

3.4.2.3.5 - Characters[6]

(Text)

3.4.2.3.5 - Characters (by Maria Catalina Payan {HS-Bremerhaven})
Covered-Topics: Visual concept behind the characters; how to design identifiable, friendly and recognizable characters in small displays.

3.4.2.4 - Final Considerations

Planning a good interface design for mobile screen is not just a matter of providing colorful buttons and fancy graphics. For a game development, *"a well-designed product based on a team effort with a simple, user-friendly interface developed within a reasonable time frame will be successful"*[21]. That was one of the guidelines used to support the learning process during the Street Droids design development. It was not a "trial and error" process, as commonly can be observed in game development. Each aspect was deeply analyzed based on the theoretical frameworks and translated for each specific case.

In that context, *ergonomics*, and *internationalization* are important keys for the design development in this project. The use of icons and symbols is one of the research areas whose results were reflected in the solutions for the user interface. In a "visual era", as the world is now experimenting, GUI allied with HCI are more than just important fields of research. They can define the success or the failure of a project. If the final product does not hold the users' attention, you will lose them.

To conclude the design overview, a general evaluation of the product (see the results at section "4.2 Evaluation") showed that the design aspects of *StreetDroids* received a positive approval by the consulted users. This indicates that the used approach to design development resulted in an attractive product. It is possible to believe that this is a reflection of two main aspects of the used approach, the choices made in consonant with theoretical foundations and the observation of a meaningful, coherent and well implemented aesthetic language.

3.4.2.5 - Future Work

One of the possible expansions of this project is the implementation of augmented reality puzzles to create an even more engaging experience. For example, it could overlay graphics of how a place used to look in the past over a current image presented on the screen.

An important issue regarding future work on the design interface is the adaptation for different screen resolutions. The Android platform is available for devices with several different screen resolutions [22], with different aspect ratios. It is not enough to simply scale the game to different resolutions, it is needed to adapt for different space proportions.

If the game is to be used by several kinds of users, it is important to consider the age factor. Discount-age applications have been developed [23], together with some criteria for the product interface design, such as simple and minimalist start menu and large icons and fonts.

> "Adaptable interfaces, where the user can adapt a generic interface for his or her disability, are frequently put forward as a solution for the dynamic diversity exhibited in older users discussed in this section. Some people might say that those with different needs are supported by systems that allow the users to configure the interface to their own requirements. Microsoft Windows, for example, offers several adaptations, which can be invoked by the users to help them use the interface."[24]

Another issue for future implementations is the translation of the game, towards the internalization of *StreetDroids*. To this end, it is necessary to use only simple instances of English text, whenever possible. "Simple English text will be easier and less expensive to translate."[5, Pg 571]. As a recommendation, German should be the first European choice (after English) [idem] and, in this context, Street Droids was placed in a positive environment.

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6   Section written by Maria Catalina Payan {HS-Bremerhaven}

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3.4.2.7 - Appendix / Visual Documentation

Other design aspects not covered by the final report. This section serves as visual documentation of the *mobileHIVE*'s project, based on voted contests made by the project members.

3.4.2.7.1 – mobileHIVE

Name of the Project: Chosen by votes, at 29.05.2009

- **Name's concept:** Bees are having a very social nature and are building communities, which is what we want the users to create by using our game. Their hive resembles our busy group that tries to develop this game..

- **Authors:** Jana Leoni Wedekind, Cristina Laura Botta

Logo of the Project: Chosen by votes, at 05.06.2009

- **Logo's concept:** In this logo three hive "capsules" are combined suggesting the union of colors, which can be also a metaphor for the union of different skills backgrounds that are presented in our group. In the center, the result of this colors' union is another hexagonal form in white color, which irradiates content for all corners, symbolizing the mobile aspect of our project.

- **Author:** Joatan Preis Dutra

- **Logo:**

3.4.2.7.2 – StreetDroids

Name of the Game: Chosen by votes, at 08.10.2009

- **Name's concept:** Androids on the street .

- **Author:** Isabella Lomanto

Logo of the Game: Chosen by votes, at 05.11.2009

- **Logo's concept:** Depicted are building blocks, which have an identical shape, but differ in color. They are stacked and interconnected with each other to form a new unit which fits perfectly into a foundation. The foundation has a door, which is opened - signaling at the openness of our platform. To make the connection to the wordmark and the

environment the game is played in, the building-like structure is multidimensional and situated on a street leading from the fore- to the background.
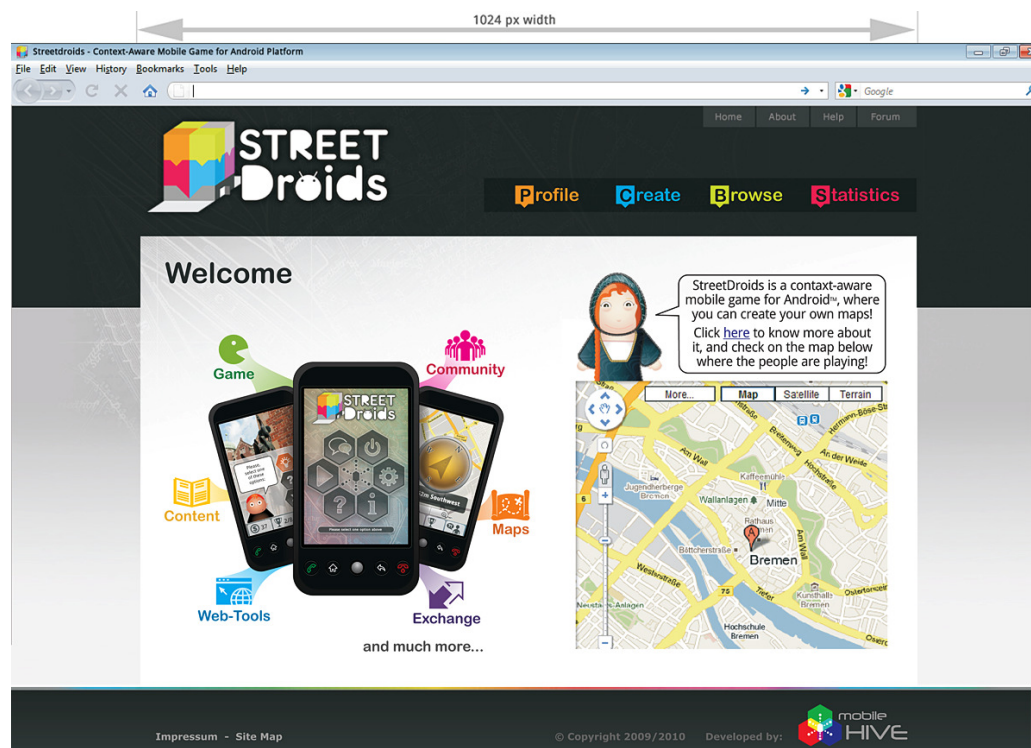
- **Author:** Till Hennig

- **Logo:**

3.4.2.7.3 – WebDesign

WebDesign model for the Game: Chosen by votes, at 19.11.2009

- **Design's concept:** Androids on the street .

- **Author:** Joatan Preis Dutra

- **Original Concept:**

3.4.2.7.4 – Poster for promotion

Poster for the Game: Chosen by votes, at 05.02.2010

- **Author:** Joatan Preis Dutra

- **Original Concept (A2 format):**