

Multiplayer Interactive Game on a Multi-touch Surface

Project III

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Interaction Design (2008 - 2010 batch)

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Project guide

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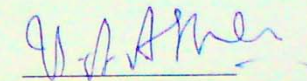
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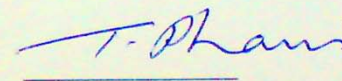
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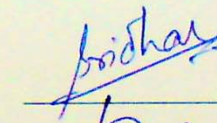
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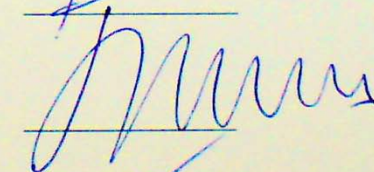
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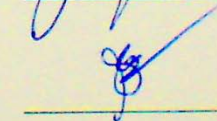
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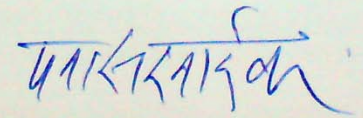
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Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/ source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Mumbai, 2 June 2010

Abstract

Computer games take us to a world full of fun, fantasy and engaging experiences. Computing power, coupled with beautiful animations, huge life-like landscapes open for exploration, and sounds make these games addictive. Players play such games for long hours.

This project started with the idea of making such rich experiential games. User studies were done to understand computer games and players' attitudes and responses. Future trends in gaming were also studied. It became clear that rich visuals and sound designs, which are 'time and skilled resource' intensive tasks, can convert simple activities into rich and engaging experiences. However, it was realized that the fun and social bonding that board games deliver was missing in computer games. It was hence decided to combine the advantages of board games and computer games.

The proposed game "GRAB" is a multiplayer computer game to be played on a multi-touch surface. The game shall incorporate the feel of a board game and facilitate player-player and player-spectator interactions. The computing power and interactivity of computer games are employed to provide engagement and fun. The novelty of the multi-touch hardware and a natural way of interacting with the game will be an attractive factor for players. The game aims at improving hand-eye co-ordination, reflexes and boosts quick decision making. The game can find place in public places like malls, resorts, clubs, schools, etc. The game activity is intuitive enough to encourage learning the game by seeing other players playing. Several concepts on converting this game into educational and learning games have also been ideated.

Acknowledgements

I am deeply indebted to my guide Prof. Uday A. Athavankar.

Prof. Athavankar has encouraged me and pushed me to think. He has been instrumental in developing in me a serious thought about game design and in turn understand the world of computer games. I have benefitted a lot in this process. The discussions that I had with him have been packets of energy and creative thoughts. I shall relish the memories of those discussions all my life.

Thinking about a computer game started with Prof. Phani Tetali, my co-guide who extended his guidance for a computer game design project. Interactions with Prof. Tetali have been extremely resourceful. From him, I received insights into the process of production of computer games and the seriousness of the business. He was always welcome to my wild ideas and showed me a constructive path to approach my work.

I am also indebted to Prof. Ravi Poovaiah for his invaluable inputs and for facilitating the use of the multi-touch hardware in IDC. Prof. Aniruddha Joshi has been very considerate and resourceful during all the interaction I had with him related to this project. I would like to thank both of them for their mentorship.

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Introduction

Gaming is extremely enamoring activity and appeals to a variety of ages. Digital (computer / arcade / console based) games have evolved from simple video games that one could insert a cassette in - plug to a TV - play using a wired remote control to consoles that detect a players motions and manifest corresponding actions on the screen.

Computer games are played widely. The success of these games depends on two different aspects: gameplay and player-experience. People are able to connect immediately with a theme in a computer game. Things not possible in board games can be easily achieved in computer games - sensory feedback like sounds, visuals and logic changing as per time and situations, automating feedback and calculations, etc.

In short through this project, I wish to

- understand the difference between board games and computer games
- learn the interaction patterns and trends in computer games
- work on the aspects of interface and interactivity
- understand the hardware and software integration and its effect on user experience
- get insights into the future trends in gaming.

The entire process of producing a computer game is very attractive for me from the learning point of view.

Process

Beginning the Project

The process of game design is a bit different than the usual design processes where one goes through the stages of primary research, user research, problem identification, brainstorming, design ideation, paper prototyping, usability evaluation, final prototyping, etc.

Game design might not necessarily begin with a problem or user group in mind. It is a random process of ideation. A game designer has to simultaneously think about the gameplay, players, hardware of the game and rules of the game.

Having undergone a game design (board games) course at IDC, I realized that to design a computer game, I need to start ideating and at the same time make myself well acquainted with the world of computer games.

Understanding Computer Games

Computer games are very different in nature than board games. Given this fact, it was very essential for me to understand the factors behind “Why people play computer games”

For this purpose, following steps were undertaken:

- playing different games

- asking players about what games they like and why
- observing the play habits of players (PC games at home, gaming parlours, arcades, LAN gaming in hostels, gaming on the move)
- study of gaming websites / online games

The findings using these methods are presented in the section **Findings** on page 21.

Playing different games

I played a variety of games to understand the gameplay; interactivity - feedback, input, output, rules; hardware, machine intelligence; quality of visuals and sound; etc.

I also tried to understand the classification of activities within a game: physical - skill, hand eye co-ordination based and cerebral - thinking, planning, strategy based.

Contextual inquiry

Using the method of contextual inquiry, semi-structured interviews with gamers were undertaken as talks about gaming and the games they play. Questions about their opinions on different games and ‘what makes them like computer games?’ were asked.

The gamers were asked to recall the various computer games they played since childhood, how their likings changed with age, what

games do their friends play, their favourite games, the last game they played, time they spent in gaming, etc.

The focus of the interviews was to seek following information through various questions like:

What do you do? (demographics)

What are your favourite games? (user choice)

Do you like *Simcity*^[1] inclination towards strategic thinking)

How much time do you play every day? (play habits)

Why do you play games? (reasons for playing games)

Do you like to play alone? (social interaction / multiplayer games)

Have you played in gaming parlours / arcades? (effect of hardware on gaming.)

Do you play board games? (inclination towards board games, appreciation of gameplay)

In all a total of 12 people were interviewed.

Mostly youngsters/students were interviewed as they have a lot of free time to play games. Gamers of this group are very passionate about games and are immersed in the gaming world.

Two working professionals were also interviewed to find any typical patterns in choice of games, effect of time available, etc.

A hawker, observed to play Snake on his mobile phone while commuting in a train, was also interviewed.

Following table is a compilation of the various gamers interviewed.

Gamer 1	21 years	Engineering student
Gamer 2	27 years	PG student
Gamer 3	23 years	PG student
Gamer 4	24 years	Engineer (working)
Gamer 5	20 years	Engineering student
Gamer 6	14 years	School going kid
Gamer 7	23 years	PG student
Gamer 8	24 years (Female)	PG student
Gamer 9	28 years	Scientist
Gamer 10	11 years	School going kid
Gamer 11	42 years	Hawker
Gamer 12	19 years	B.Com. student

Table 1: Gamers - Contextual inquiry

[1] *SimCity* is an open-ended city-building computer and console video game series. In *SimCity*, the player is given the task of founding a city, while maintaining the happiness of the citizens and keeping a stable budget. In the latest three versions, a player is also allowed to alter the terrain of the city before building on it.

Observing the play habits of players



Figure 1: Players in Action

Players in action were observed to record their play habits. Observations about what excites the players, moments of excitement and concentration levels with respect to various games were made.



Figure 2: Observing Players' Habits



Figure 3: 'Snake' Mobile Game.

Many people play games on their mobiles while travelling or as a time killing activity when they are idle. From the most basic phones with 'Snake' to the recent iPhone games having accelerometers, gaming on handheld devices have come a long way. People involved in games on mobile phones / handheld gaming devices were observed.

Multiplayer games^[1] being played in gaming parlours or in halls/hostels were observed. People play on separate machines but can sit next to each other. This was an interesting setting as it slightly matched the way board games are played.



Figure 4: Gaming Parlours and Multiplayer Games on LAN

[1] A multiplayer video game is one which more than one person can play in the same game environment at the same time. A multiplayer setup allow players to enjoy interaction with other individuals, be it in the form of partnership, competition or rivalry, and provide them with a form of social communication that is almost always missing in single-player oriented games. Players may individually compete against two or more human contestants, work cooperatively with a human partner(s) in order to achieve a common goal, supervise activities of other players, or engage in a game type that incorporates any possible combination of the above.



Figure 5: Kids Playing games in Arcades

A few visits to gaming arcades were conducted to have a look at the type of games people played, the different people coming to play and their age groups, effect of hardware on play habits (motor-bikes, balls, coins, cards, etc...), social interaction: between co-players and spectators.



Figure 6: A Gaming Arcade in Dharavi

Study of gaming websites / online games

There are thousands of gaming websites and millions of games available online to play. Flash / Java based games can run in an internet browser and are easily accessible. e.g. www.zapak.com

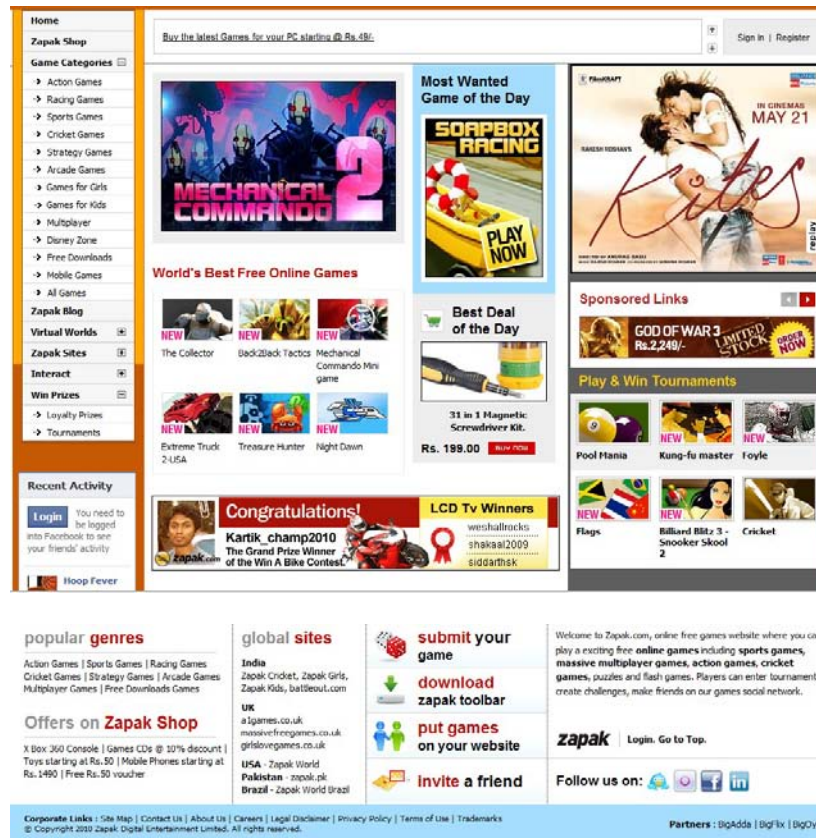


Figure 7: Screenshots of Gaming website - www.zapak.com (referral date: 19 May 2010)

There are Massively Multiplayer Online Role Playing Games (MMORPGs) that are very popular as you get to play against actual people. Here, the games are almost endless and run into levels where players earn powers and rise in the points charts.

e.g. Games like Farmville, Mafia Wars on Facebook (a social networking site)



Figure 8: Screenshot of 'Farmville' a MMORPG played on the social networking site www.facebook.com

Another useful exercise was reading game reviews. There are websites that are very actively involved in reviewing new games. Various sites cater to various genre's of gaming like art games, casual games, etc.

e.g. <http://playthisthing.com>

These websites were studied to realize the following:

- game categories
- types of games people play most
- trends in playing online games
- how are games reviewed (criteria for reviewing)

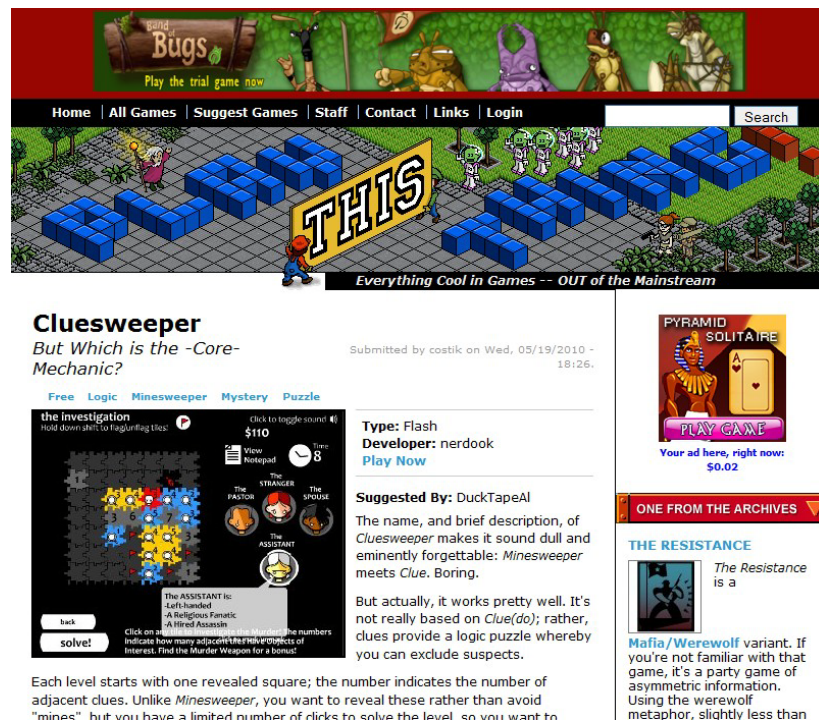


Figure 9: Screenshots of Game review website - www.playthisthing.com (referral date: 19 May 2010)

Findings

Following are the top insights and observations compiled from the above study. Specific findings from the contextual inquiry are presented below. Findings of some general nature are described later.

- One of the gamers interviewed (female) told she had never played games before, only a few times in fun-fairs and arcades with her sibling. However, as she now has a laptop, she plays many games from Solitaire to Counter Strike and Farmville.

Findings from the contextual inquiry

Initiation into the world of gaming

- The initiation into the world of gaming at an early age was prominently seen across most gamers interviewed. They mostly began with TV video games available on *rent at home*^[1] or in gaming parlours on a *per hour basis*^[2]. Later such games became cheap and *affordable*^[3] to be bought by people.
- With the advent of games on a PC, many people, who had access to computers, shifted away from console games. Also, during this time, gaming parlours started mushrooming as a PC was still beyond the reach of many.
- Almost all the gamers interviewed now have their own computers. Two gamers confessed that they previously were addicted to going to gaming parlours where they could get 'high performance machines with loud sounds and an environment for gaming'.
- However, one gamer playing 'Snake' on mobile phones said that he did it to kill time and not especially for enjoyment. He had no history of playing video/computer games.

[1] The typical rent for a gaming console in the year 1992-1995 was Rs. 15 for 6 hours, this was complemented by a 999-in-1 games cassette. Every game cassette apart from this was charged Rs. 5 for every 6 hours.

[2] The per person charge in gaming parlours in the year 1992-1995 was Rs. 3 per hour.

[3] The price of a SEGA console in the year 1992-1995 was about Rs. 4000/-, the price of a basic refrigerator in those days. From the year 1996 onwards, prices started falling and had reached upto Rs. 1500 - 2000/- in the year 1998.

Choice of games

- Almost all the gamers interviewed, during their school days (teenage 13 to 18), used to play the games their friends played. Discussions about games were a hot topic amongst their friend circle and hence they ended up playing the same games. Moreover, as their parents did not allow much time for computer games, it took time to explore different levels in a game. It was thus a daily competition to finish levels in games and later discuss the scores, challenges, etc.
- Availability of games was also a major factor in the choice of games. Game software in the form of CDs was shared amongst friends. Very few people went ahead and bought games, mostly pirated CDs were into circulation. Any new game instantly became a topic of discussion.
- Many gamers observed that the games they played have gradually become more violent in nature. Initially, they played Mario or Contra. Contra was an action game but it did not give an actual feel of shooting or destroying. Current 3D games have very realistic visual and sound effects. First person shooter games are now very popular.
- Only two of the 12 gamers interviewed liked Simcity. Many said it was a 'game for geeks', some said it was a 'girls' game'. This fact showed that choice of games also depends on an individual's sensibilities and the conditioning he/she has had as regards computer games.

Time spent in playing computer games

- Four gamers out of the 12 interviewed said that they usually play for more than about 3 hours daily. On some days they recall having played for more than 10-12 hours straight without any break. These gamers were degree students staying in hostels.
- Working professionals interviewed said that they played games which could be finished in small time spans. Those playing games on mobiles said that during travel it is a good way to kill time without much botheration about strategy and planning. Even at home they played games for short spans of time and many-a-times quit midway too. This was unlike students/youngsters who played to explore, master and finish the entire game with maximum points.

Social interaction, board games

- Almost all gamers interviewed said that they liked arcade games because these games were short and the hardware was more 'direct'. Also, performing in front of the many people in these public places gave them a feeling of victory and acknowledgement. They recalled having gone in groups / with parents to malls or fun-fairs and played such games.
- 6 out of the 8 intensive gamers said that they liked multiplayer games and playing games on LAN in their hostels or in gaming parlours. Although they could not see each other, they liked the feeling of playing against an actual person rather than the computer. They enjoyed defeating and then teasing a real person more than defeating a computer.
- However, some gamers said that they also liked to play computer games alone. They typically 'liked to play without any disturbances, with full concentration'. The apparent reasons are slow players taking their own time to master the game. Also, some players liked exploring the games apart from the mission they were supposed to do; e.g. one gamer was fond of playing Need for Speed and driving his car in the opposite direction or along paths that were not a part of the race track.
- When asked about board games, most players recall playing them during summer holidays or with relatives. Many gamers recalled playing cards where- everybody in the family - young or old, played. They remember the experiences; the people vividly and also have many stories associated with playing board games.

General observations

Following are some generalized observations based on the user studies (playing different games, contextual inquiry, observing the play habits of players, study of gaming websites / online games) and my readings (please see the Bibliography section) on computer games.

Individuals' choice of games / favourite games depends on

- Peer group (Within a group, a particular type of games are discussed and people have a competition of sorts to complete that game and prove themselves. It becomes very intense as people spend hours exploring the game and conquering the levels therein.)
- Exposure to games (Many games are not available easily, ideally games have to be purchased but even the pirated ones are available within the circuits of internet connected PC users. Hence there are lesser opportunities to explore.)
- Their age (Age plays an important role in determining the choices and likings of gamers. Small children like racing, task based games, teenagers like first person shooter games / violent games, adults like part strategy – part action game.)
- Habits (Many factors like time available, work / home environment, leisure activities, culture affect the choice of games. A person on the move plays games on mobile. People travelling in local trains

where they do not want to think much play 'Snake' which is an engaging and addictive game.)

- Their nature (A person's inherent nature makes him/her like action or strategy or fantasy games. Girls like fantasy games whereas boys like action and strategy games. Some boys think extreme strategy games like 'Simcity' are games for girls while some boys spend hours playing the same. A person's sensibilities play a major part in determining his choices and inclinations.)

Computer games are liked by people because of several reasons

- A single person can play a computer game as against a board game where one needs people to play with. A player can have his / her personal space and enjoy on his own.
- There is no set-up (board, hardware, sitting arrangement etc.) required to play PC games. It all happens at the click of buttons.
- Computer games provide a high sensory appeal through audio and visuals. Most computer games have life-like graphics and an amazing sound design. Such games transfer players into a virtual world of fantasy.
- Activities that one cannot do in daily life, e.g. firing bullets, driving fast cars, going on military missions, conquering countries, playing football in a packed stadium, planning and building cities, etc., can be done in computer games. This is known as role playing. The

fantasy and virtual experience of doing such activities gives thrill to players.

- Many computer games narrate stories and have life-like scenarios, this is entertaining.

Interactivity in computer games plays a major part in making play interesting and fast

- The computing power of a computer is used to do functions of time-keeping, record-keeping and updating.
- The computer can process player actions and give instantaneous feedback to these actions. The screen can change as and when required. There can be surprises and situations that exist for just a few seconds and vanish. The interface is constantly in action during play as against a board game where generally the board is a printed sheet.
- In a computer game, the rules are obeyed automatically as any actions beyond a rule violation lead to loss of points / health / life. The game ends on committing errors or on violating constraints. A player doesn't have over the scoring system, nothing can be manipulated.
- Computer games allow players to adjust the difficulty levels and play in stages. This flexibility allows players to develop their skills and become expert at their own pace.

The **gratification** on accomplishing tasks gives a high to players

- When these tasks are more like a part of a mission, players feel as a part of the story.
- Gratification is also achieved by mastering the game – by gaining control over controls. Expert hand-eye co-ordination, quick decision making and responding to audio-video clues to make moves gives a feeling of accomplishment.
- Computer games record a player's performance and award him points. These remain in the memory of the system and are reflected as high scores / records. Having one's name in the 'hall of fame' is a motivator to play more. A player can achieve peer acclaim by showcasing his records.
- Computer games also give a chance to restart and forget errors, whereas if playing a board game against an actual opponent, it is difficult to walk out of the game.

Good computer games have great interfaces with metaphors to show points/health and resources. Some games have themes and missions; some games have abstract elements which primarily don't mean anything but their behaviors are understood over a period of time by exploration.

Whatever be the theme, the gameplay is one factor that can make a game interesting even if the audio-visual experience is not very great.

There appear two factors in a computer game that can make it a good game – gameplay & audio-visual experience. Some games have a very

good gameplay e.g. Chess, but there is not much that has been done in the audio-visual experience area – still it continues to be the king of games.

Computer games like *SIMS*^[1] are not actually games but toys that one can play with. It's a virtual world simulated to match real-life. The audio-visual experience of SIMS (and other similar games) is excellent and hence in spite of not having no definite gameplay, it is highly successful.

A balance between good gameplay and engaging audio-visuals is seen in games like *Age of Empires*^[2].

[1] The Sims is a strategic life-simulation computer game. Instead of objectives, the player is encouraged to make choices and engage fully in an interactive environment. The only real objective of the game is to organize the Sims' time to help them reach personal goals. The Sims technically has unlimited replay value, in that there is no way to win the game, and the player can play on indefinitely. It has been described as more like a toy than a game.

[2] Age of Empires is a series of historical real-time strategy games, and their gameplay revolves around two main game modes: random map and campaign. The games are set amidst historical events. The objective is to conquer and win territories while managing the resources. The players have to think strategically keeping in mind the geography and the resources they have.

While **comparing computer games with board games**, following points were noted

- In a board game, two or more players play against each other. However, in most computer games, a player plays against the computer. The computer does the thinking as well as processing of events and actions.
- It is challenging to play against a computer. The computer can process results faster and forecast the opponent's moves; creating more challenges and springing more surprises. It can do a lot of parallel processing. However, unlike a board game, there is no feeling of playing against an actual opponent.
- Also, the way a computer plays is based on rules - the way a game is programmed. There are limitations to how much a computer can think and how fast/slow it can cause actions to happen. In board games, when human beings play against each other, there is no limit to creativity and new methods and styles of play.
- Fun in board games is derived not only out of playing the game but also out of the interactions that the players have with themselves. Player-player interaction, player-spectator interaction is a very important phenomenon in board games. In fact, a major reason why we play games is because we like to play it - with our friends/with a particular friend, at a particular place, sitting together comfortably.
- The comments players make, analogies players attach to the game mechanics, remarks on a particular players' style, etc. make it a fun experience. E.g. In simple card games, there are many who

cheat just for fun and their friends/relatives know that - this creates comments during that player's moves.



Figure 10: Fun with board games, kids playing Carrom.

Future trends in Gaming

- Gestures, actions and speech are the natural way we humans communicate and interact with others and our environment.
- Hardware is a means of communicating our inputs to a digital device. The future now lies into dissolving the hardware as much as possible and making ways of interacting as natural as possible.
- **Nintendo Wii** is one such example. It is a gaming console with a handheld remote as an input device. A distinguishing feature of the console is its wireless controller, the Wii Remote, which can be used as a handheld pointing device and detects movement in three dimensions. It uses a combination of built-in accelerometers and infrared detection to sense its position in 3D space when pointed at the LEDs within the Sensor Bar. This design allows users to control the game using physical gestures as well as traditional button presses. The controller connects to the console using Bluetooth and features rumble as well as an internal speaker.
- Games are specially designed for the Wii. These games show a unique trend, they tend to move from traditional computer games to sports that can be simulated using the console.
- Some examples of these games are: Wii Tennis, Wii Bowling, Wii Archery, Wii Baseball.



Figure 11: Wii Games, source: <http://www.blur.in>

Further examples of **Natural user interfaces** in gaming are the iPhone and Microsoft Surface. Both are multi-touch devices and the user can input by touching the screen and performing natural gesture like sliding, flipping, tapping, pinching and reverse pinching.



Figure 12: iPhone Games

- iPhone also has an inbuilt accelerometer that helps it to understand gestures like shake, turn and other movements.
- Thousands of iPhone games have been developed and are available for download. These are mostly short duration games that can be played by touching the screen and performing gestures. Some games also use the accelerometer in sensing the players' movements e.g. in a car game, the phone held in both hands acts as a steering. Thus a user can directly manipulate the controls.



Figure 13: Microsoft Surface Games

- Microsoft Surface is a multi-touch product from Microsoft which is developed as a software and hardware combination technology that allows a user, or multiple users, to manipulate digital content by the use of gesture recognition. This could involve the motion of hands or physical objects.
- Many games are being developed for the Surface and these are mostly multiplayer games that can be played in a setting similar to board games.

Initial Ideation

While doing the user studies, I had started with the ideation for 'a computer game'. There was no brief, as is generally the case in game design (there are many schools of thought that do not start with ideation without a design brief, however, in game design it is many a times a common practice to start with random ideas and then develop them following a formal design process).

I started with a crude brief in mind

- the game must have an experiential factor
- role play
- strategy and thinking
- gratification of doing simple to complex tasks

Some of the ideas are described below:

A game on Mumbai Dabbawalas

- You start as a Dabbawala in Mumbai.
- The basic initial task is to pick up a Dabba from homes - deliver it to the owner's workplace - bring the Dabba back home.
- The more Dabbas you manage correctly, the more you score.
- The strategy part of the game came when you have to operate under the challenges of:
- Timely pick up and timely delivery of Dabbas

- Planning of pick-up and drop sequence across geographical locations
- Understanding how local trains work and where different stations are located
- Understanding railway stations, platforms, local train timings and the travelling etiquette
- Managing resources and minimizing expenses
- Coming up with new offers, schemes and strategies to maximize profit and reduce efforts

Broadly speaking, it would be a management game with an interesting and realistic theme, a player would rise across levels doing simple tasks and gradually managing a huge team of Dabbawalas, etc.

A game on wildlife photography

Multiplayer game involving wildlife photography which involves players playing against each other.

The target is to shoot photographs within the given constraints.

A jungle can be created to house animals and birds and players move around clicking photographs.

Following are some details of the game described as levels:

Level 1

- Player has a camera
- Player explores the jungle
- Sounds / movements

- Player has to click any one animal

Level 2

- Player has a camera
- Player explores the jungle
- Sounds / movements
- Player has to click a particular animal (monkey)
- Bananas / Food available

Level 3

- 2 Players, 2 Cameras
- Time limit
- Click a photo
- Competition, following, moving separate, hiding

Level 4

- Many Players Few Cameras
- Time limit
- Click limit
- Player has to click 2 photos
- Fight for camera, planning

Level 5

- Players win cameras
- Time limit, click limit
- Click a photo of a rare animal (tiger etc.)
- Photo Quality

Level 6

- Many Players

- Time limit, click limit
- Dangerous animals
- Poisonous snakes, bees attack etc.
- Food, water shortage
- Medicinal plants etc.
- Self protection, jungle knowledge

Game Elements

- Role play, challenge
- Experience
- Thinking & Planning
- Tasks
- Constraints
- Agility

The gameplay involves inducing competition and uncertainty through

- visibility / invisibility of players to each other
- mutually shared camera (in some levels of play)
- changing density of animals in the jungle
- animals hiding from intruders
- limitations on number of camera clicks
- accidents like: animal attacks, water and food shortage
- tribal attack / help; natural disasters
- disabling clicking of animals already clicked by a previous player
- time constraints
- photo quality

The experience of the jungle can be created by the following factors

- diverse vegetation
- sounds in the jungle
- time of the day (light situations)
- weather conditions (rainfall, temperature, sunshine, heat)
- terrain

Apart from these, there were many other ideas like:

Travelling in Mumbai

A game where a player is new to Mumbai city and has to travel from one place to another doing tasks.

He has to battle against time, money, tasks, calamities, bus train auto taxi, maps, simulation, rush hours, climate, events, language problems, etc.

History / War

A game where you get to play a part in history.

Some of the keywords that were thought about the game are:

scrambled chronology, role play, guerilla warfare, geography, independence struggle, historical characters (Shivaji Maharaj), etc..

Cooking food

An exciting game on cooking, where you are the cook and you have to play against challenges of

time, material, procedures, execution, multitasking, recipes, guests.

Contraption

A series of events, at every level player finds a link to organize or destroy the contraption, physics game.

Design Direction

Having worked on many ideas for a computer game, one could have selected an idea and executed it. However, based on my user studies, understanding differences between board and computer games and some thought over the future of game design, I finally came to the following thoughts:

Many computer games are not games at all. They are interactive experiences. As per the classical definition of a game, the gameplay must ensure that “one player’s move affects the other player’s move”; the degree of the co-relation may vary but satisfying this condition is a must to call it a game. E.g. Snakes and Ladders is a race, not a game.

By applying different themes, characters and scenarios to a certain gameplay, a new game is developed.

There is a change in the number of variables in the gameplay; a clever balance of the variables and a story/mission woven around it makes a new game.

The most important reason why new games based on an already existing gameplay still become a hit is:

- visuals and animation quality
- sound design
- interactivity (new hardware, cool interfaces, networking, etc.)



Figure 14: Official Counter Strike poster

E.g. Many First Person Shooter (FPS) games are apparently just about killing. However a few become very popular with the introduction of

- new plots and maps to play on
- new weaponry
- interesting info-graphics
- sound
- interesting features like – slow motion action replays, realistic effects of blood oozing on a bullet hit, etc.

I realized that it is extremely time consuming to create the same visuals, animations and sound effects. In reality, teams of 200-400 people work together for a year or two to produce a commercial computer game.

Due to these reasons, I started thinking about games that would be different in nature to computer games.

I realised that one could bring about these new ideas by changing players' interaction with the game. This could be done by changing:

- game hardware
- e.g. input methods, sitting arrangement, hardware manipulation methods
- game participants e.g. number of players, different roles given to different players (like a Kaccha limbu in many sports), spectators
- game interactions e.g. input methods, natural interfaces, gesture/speech recognition, etc.

These points lead to formulation of game design ideas which have components of both - board games and computer games.

The **Design Brief** for the computer game was now reformulated to achieve the following:

- a game that would combine the advantages of board and computer games
- a game facilitating natural input methods

- a game that would increase player-player interaction, player-spectator interactions

In such a game design, one would have to combine the advantages of both - board and computer games.

Board games facilitate interaction between players, players and spectators and also involve direct manipulation of play elements.



Figure 15: A game of chess, gripping for the players and spectators.

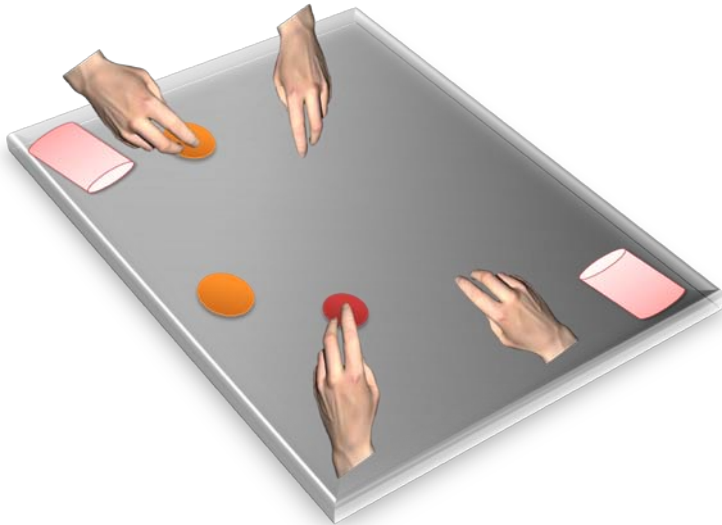
Computer games have moving images and sounds. They have computing power to make run-time logical decisions, do score & time keeping. Also, it is ensured that the rules are obeyed. A player can go through levels and earn powers gradually.

Final game idea

After some initial ideations, I came to the final concept. Following is the description of the game in brief.

It is a multiplayer game played on a multi-touch sensitive surface. The players would sit confronting each other, exactly as in a board game.

As the surface is touch-sensitive, the players give their inputs i.e. manipulate the play elements by hand- touch gestures.



Different coloured circles pop-up on the screen randomly and vanish in a flash.

The basic activity is capturing a circle by placing a finger and then dragging it in one's basket to earn points.



An initial paper prototype test done to understand the activity, was done. Two players were made to sit on chairs, an area of about 0.6 m X 0.6 m was marked as the players' play area.

A test volunteer, in standing position, dropped different sized cardboard cut circles within the play area in order to simulate a sudden and random pop-up on the play area.

The players were instructed to grab the circles that fall, by placing their fingers on the circles and dragging them to their hypothetical baskets.

The cardboard cut-outs were dropped at different frequency and on different places within the marked area so as to create randomness in their pattern. This way the 'circles popping on screen' was simulated.



Figure 16: Paper prototype



Figure 17: Players in contest for grabbing the circles.

Result of the test

It was noted that the activity of grabbing balls within an area, which both players can move on, gave a huge adrenaline rush to players.

The activity was found to be very entertaining, enamoring and fun for the players as well as the people around.

With this confirmation that the activity is pleasurable, time was now invested into developing the gameplay.



Figure 18: Players enjoyed the basic activity

The Game

A detailed Game Design Document shall be made by the time the game is coded, executed and tested. Following is a description of the game.

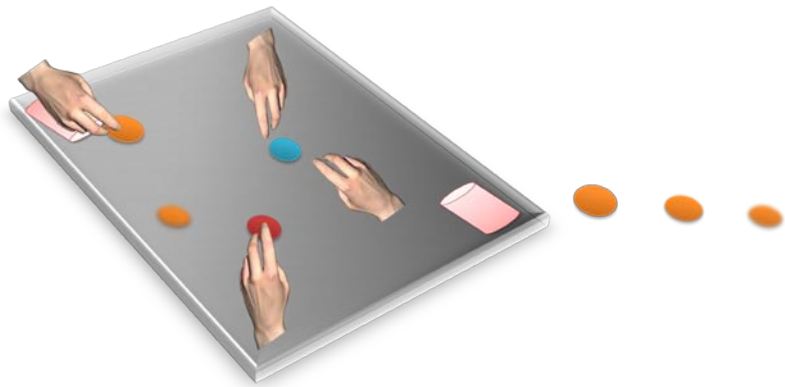
Different coloured circles pop-up on the screen and vanish in a flash.

The basic activity is capturing a circle by placing a finger and then dragging it in one's basket to earn points.

The circles pop-up on the screen – an area that is common to both players. The players sit facing each other across the table.

Both players have equal opportunity to capture a circle, the quicker player gets the circle.

A circle not captured diminishes and disappears.



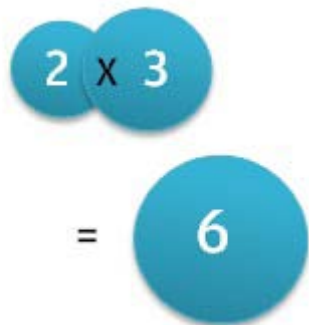
New circles continue to pop-up randomly and diminish if not captured.

It now becomes a fast paced competition to quickly capture the circles and drag them to the basket.

Adding a circle to the basket is an addition operation e.g. if the basket had 20 points and you add a circle worth 4 points, the total score is (20+4) i.e. 24.

Any player could continue adding balls to the basket one-by-one. However, there are other ways to score faster.

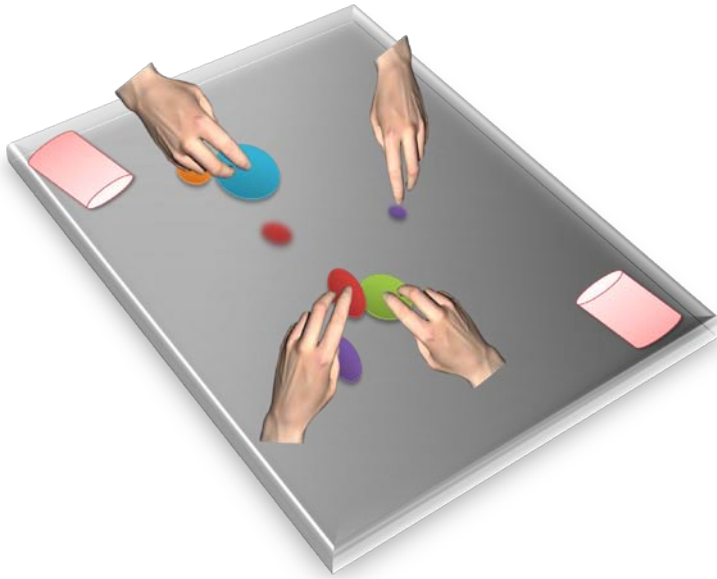
Similar coloured circles can be mashed into each other. The result is a multiplication operation.

e.g. 

The aim of introducing this rule is to make players strategise to score more. It is an incentive for players to encourage them to use both their hands. This way the gameplay becomes more challenging and rewarding.

However, there is a risk associated with this reward.

No two circles of dissimilar colour can touch each other; if they touch, they vanish.



Players have to take care and plan not to allow circles to touch each other.

Having laid these basic rules of the game, the game can be played by 2-4 players, against a time limit and the player with more points wins *or* game continues till one of them fills up the basket.

Rules

Difficulty levels and powers

Difficulty levels can now added to this basic gameplay.

Also, special powers can be given on achievement of certain objectives.

Making dragging a circle risky

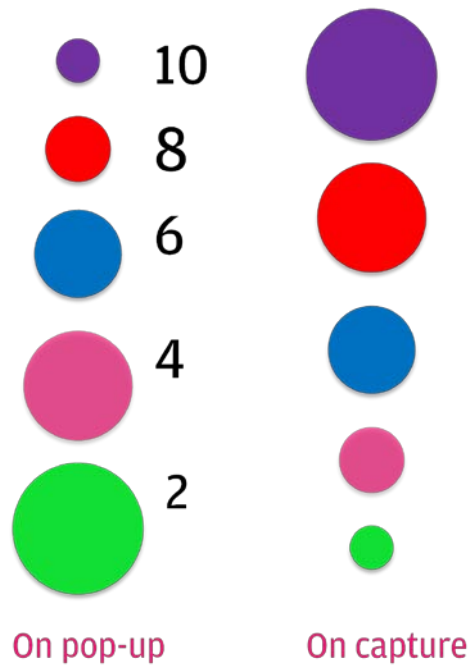
A player cannot keep his/her finger contacts stationary for more than 10 seconds; else the circles under his/her fingers disappear.

If a captured circle being dragged collides with a new circle that pops up, the captured circle vanishes.

The new circle that caused this pops up in a region that is favourable to the opponent/s.

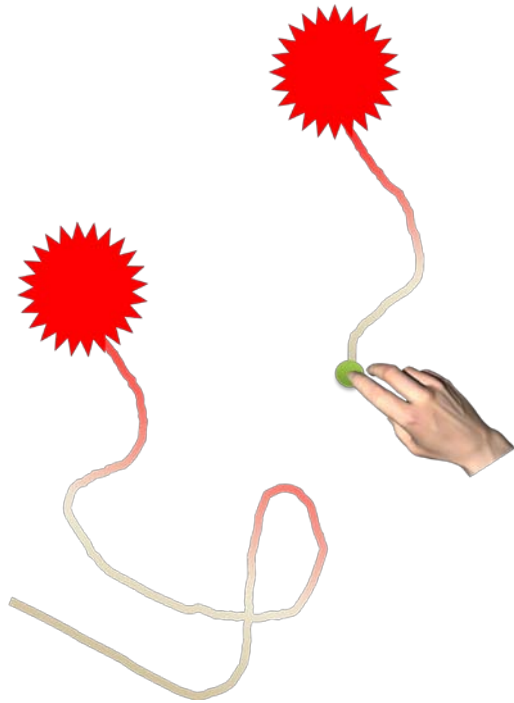
Circle sizes

Circle sizes invert after capture! This is so because, it is easier to catch a large circle but risky to keep holding it/drag it & is difficult to catch a small circle but easy to keep holding it / drag it.



Scoring opportunities | Fireball

These would be circles that would pop-up randomly and move along a random path when players are dragging the captured circles.



Response time is less.

A player can score more during this time by dragging any circle along - so as to trace the Fireball's path.

The circle size plays an important role while it is selected for being dragged over the Fireball's path. This is crucial as it is difficult to drag a larger circle exactly over a curve.

Trail left by Fireball diminishes gradually if no player is tracing it. Error in following the path leads to score being deducted from the basket.

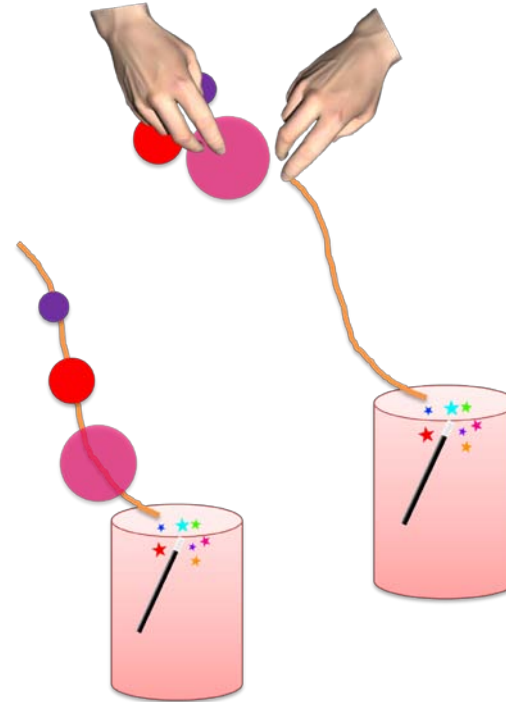
A player can pursue the Fireball even as his opponent is tracing the path because, if the opponent fails, he/she has the chance to complete the task.

Special powers: Free run mode / safe path

On achieving a certain no. of points, a player can get a free run mode where he can move all captured circles freely without the care of collision with each other or with new pop-ups.

As the touch surface won't be able to identify between player 1 and player 2, this free run mode will be limited to an area, where the basket holding those scoring points exists. This area would naturally be favourable to the scoring player.

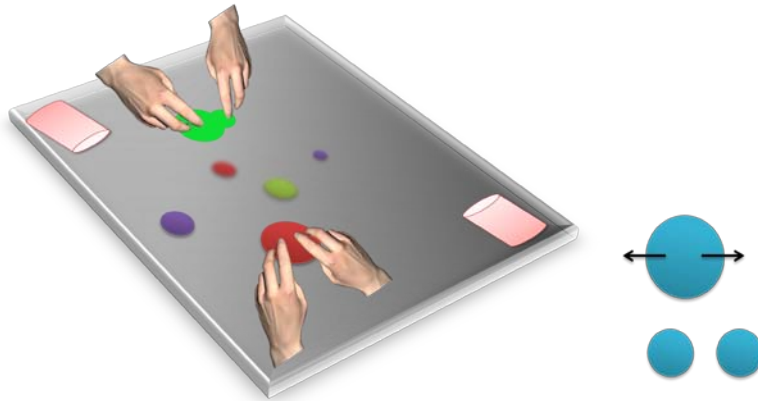
Another power could be a magic pencil which will help players draw paths and send captured circles along these to reach the basket. The pencil would be introduced in a player's basket. He has to touch-drag it and draw paths.



Distributing liabilities | Gestures

A circle can be split into two.

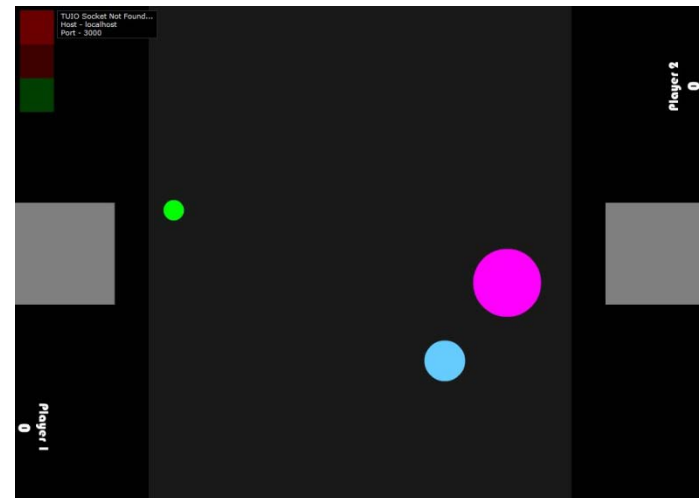
The result is a division operation ($x = x/2 + x/2$)



e.g

Here are some final images of how the game looks like:

The game is named “GRAB” as players have to grab the circles as cleverly and as fast as they can.



Interactivity

The game will have a very simple and minimalistic interface. The interface will just be there to enable essential actions like start / stop etc.

Interface would generally consist of

- Timers
- Scores
- Performance charts/visualisations (info messages)

However, during the play, there would be very few interaction elements on the screen. Only those necessary in particular situations shall show-up on the screen.

The reason for this is that the game is played between the players (not the individual players and the computer) and in order to increase the interaction between them, one has to reduce interface elements that would grab the players' attention or assist them during play.

The visual design of the interface is planned to ensure that there is minimum distraction to the players while playing. The visual language of these interface elements would be 'silent and calm'.

Gestures and interface elements

Natural gestures are an important part of playing this game. Since a multi-touch surface is being used, all interactions are planned to be gesture based and intuitive.

As of now basic/common gestures have been planned but play testing during prototyping is expected to lead to develop understanding of and exploiting the gesture recognition capability of the medium.

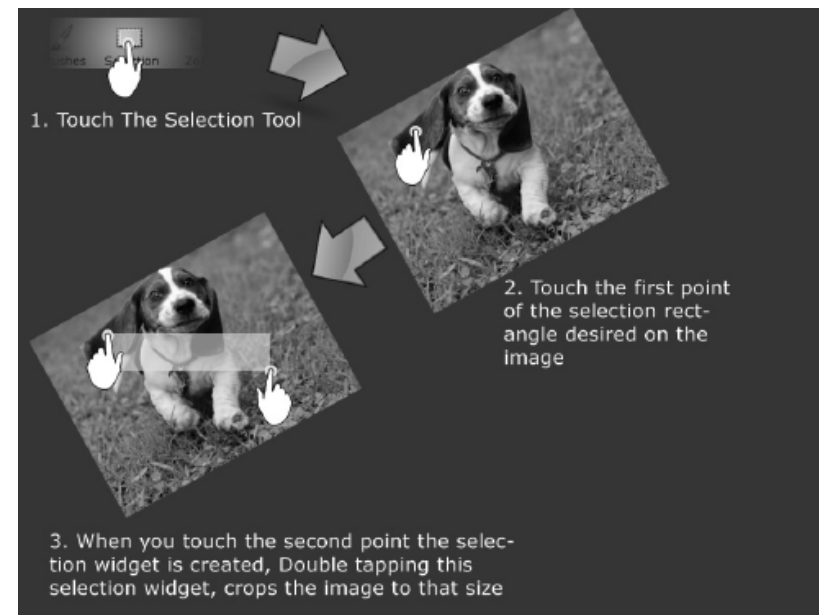


Figure 19: Examples of gestures in multi-touch applications, SOURCE: Pg. no. 31, Multi-Touch Technologies, NUI Group Authors, 1st edition [Community Release]: May 2009.

The input method for the players is touch. Thus, we can exploit possibilities of using multi-touch as the players could use a maximum of 10 fingers at a time.

The shapes and sizes of the buttons / interactive elements are being designed keeping in mind the requirements of a touch interface.

The players can either sit across the table or stand and play. Standing is a more flexible option as a player can bend and reach out his hands. Also, players could move around the touch table and play.

This way there is constant excitement while playing the game.

Players shall experience a difference while playing the game because of

- novelty of the hardware
- direct manipulation of play elements
- animations and sound that shall be used to give feedback on the players' actions

The general nature of the game is intended to be a fun, fast-paced game demanding quick decision making.

The game would improve to a great deal, hand-eye co-ordination, reflexes and quick decision making capacity and skills.

Social interaction and Learning curve

The game is aimed at increasing player-player and player-spectator interactions.

The various ways in which this is being achieved is

- The players are in constant engagement with each other as the balls pop-up on the entire board which is a common area for both players.
- Thus, they can capture a ball popping-up anywhere. Hence, as they are on a look-out for at the balls popping-up, players also are aware of the movements and positions that their opponents are taking - their position around the touch table and position of captured circles on the table surface.
- This way there is constant involvement between players.

A major part of the game is about strategies or routines to capture more balls and score more points. Hence, an understanding of a particular player's style of play and the strategies he/she applies is very important. Similar to board games, there are vital clues one can extract from the opponent's body language, facial expressions (a bit difficult as both players generally would not look up while playing), exclamations and play style.

Thus, through observation and repeatedly playing with each other, players push themselves to develop new strategies to play and understand the game in a better way.

It is intended that there would be no “**how to play**” or “instructions” menu in the game.

- The main intent behind this is to foster interactions between everyone involved in the game.
- As the rules are not present, players decode the rules of the game by themselves. Just a few clues in the form of audio feedback would be given to supplement indicate the events in the game. E.g. a mistake, a loss of points, an achievement would get appropriate audio feedback.
- Some players might collaborate; some might keep their observations to themselves and have an upper hand in the game. Both ways, there is a lot of information exchange between players intentionally or unintentionally. Players learn from each others' mistakes and achievements.
- This process develops a strong model of understanding the actions and their effects through mutual observation. Discussions on the game, exclamations on surprises in the game, ecstasy on decoding a certain rule/pattern in the game - all are instances of increasing and facilitating social interaction.
- Discussions, debates on one's perception of the game rules and observations lead to excitement, bonding and experience sharing between players (and spectators too).
- Thus, a considerable amount of fun and entertainment is achieved out of social interaction and not just by playing the game itself.

- Also no specific theme has been given or nomenclature given to the game elements (they are abstract) so that players can have their own terminologies and themes.
- This way players figure out the rules themselves, thus boosting social interaction.
- For becoming an expert in the game, one would have to keep playing with different opponents and understand the rules of the game perfectly. Decoding the logic behind the behavior of various game elements might take some time.
- Advanced understanding like predicting events in a game, forecasting events, planning according to the game logic and patterns would take a lot of time. In this, playing with different players would be helpful. Understanding other players and having fun with them is an activity that players would love to do.

However, in places like malls and hotels where all the users might be first time users, it is necessary to minimize the learning curve. For this purpose, a demo video explaining the game rules is planned. This demo would show the basic rules of the game using sounds and animation.

Also, during play, messages and tips would be introduced on the play surface to instruct players.

The game is primarily a semi-public place game and shall find a place in clubs, hotels, resorts, restaurants, offices and schools.

Spectators present would support the game by cheering the players, suggesting how to play, shouting, giving hints and clues, etc. They are also a major part of the social interaction that the game would facilitate and establish.

The proposed game can be played by any age-group. 'Easy, medium and hard' level settings could be done at the start.

However, the levels of play automatically get adjusted to players' skills, as here; it is humans playing against humans, not humans playing against computers. If there is a big divide between the players' skills due to age, the elder player is likely to slow down or give opportunities to the younger one. This is because, players realise that they derive more fun when they get to play against each other.

Software – building the logic

The game programming is being done in a fashion of creating generic code snippets. E.g. behavior of the circles is being coded as a function, whose input variables are circle colour and size. The position of popping-up gets determined by another function.

The touch surface backend works in a way so as to understand touch and motions on the surface. It tracks the co-ordinates of touch. If there is a line/curve being tracked by the backend, it will understand that it is a motion.

Now, this tracking coupled with the track of time that the computer can keep leads to understanding these motions as vector quantities of velocity and acceleration.

It now becomes easy to build logic in the game by using real life terms like:

faster/slower, not before, sooner than, in the path of, possible collision, might collide, might go back, might not reach, etc...

Programs can predict and forecast positions of finger-dragged elements and accordingly change the game logic to suit the context, making it challenging and leaving very less to the mercy of chance/luck.

Scalability and reusability of code

The elements popping up and getting manipulated are a function of a code that lets them be manipulated in certain fashions.

In case we change the elements, the same code could hold true. E.g. if we replace a circle with a triangle, we might still use the collision detection code or the basic code that allows selecting and dragging that element.

Also the basic behaviour of the game elements and their response to actions like dragging, rotation, scaling, etc. is a generic code.

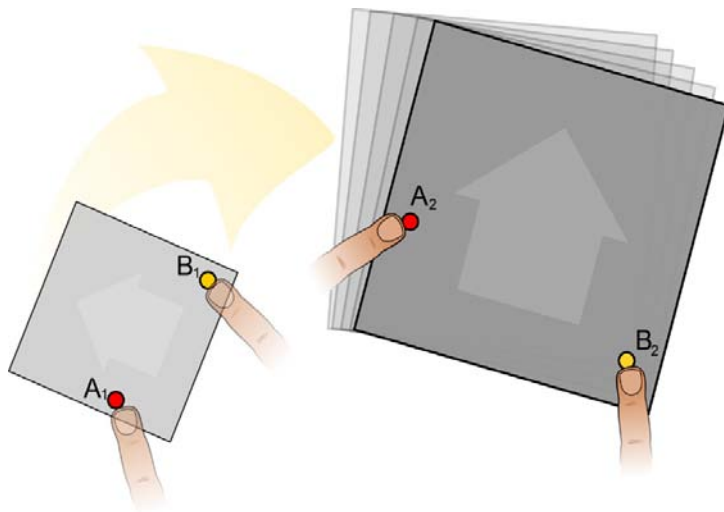


Figure 20: Rotate/Scale/Move Interaction.

A user can touch two points on an object and move it another place. SOURCE: Pg. no. 46, Multi-Touch Technologies, NUI Group Authors, 1st edition [Community Release]: May 2009.

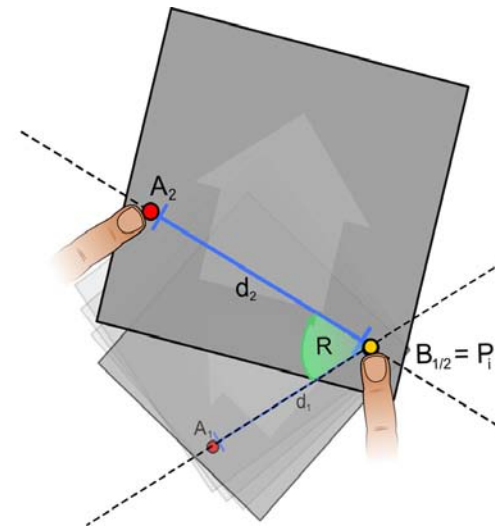


Figure 21: Rotate/Scale/Move Interaction

From two touches (A and B), various parameters have to be computed. The scale by which to enlarge/shrink the object (d_2/d_1), the angle by which to rotate the object (R), and the point around which to perform these transform. SOURCE: Pg. no. 48, Multi-Touch Technologies, NUI Group Authors, 1st edition [Community Release]: May 2009.

Such code could be reused in making versions of this game and newer games that involve such manipulations.

Playing with the gameplay

During the game idea detailing stage, there were many experiments with the various variables involved in the game.

Addition or deletion of small elements and asking the players to think a little more changes the dynamics of the game.

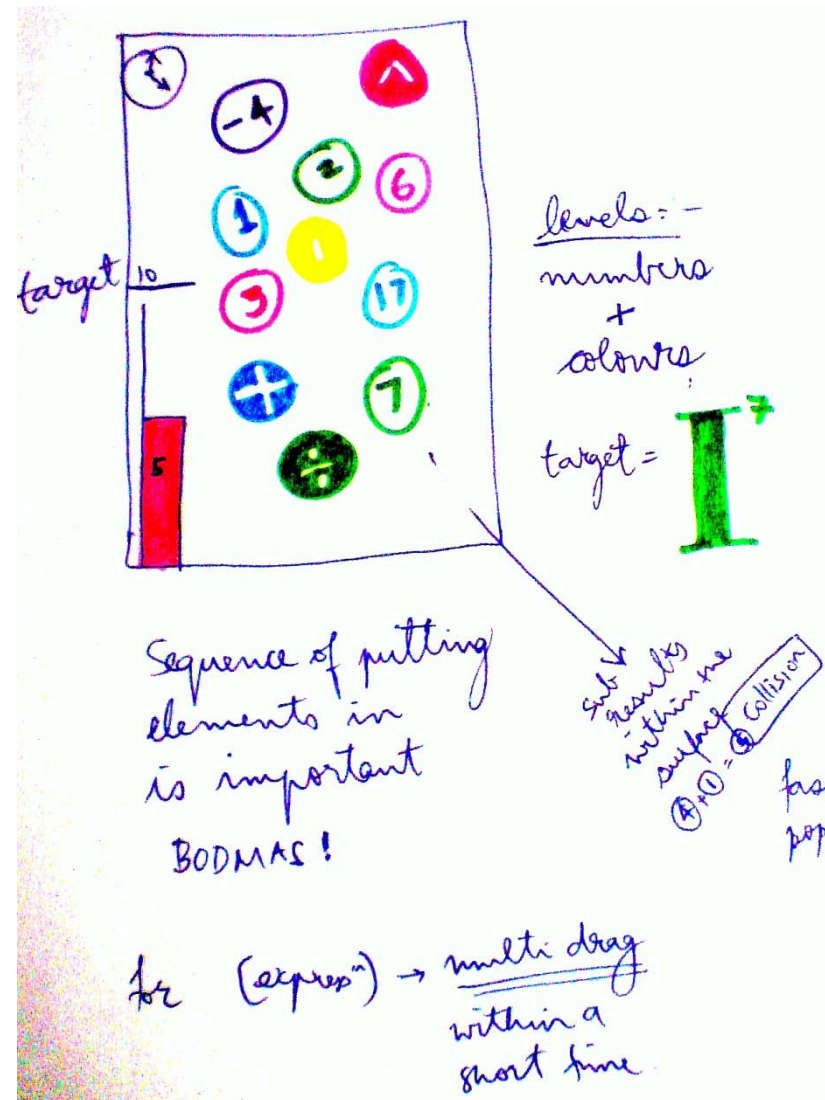
It was noted that the moment one tried to demand a little more thinking, the speed of the game dropped.

Thus, speed of play (overall player movement, fast actions, activities on the screen, etc...) was found to be inversely proportional to the thinking and strategy required in playing.

E.g. A few versions of the game have been tried where, the basic activity of elements popping-up and players dragging and dropping these elements was maintained but the theme and the meanings of these elements are changed.

These are mostly educational versions of the proposed game.

Math games



Here, the elements that pop-up are numbers and operators.

A player has a target to complete.

E.g. a player has to make 10 points

Player has to drag and drop the numbers and operators (popping-up on the screen) into a number-bag.

The sequence of dropping the numbers and operators in the number bag results into a mathematical expression and the result at each step is the points in the bag.

Thus the player has to keep track of the numbers and operators and choose them carefully.

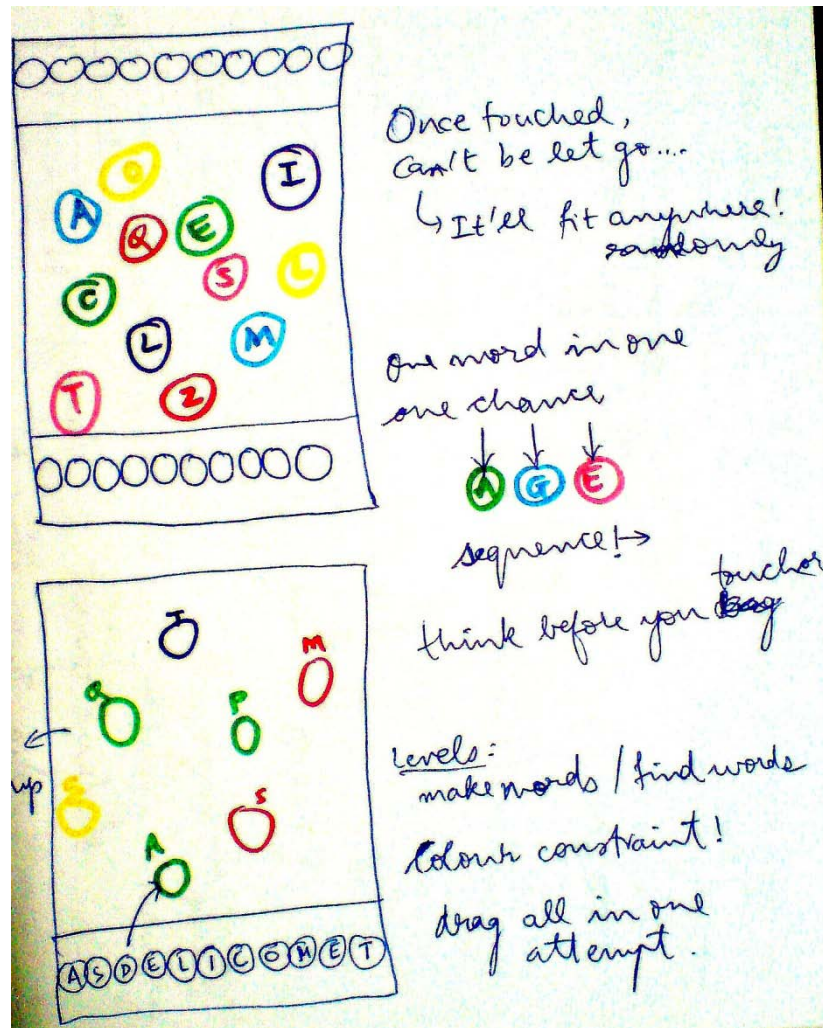
Mathematics now coupled with colour theory becomes an even complex thinking and strategy game.

E.g. a players target could be 10-RED, meaning he has to score 10 points and the resultant colour in the number bag must be red.

The elements: numbers and operators could have colours and as we mix them up, a new colour gets formed.

A player now has to select elements even more carefully and not miss the exact ones he/she needs.

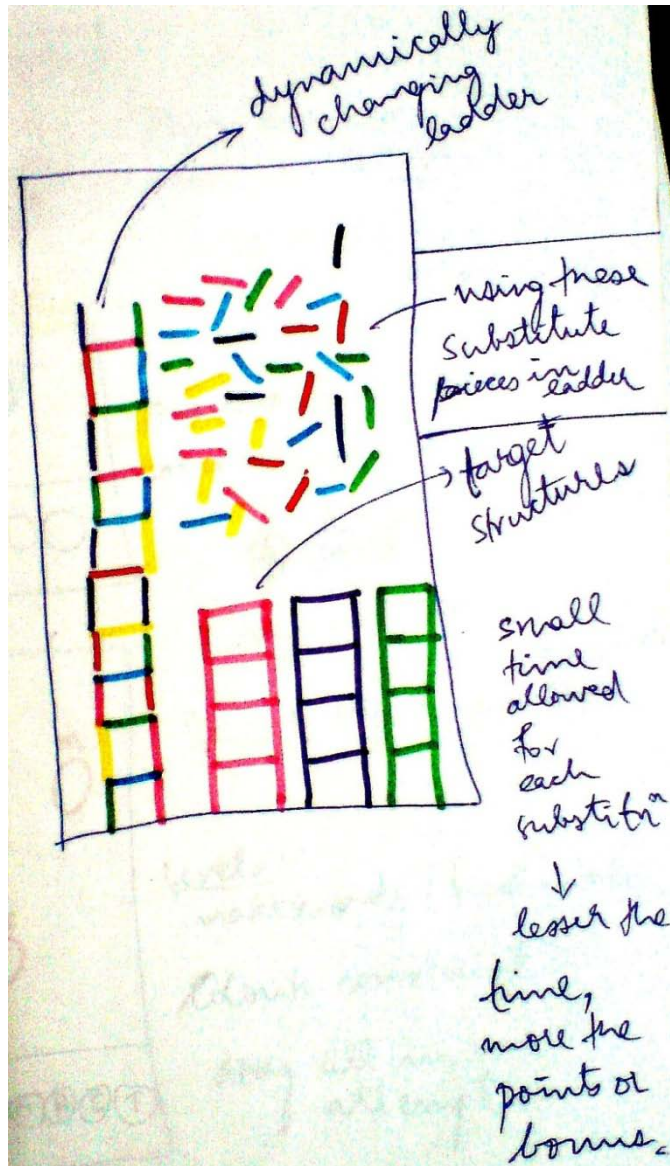
Word games



Similar to the math game, instead of numbers, letters could be the elements popping-up and the targets could be guessing or forming words.

Good vocabulary games could be developed using this idea.

Spatial Thinking/strategy games



A game where now the popping elements are small lines of different colours.

There would be different shapes composed of mixed coloured members, e.g. the ladder as shown.

A player's target is to replace the members in the shapes on the screen with the new popping elements and finally make shapes which are made up of just one colour.

From the **scalability** point of view, the game can be made complex or less complex as required, by introduction of new levels and newer themes.

On adding new themes the game pace will automatically vary to suit the players as it is the players who indirectly determine the pace.

The gameplay would change a bit depending on the themes selected. E.g. if in the game, instead of circles, some animals would pop-up in a jungle terrain and we were to play 'Protect the Animals', then the game could become a collaborative and less aggressive type of game. The gameplay would also have to be tweaked a bit.

There are many possibilities springing out from this basic framework of reusable code and elements.

There could be single player versions of the same game where, one could play against the computer (actually against variables of time, speed and strategy).

Game Evaluation and Testing

A computer game has to be evaluated for the experience it claims to provide and tested for the different scenarios and contexts.

Computer game testing is both qualitative and technical in nature.

Basic most usability testing for this game is required in terms of testing the game actions on the touch table against the parameters of design goals, playability and fun.

The speed of play would have to be adjusted and tested for different users. Difficulty levels would be configured based on this testing.

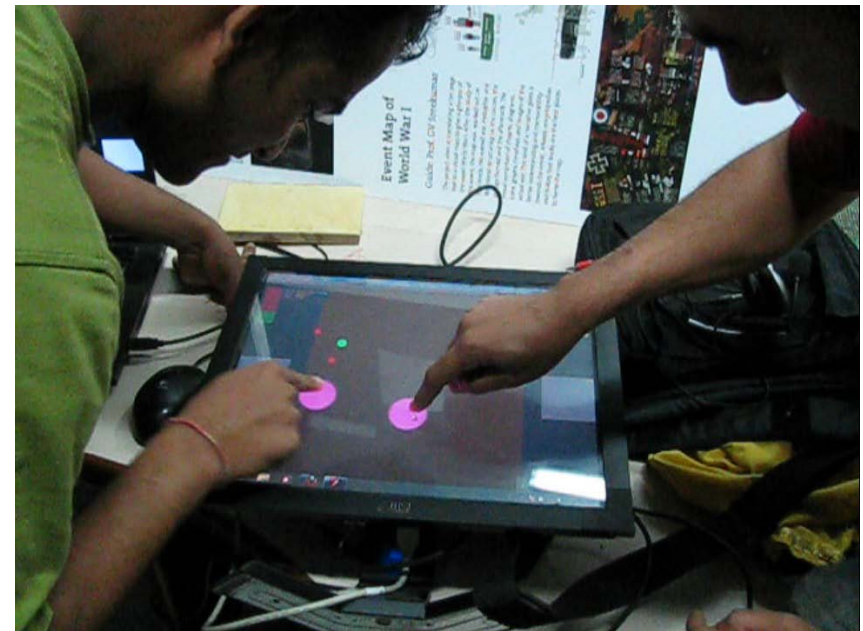
Testing the code for any bugs or loopholes is another important step.



The game testing and usability evaluation was undertaken in the following ways:

- A single touch screen was used to ensure that the circle sizes used do not hinder the playability of the game.
- The game testing on the touch surface was done in a public place to validate the claims on social interaction that the game aims at.
- A game evaluation criteria prepared by my guide Prof. U.A. Athavankar (generally used for board games evaluation at IDC) was used to evaluate the game and find out its degree of gameness.

The **single touch screen** (optical touch sensing) was used with two players who did not have any idea of the game. They were left alone with the game and the testing led to following observations:



- Players took a few moments (10-12 seconds) to get adjusted to the hardware and judge its response.
- Initially (0-20 seconds) the players kept to themselves and concentrated on the basic activity of grabbing the circles.
- The players opened up quickly.
- Natural user interfaces like a touch screen are easy to learn. As there was no burden of a menu or options to be looked at, players started playing immediately without any significant learning time.
- Players learn faster by performing actions than by reading rules.
- Players gave their own names to the abstract elements.
- The activity was observed to be pleasurable and made the players happy.
- Within 60-70 seconds, players started to exercise “legal mischief”.
- A single touch screen revealed a new dimension to the game – “players fighting for touch”.
- Sensitivity of the touch screen is important; however players adjusted their play to the hardware.
- Players started strategizing after they got hang of the hardware and the game activity, game rules and reward system.
- Affecting each others’ move and verbal intimidation was noted as the game progressed.
- The sizes of the circles were playable.

A testing of the game on the **multi-touch surface** was done with a total of around 150 users at IDC’s annual design exhibition at Nehru Centre on the 26th and 27th of July 2010. The videos of the testing are available in the CD submitted with this report.

The rules of the game were not explained to the players. They were encouraged to play and figure out the rules for themselves.

Following are some important observations:

- Learning time is very less: 10-12 seconds.
- It took a few seconds to get a feel of the hardware but players picked up the activity from that point very easily.
- People of different age groups could play with ease.
- Almost all spectators cheered up / encouraged the players and helped the players in decoding the game.
- Forming teams was a common phenomenon when it came to distributing all people around the game who wanted to play.
- New terminologies and names for the game and the game elements were noted.
- The game seems to have huge potential in public and semi-public places.
- The novelty of a multi-touch screen is a major factor in attracting players.



Following is the **game evaluation criteria** prepared by my guide Prof. U.A. Athavankar (generally used for board games evaluation at IDC) filled up by the players after the initial game testing on the multi-touch surface.

The table is a summary of the responses of a total of 12 players.

Factors that define the degree of gameness	
Ability to attract repeat play	<i>Strong. Very addictive.</i>
Degree of Entertainment and Fun Why?	<i>High. Adrenaline rush. Fast paced mental and physical activity.</i>
Degree of socialisation	
1. Between players	<i>High</i>
2. Between players and spectators	<i>High</i>
Level of 'play' interaction	
1. Between players	<i>High</i>
2. Between teams	<i>High</i>
Conflict: Does opponent's decision affect the first player? How much?	<i>Yes. Average. Conflict / co-operation</i>

Due to conflict / co-operation?	
Level of education due to the game Direct / Indirect	<i>High: Indirect (agility, hand eye co-ordination, reflexes, decision making)</i>
Equal chance of winning	<i>Yes (even a slow player can strategise and win)</i>
Balance of play based Risk and Pay-off on players decision	<i>A player may choose to play so, wait but score more. But risk of losing a circle !</i>
Basis of play innovation	<i>1 - large extent 2 - not much 3 - moderate 4 - highest</i>
Degree of problem solving challenge	<i>1 - large extent: Hand-eye co-ordn., reflexes, judgement of the hardware 2 - after a few initial minutes: pattern and rules decoding, finding</i>
1. Skill based 2. Intellect based ARTICULATE the challenge	

	<i>ways to score more</i>
Balance of luck and/or strategy	<i>Equal</i>
Appeal of fantasy, nostalgia	<i>Good - reminds of board games / arcade games / sports.</i>
Degree of playfulness 1. Activity based 2. Manipulations based 3. Legal mischief based	<i>1 - HIGH 2 - HIGH 3 - MODERATE</i>
Degree of control over choice in board adjustments control	<i>Good: Players can move around and reach for the balls.</i>
Ability to hold interest 1. Long time 2. Short time	<i>Short time but repetetive</i>
Fluctuation of tension 1. Early game 2. Mid game 3. End game	<i>High: throughout : Gradually increases. End is a mad rush.</i>
Control on pace of the game	<i>No control. Not required.</i>
Potential of frustrating opponent	<i>High. Legal mischief and by scoring more. Verbal intimidation.</i>

Possibility of player becoming an expert 1. With practice 2. With intellect	<i>Both ways</i>
Learnability	<i>Quick. Though there are no rules told.</i>
Easy to follow the score?	<i>Very easy. Direct score board.</i>
Watchability? What will spectators do?	<i>High. Spectators cheer / participate / decode rules.</i>
How age specific?	<i>No age limit. Scope of mutual agreement between players of different ages.</i>
Interpretability of players' nature and profile through this play	<i>Yes. Infact players count on that while playing.</i>
Ability to generate variations 1. Structural variations 2. Graphic variations	<i>Very high. Themes could be added. Educational versions. Hardware variations: Single touch screens, mobile phones.</i>

Ability to generate levels in the game.	<i>Below average.</i>
Easy testability	<i>No. Hardware dependant.</i>
How busy are the players during the play?	<i>All players busy. Even spectators are busy.</i>
Location and hardware specific? 1. Easy to carry? 2. Easy to play in train? 3. On the bus stop?	<i>Highly specific. Large hardware set-up.</i> <i>Public / semi-public places like malls, resorts, clubs, schools, arcades.</i>
Ease with which Physically impaired can play this game...	<i>NOT SUITABLE FOR Visually impaired</i> <i>Speech/Aural impaired can play.</i>
Is all the hardware essential always? Redundant play pieces?	<i>-NA-</i>

Technology & Prototyping

The game **hardware** is based on a phenomenon called FTIR.

FTIR is a name used by the multi-touch community to describe an optical multi-touch methodology developed by Jeff Han. The phrase actually refers to the well-known underlying optical phenomenon underlying Han's method.

Total Internal Reflection describes a condition present in certain materials when light enters one material from another material with a higher refractive index, at an angle of incidence greater than a specific angle.

The specific angle at which this occurs depends on the refractive indexes of both materials, and is known as the critical angle, which can be calculated mathematically using Snell's law.

When this happens, no refraction occurs in the material, and the light beam is totally reflected. Han's method uses this to great effect, flooding the inside of a piece of acrylic with infrared light by trapping the light rays within the acrylic using the principle of Total Internal Reflection.

When the user comes into contact with the surface, the light rays are said to be frustrated, since they can now pass through into the contact material (usually skin), and the reflection is no longer total at that point.

This frustrated light is scattered downwards towards an infrared webcam, capable of picking these 'blobs' up, and relaying them to tracking software.

I shall be using a hardware based on the same lines developed by the OOBi group (<http://oobi-idc.blogspot.com/>) at IDC, IIT Bombay. OOBi is a group of interaction designers from IDC.

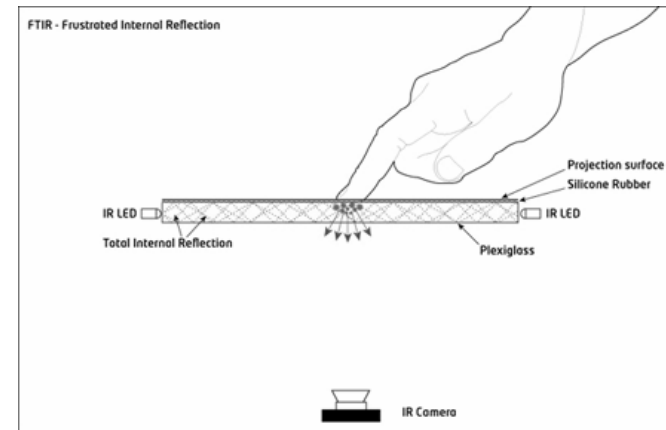


Figure 22: FTIR schematic diagram depicting the bare minimum of parts needed for a FTIR setup. SOURCE: Pg. no. 9, Multi-Touch Technologies, NUI Group Authors, 1st edition [Community Release]: May 2009.

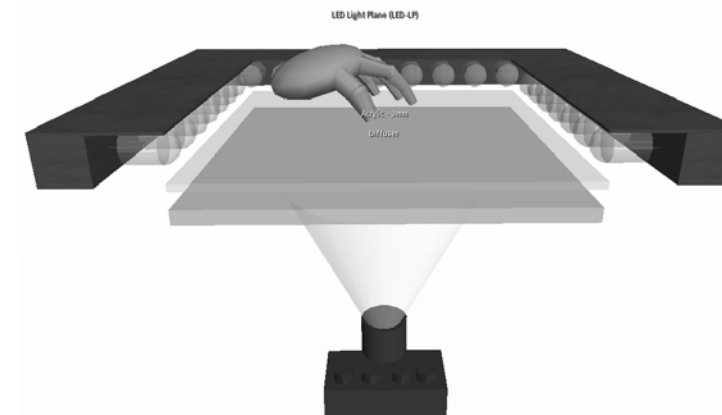


Figure 23: LED-LP 3D Schematic created in SecondLife. SOURCE: Pg. no. 18, Multi-Touch Technologies, NUI Group Authors, 1st edition [Community Release]: May 2009.

The **software** and data flow of the entire set-up is shown in the following schematic.

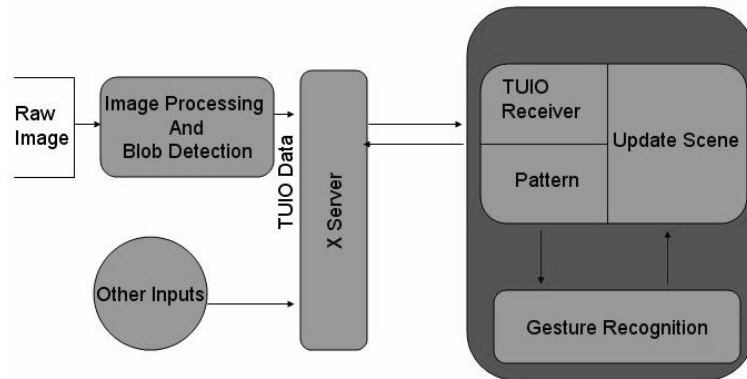
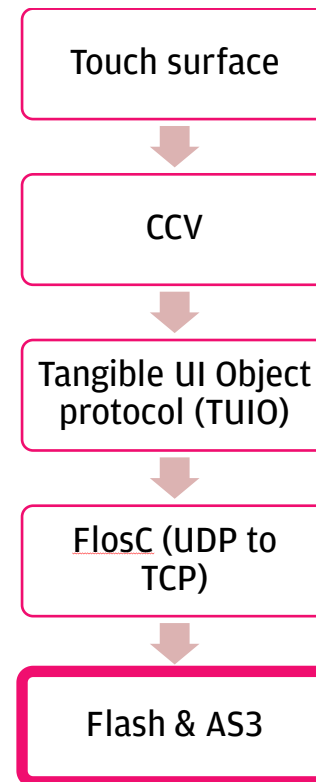


Figure 24: Blob detection to gesture recognition framework outline SOURCE: Pg. no. 33, Multi-Touch Technologies, NUI Group Authors, 1st edition [Community Release]: May 2009.

Shown alongside is the schematic of data flow across various software using various protocols and methods.



Moving towards making a prototype, my task was to understand the various software and protocols and then make a Flash application that would communicate with the other software.

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