A REPORT

ON

DESIGN OF FRONT END

FOR

COWS & BULLS

BY

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Prepared in partial fulfillment of

Human Computer Interaction Course (BITS C364)

AT

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

ACKNOWLEDGMENTS

We would like to express our sincere gratitude to our instruction Mr. Mangesh Bedekar for having provided us this opportunity to successfully complete this project.

We are obliged to comuf.com for having provided us with a free web space to host our project. Our thanks are due to our brothers and sisters for taking part in this research and for patiently answering our questions. We would also like to thank our friends for taking part in this analysis procedure.

ABSTRACT

The goal of this report is to design an application based on human interaction for cows and bulls game. Necessary techniques are applied using Human Computer Interaction principles and conclusions are drawn. Based on these conclusions a User Interface along with a working back end is designed. This report deals more on the front end design and the principles related to it. A brief description on cows and bulls (mastermind) game is also given.

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INTRODUCTION TO COWS & BULLS

Cows & Bulls is an interesting and entertaining code breaking or number finding game. It is one of the alternate versions of the Mastermind game. This is a game which tests logical reasoning and presence of mind. It is usually played between two players. The aim of the game is to find the secret (4 digit) number chosen by an opponent, in as few guesses as possible.

On a sheet of paper, the players each write a 4-digit secret number. The digits must be all different. Then, in turn, the players try to guess their opponent's number who gives the number of matches. If the matching digits are on their right positions, they are bulls, if on different positions, they are cows.

Example

- Secret number: 4271
- Opponent's try: 1234
- Answer: 1 bull and 2 cows. (The bull is "2", the cows are "4" and "1")

Rules of game are pretty simple. They are tabulated as below

- only four digit numbers (although 3, 5 digit games are also played)
- The digits cannot repeat.
- Players cannot take back a turn.
- The number cannot start with 0, but can have 0 in other positions.

INTRODUCTION TO HUMAN COMPUTER INTERACTION

Human–computer interaction (HCI) is the study of interaction between people (users) and computers. It is often regarded as the intersection of computer science, behavioral sciences, design and several other fields of study.

A basic goal of HCI is to improve the interactions between users and computers by making computers more usable and receptive to the user's needs. Specifically, HCI is concerned with:

- methodologies and processes for designing interfaces
- methods for implementing interfaces
- techniques for evaluating and comparing interfaces
- developing new interfaces and interaction techniques
- developing descriptive and predictive models and theories of interaction

There are obvious differences between humans and machines. In spite of these, HCI attempts to ensure that they both get on with each other and interact successfully. In order to achieve a usable system, one needs to apply what he knows about humans and computers, and consult with likely users throughout the design process. In real systems, the schedule and the budget are important, and it is vital to find a balance between what would be ideal for the users and what is feasible in reality.

A long term goal of HCI is to design systems that minimize the barrier between the human's cognitive model of what they want to accomplish and the computer's understanding of the user's task.

Researchers in HCI are interested in developing new design methodologies, experimenting with new hardware devices, prototyping new software systems, exploring new paradigms for interaction, and developing models and theories of interaction.

DESIGN PRINCIPLES OF HCI

A number of diverse methodologies outlining techniques for human–computer interaction design have emerged since the rise of the field. Most design methodologies stem from a model for how users, designers, and technical systems interact. The following are some of the most important design principles of HCI. We will also try to describe each design principle in brief since they will be referred to in various parts of this document. Please note that these principles are broad in scope than just guidelines i.e. they are more fundamental, widely applicable, and enduring.

Principle1: Know The User

- Identify all the users who will be using the application.
- Diversity across multiple dimensions: age, gender, physical and cognitive abilities, education, culture or ethnicity, training, motivation, goals, personality.
- Two types of user knowledge:
    - Interface: knowledge of the technology that we will be creating.
    - Domain: knowledge of the user in the desired field.
- Accommodate different user profiles even though they are not in the domain of present users.

Principle2: Identify the Tasks

- Also known as know the domain.
- Try to fit together all the requirements and if we have an idea on case analysis, try to design the use-case analysis of the task
- Task decomposition
    - Specify which tasks are atomic
    - How the composite tasks are put together
    - Calculate the task frequency i.e. which task are more frequently used.
    - Design the invocation methods structure.

Principle3: Choose an Interaction Style

- Interaction style simple means the user interface.
- The best user interfaces provide the best match between interaction style, user profiles, and the Tasks.

Principle4: The Golden Rules

- The golden rues provide individual takes on the most important elements of good user interfaces. Here are Shneiderman's Eight Golden Rules.
    - Strive for consistency
    - Cater to universal usability
    - Offer informative feedback
    - Design dialogs to yield closure
    - Prevent errors
    - Permit easy reversal of actions
    - Support internal locus of control
    - Reduce short-term memory load

Principle5: Prevent Errors

- This is the ONE RULE to rule them all. If there is any single golden rule that distinctly rises above the rest, it would be Shneiderman 5^{th} on the above list i.e. Prevent Errors. Here are the ways to do so.
    - Specific, positive, and constructive error messages
    - Provide constant feedback on the state of the application i.e. suggest what can or cannot be done at a given time
    - Correct actions: Understand conditions that may foster errors and either keep the user from performing erroneous actions or allow them to undo these actions
    - Complete sequences: group multiple consistent steps into single, replicable composites.
    - Unit test the application after each level of development.

Principle6: Automation vs Control

- Sanders and McCormick suggest that we play to a human being's strengths as opposed to a machine's.
- Automation: Avoid routine, tedious, and error-prone tasks.
- Control: Focus on making decisions, dealing with the unexpected, and planning for the future.
- We generally don't want the computer to have a mind of its own
- Thus, striking a perfect balance between the two is of at most importance.

OUR APPLICATION

Cowsnbulls.comuf.com is a web based application designed with a successful human interaction in mind. It is hosted at http://www.cowsnbulls.co.nr. We would like to once again thank comuf.com for hosting our website for free.

What we used

Our web application is developed in HTML and Java Script alone.

Why we used

Reasons for choosing HTML

- A browser is the most available application in every computer.
- It is also available in most of the mobile devices like cell phones.
- This makes sure that whoever wants to interact with our application can do so without the restriction.
- Web applications are also platform independent. i.e. compatible with all operating systems.
- There is no problem for handling different versions. The user doesn't have to update the application every time there is a change.
- The interaction can be made fun and easy since everyone is already familiar with basic navigations in a browser.
- The HTML code can be reused to make vista widget which will help in a better interaction with the users.

Reasons for choosing Java Script

- We want the interaction to be seamless. I.e. without any lag.
- Since the web app is hosted in a remote server, a server side scripting language like php or jsp is avoided since the user needs to wait a long time for processing to be done. Hence we decided to do the project in client side scripting language like java script.
- Further, wasting bandwidth just to play a game when u can do the same without even connecting to net is something which we feel is what every agrees with.

Categories of Description

Our website is described in the following categories.

- Look and Feel
- Customization
- User Friendliness
- Speed of Operation
- Features

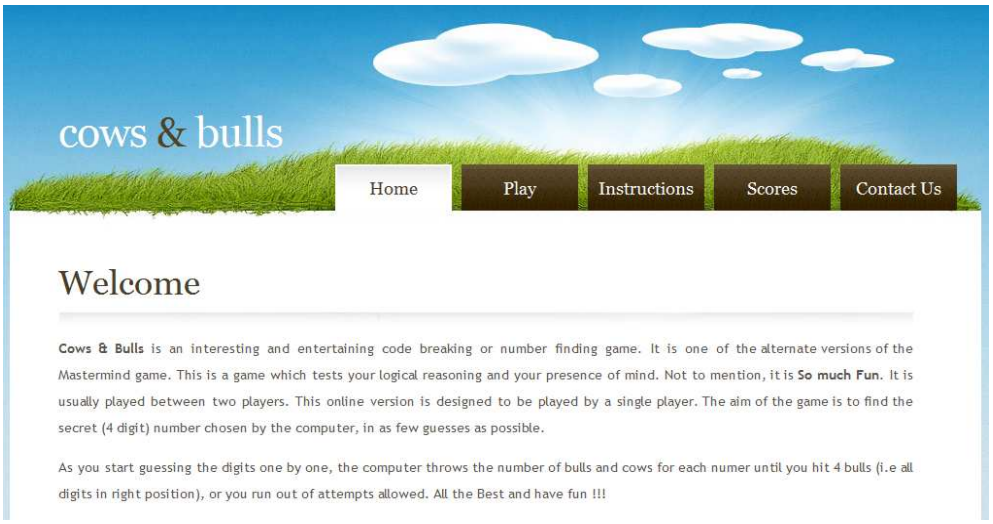
In each category we specify the design principles (refer to previous page for design principles) used to design it. We will also describe some of the problems faced by us for designing the respective category and the methods we devised to counter them.

LOOK AND FEEL

This section describes the way website looks to a user. The term “look and feel” includes everything from the font to the color combination of background. A better look is created when there is a clear contrast between the background and the text above it.

The first thing which we did to decide the look and feel of the application is to apply the First Principle i.e. to understand the user. Since, we are developing a game application it is expected to have users who love games. Further they will be expecting a fun and bright environment. In fact major users may be young and hence love graphics and animations. The following conclusion can be made from the above discussion.

- Web app should be bright and funny
- Web app should have the look of a game
- Desirable to have pictures and animations



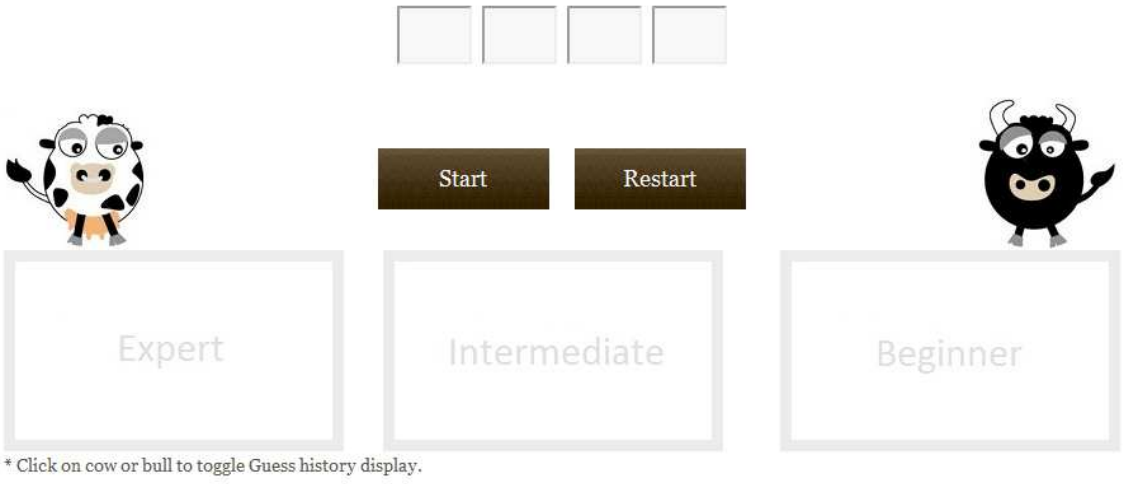
Added to the above principles, we can also conclude that we will be developing a game which will involve mathematics and concentration heavily. Hence having lot of images and animations may distract the user from concentrating on the actual game. User should have nothing on screen which can be a distraction, just the plain numbers for at most concentration. We thought a lot on this matter and came up with a solution which brings a correct balance between the two extremes. Exactly how we did this is explained in the next section.

CUSTOMIZATION

This section describes about the way the user can modify the interaction procedure of the web application to suit his style and needs. One this to note here is that customization of web applications is a very difficult process mainly due to the restriction of the web application within a browser.

One way to customize any web application is to force the user to log into the application as soon as they enter the site. With this we can track all the customization features which the user wants, save them and then redisplay the next time the user logs in. further the top scores feature also requires a login in mechanism. But we feel that doing so poses e a lot of problems as shown below

- It violates the first rule to understand the user. Since most users may have no idea on logging since they can be young kids or can even be aged users who have no idea on logging
- Logging into a website with usernames and passwords just to play a game is something no one would be willing to do
- It violates the second principle since we are moving the actual task (i.e. playing game) away from hands of users.



Based on the above conclusions, we decided not to have a login feature. In fact login is not the only solution for customization. We designed the website in such a way as to allow the user to quickly set the application in the way he wants it to look.

This way we are solving another problem which we had in the previous section. If we customize the website in such a way to let the user have at most concentration, it will definitely help in a better interaction. But we really don't know what would be the best way for all the users. Since what is good for one user is not at all good for the other. A better way is to design the website and ask the user to quickly arrange it himself in such a way in which he can have good concentration.

USER FRIENDLINESS

This section describes the user friendliness aspect of the websites. User friendliness is an important criteria as the people visiting the website may not have any technical knowledge of any kind. The ability of the web application to let the user easily access its content is of at most importance.

Again applying the first principle in user friendliness direction the following conclusion can be drawn

- All the buttons must be recognizable.
- Links must be neatly colored and distinguishable.
- The web application must use the standard symbols for seamless interaction
- Appropriate images must be used so that a user can understand the application in a better manner even if he has no technical knowledge.

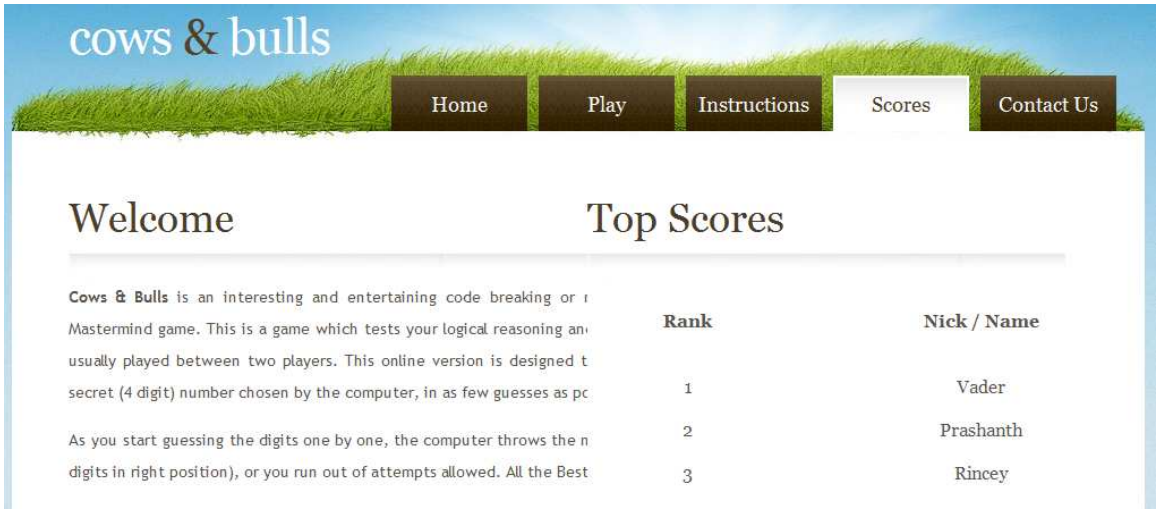
Additional points on user friendliness are discussed in the features section of this report.

SPEED OF OPERATION

Research shows that a user avoids a website if it doesn't open within its first 6 sec of access. Hence, the speed of operation is an important criteria for successful interaction with the application. By speed of operation we mean the level of interaction which the user has to go through to play the game.

An important point to note is that the speed of operation is affected by a lot of parameters like the time of use, the region of use, the number of people currently using the application etc. The following design methods assure a very good speed of operation.

- The user has no need to log into the website to play the game.
- The complete application is developed in JavaScript there by avoiding any server client communication. This gives the game a seamless and smooth interaction.
- The game part of the web application is linked perfectly so that a new user doesn't have to go through a lot of navigation to play.



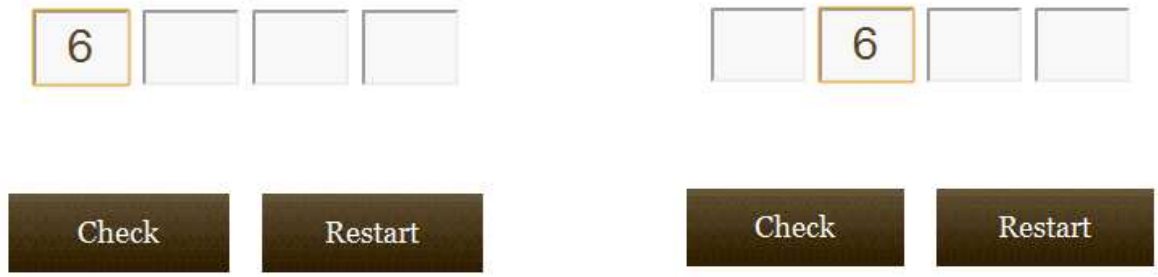
FEATURES

This section describes about the features provided by the web applications for successful interaction with the user. Since this is a game application the foremost features should facilitate the user to play the game better. A lot of features which makes the interaction easier and simpler are incorporated. Since this is a huge section in itself we have divided it into a much smaller sections for better case study.

Error Handling

This is where principle 5 comes into play. When the game starts, the user inputs his guess number into 4 input boxes. Since the user may enter wrong / invalid entries we have to handle them properly, and show an appropriate error message. Instead we went one step ahead and tried to completely eliminate the happening of errors in the first place. I.e. even though the user enters an invalid entry, the web app handles it in such a way that he immediately knows what he did was invalid even without getting a single error message from the system. This is shown is the following picture.

This is an example when user enters two 6's in first and second box simultaneously. Ordinary method is to detect the second 6 and then throw a message that repetition of digits is invalid. In the following method, when the user enters the second 6, the first 6 is removed and automatically put in the second box.

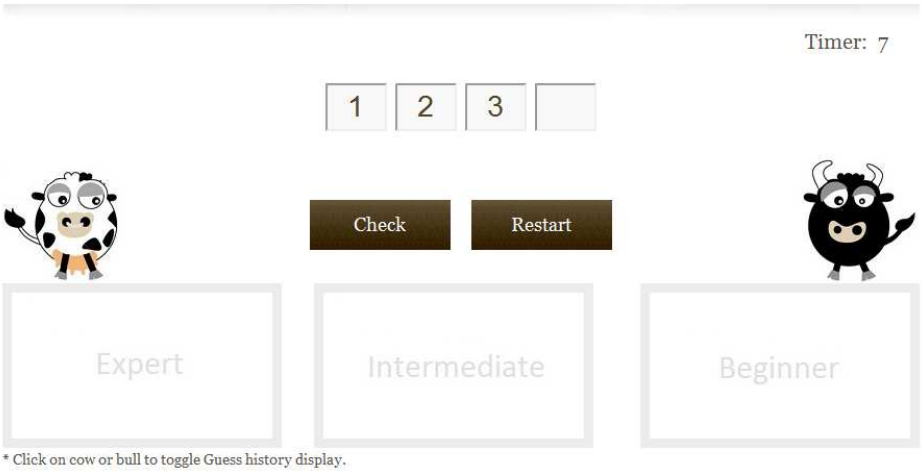


Real-time Validation

Another important feature is the real-time validation. I.e. the inputs are validated immediately as they are entered rather than when the user enters the Check button. This makes the interaction a lot better and also easier.

- When a user try's to start with 0, it is automatically prevented. Thus he himself intuitively understands that he cannot start with a 0 and try's to avoid it. This is in a way making the user a better player.
- When a user enters a same number in two different places. The web app itself removes it from the first position and puts it in the new one. Thus the user intuitively knows that he cannot repeat a number twice without even receiving any error message.
- When a user doesn't enter all 4 tabs the submit button is kept inactive. Thus the user intuitively knows that he cannot proceed unless and until he fills all the 4 fields.
- One more thing to add is that user doesn't even have to press the back space when he wants to overwrite an entry. He can just select the box and type a number, the old number will be automatically overwritten. Thus the user intuitively knows that only one number can be typed in an input box.

This is exactly what Sanders and McCormick are referring to in principle six when they say give control to user while giving the automation to computer.



Hover Help

One more feature is the on hover help in addition to normal help. I.e. if the user is trying to do something which is invalid, then instead of giving an error message and annoy the user, we change the mouse to its respective symbol there by letting the user know that it is invalid and cannot be done.

For example when a user try's to enter values into the input fields w/o even starting the game then the mouse turns into a red NO symbol there by telling the user that it's not valid. We think this is a better form of interaction especially for people who doesn't even know what enabled or disabled means.

Guess Log

One feature which we felt necessary is the guess log feature. But after some little study we found out that most of the experienced players don't want to play the game by watching their previous guesses, rather they want to remember each and every number along with the number of cows and bulls. Thus display of guess log for such users is not desired. Thus we came up with the idea of slid able guess log which the user can set into the mode he feels more comfortable with. This will further help ups in the idea of putting all the concentration on the game.

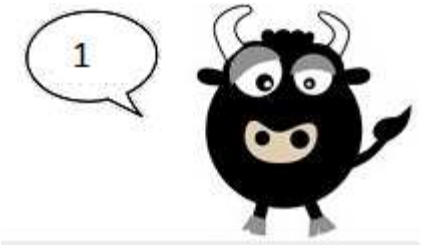
Another best part is that we designed a method of dividing the game into different levels as easy, intermediate and hard. Further rather than just telling the user after completing, we integrated the level and guess box into a single area which not only

shows a user's guess history but also the level in which he is and how many more steps to complete in a desired level.

* Click on cow or bull to toggle Guess history display.

Cow and Bull Values

The most recent cows and bulls values are shown as chat by a cow and bull as shown in the pic. This will not only help for users who are trying to solve without the help of guess log but will also make the interaction as fun as possible. Further on clicking any of the pictures, the guess log display can be toggled on / off.



Top Scores

This feature shows the top 10 players based on the score whenever the web app is connected to internet.

Rank	Nick / Name	Score	Time
1	Vader	3014	5
2	Prashanth	2056	7
3	Rincey	1527	8
4	Krishna	1027	15

Feedback and Analysis

Feedback and analysis are two very important elements in a game. The user must know how his attempt went. Thus at the end of the game, the user will be display a total information on his game along with score, the time taken to complete, the number of steps and also on his level of expertise in the game.

CONCLUSION

The result of this report is tabulated as below.

Category	**Key Design Principles**
Look and Feel	Principle1: Know The User
Customization	Principle1: Know The User Principle2: Identify the Tasks
User Friendliness	Principle1: Know The User Principle4: The Golden Rules
Speed of Operation	Principle2: Identify the Tasks Principle3: Choose an Interaction Style
Error Handling	Principle5: Prevent Errors
Real-time Validation	Principle6: Automation vs. Control
Hover Help	Principle4: The Golden Rules Principle5: Prevent Errors
Guess Log	Principle1: Know The User
Recent values	Principle1: Know The User Principle3: Choose an Interaction Style
Top Scores	Principle2: Identify the Tasks
Feedback	Principle4: The Golden Rules

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