# Bionic Roshambo

Hand gesture recognition as an arcade gaming interface.


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# Declaration

## Bionic Roshambo

**Supervisor: Mikael Fernstrom**

This Thesis is presented as partial fulfillment of the requirements for a degree of Master of Arts in Interactive Media at the University of Limerick in the Department of Computer Science and Information Systems, College of Informatics and Electronics. It is entirely my own work and has not been submitted to any other university or higher education institution, or for any other academic award in this university.

Signature

**Kieran Nolan**

Dedicated to Mum, Dad, Maria and Joseph.

# Acknowledgements

Thanks to:

Project supervisor Mikael Fernstrom,
The I-Media tutors and class,
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My family
and everyone who helped me in any way to complete this project.

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# Abstract

Bionic Roshambo is the culmination of nearly four months of research into the symbolism of the hand as a link between humans and machines and how this could be implemented into a video gaming experience, one that would respond to hand gestures and provide the user with the sensation that they are truly interfaced 'one' with the machine.

The project developed from an initial set of ideas focused more on technology than usability into the tailoring of an interface solution for a specific task. An everyday piece of computer equipment, the humble pc keyboard, provided the basis for what would become the Bionic Roshambo glove.

What was achieved was a two player arcade experience that takes a culturally transcending game concept, that of 'Rock, Paper and Scissors' and translate it to the arcade gaming domain. The end result is an original approach to video gaming and an engaging experience for users.

# Introduction

“He watched the kids stand in front of the machines their bony arms like umbilical cords joining human and machine. He asked the kids questions about what made a good game. Arawaka realized the most successful games had something that player’s couldn’t articulate. The words used to describe them were usually reserved to describe forms of intimacy between people. It was as if the players and the game itself had somehow merged.” (David Sheff, 1993)

The first chapter covers the original line of research for this project and how this changed from the quest to combine electronic gaming and mobile phones to creating a video gaming experience that would respond directly to natural hand gestures.

Chapter two is a technology review of the leading examples of glove interface technology, highlighting their applications, strengths and weaknesses.

In chapter three the area of arcade based video games is examined as are the strives in recent years to focus more on creating unique and enjoyable games through novel control devices rather than concentrating on increased polygon counts.

The topics of cyber culture and the increasing convergence of humankind and machines are examined in chapter four. Scenarios of human machine symbiosis from both science fiction and science fact are examined.

Chapter five details how all the collected research was considered and distilled to become the final project concept. This chapter also provides an explanation of what exactly roshambo is and why it was chosen.

The sixth chapter explains exactly how the Bionic Roshambo game and interface were built and how they function. Also covered are technical challenges encountered during the prototype glove development and how these difficulties were overcome.

Chapter seven details the aesthetic considerations for the project, explaining why it was deemed necessary to create an arcade style presentation unit and how all the elements of the project were combined to create the final finished product.

In the eight chapter an account is provided of a usability evaluation carried out on a working demo of Bionic Roshambo.  The test was carried out using the ‘thinking aloud’ method to gain an insight into how the general public would respond to the game concept and also to search for areas of the system to in improve upon.

The discussion chapter assesses how Bionic Roshambo compares to the arcade game and glove controller technologies covered in chapters one and two.

The ‘Future Possibilities’ chapter examines the limits of the Bionic Roshambo interface and discusses possible routes for its further development.

Finally the conclusion reflects on the project experience looking at what had been set out to accomplish, how this had been achieved and what has been learned during the process.

# Chapter 1: An extension of the arm

## 1.1 I-Mode

When considering an area of Interactive Media to conduct research in for my dissertation project I-Mode was the initial choice. I-Mode is a brand and a service of wireless Internet provided for mobile phones in Japan, founded in February 1999 by NTT DoCoMo (Do Communication Over The Mobile Network). The aim of this research was to examine the creative and technical possibilities of gaming over next generation mobile phones. I-mode was the obvious choice because of its technical capabilities and phenomenal success in Japan.

The social and technological factors towards I-mode's success were examined in depth. Technology wise, I-mode's rapid uptake can be attributed its the always-on connection of I-mode and the fact that users are only charged for the data transferred. In comparison with WAP's by the second billing and slow dial up times I-mode is much more accessible. Also cultural aspects such as the high percentage of time spent by the average Japanese commuter isolated on public transport and the fact that dial up internet access is an expensive commodity have helped boost I-mode's appeal, with over 7 million subscribing to the service in 2000 (Mobile Phone Background Analysis, 2000).

## 1.2 The Kanny

The mobile phone had been a main area of personal focus throughout the course. This interest stemmed from curiosity concerning why people depend so much on the said device and what new uses could be found for mobile phones. During research for the Cultural Studies module in semester one the following text from Anthony M. Thousand was unearthed discussing the near symbiotic relationship between mobile phones and their users.

> "Relationships with the object: an extension of the body, the mobile phone is more and more becoming perceived as an extension of the body, again though perhaps more in a virtual sense than a purely physical one. As Wired magazine reports:

> In the last couple of years, Finnish teenagers have quit referring to their mobile phones as jupinalle "yuppie teddy bears" started calling them kannykka or kanny, a Nokia trademark that passed into generic parlance and means an extension of the hand.
> (Silberman, 1999)" (Anthony M. Thousand, 2000)

Of particular interest was conducting exploration into whether the current I-mode (2.5Gen.) always-on network connectivity could be used in tandem with inbuilt digital cameras such as the I-pixel to create new game-playing experiences. The I-pixel camera (Figure 1.) clips onto an I-mode phone and is capable of converting pictures to a 96x96 pixel resolution gif (or animated .gif) for display on regular I-mode phones / I-mode pages.


**Figure 1.** I-Pixel Camera.

From this research of I-Mode carried out it was concluded that the technology, whilst sufficient for short emails and simple graphics (similar to a low end pc running a 100mhz CPU possessing a 9.6kbps data transfer rate) was not a suitable platform for hosting the video game originally envisioned. The initial idea was to build a game in Flash MX that took advantage of its web cam abilities, as a simulation of what could be achieved through gaming on mobile phones with camera capabilities. However whilst simulating a phone on-screen might have been acceptable for a single player it was concluded that attempting produce a multi player experience through this method produce another pc based game, and not the wireless multiplayer experience as intended. Also while Macromedia Flash content could be ported over to a 3G device running Windows CE it was evident after conducting research into I-mode that it cannot handle Flash.

## 1.3 “Hang up and try again…”

At this stage it was necessary to return to the initial brainstorming list.

- Video manipulation / video collage - such as the work by Emergency Broadcast Network and Luckly People Centre – ‘ Video Percussion’ – digital tv / realtime video manipulation

- Graphic Art / Animation – eg Gorillaz, Wave Twisters, cartoon network productions like Dexters lab, Japanese animation, House of Rock (Channel 4), Graffiti Art…

- Music, sample based, chopping up of samples in realtime… this ties in again to the video manipulation part above…

- Robots! Cyborgs, avatars, sciencefiction and the type of content covered in my project for cultural studies ‘Sciencefaction’…

- Video games, what got me interested in computers in the first place. The video games industry pushed the whole idea of vr headsets and alternate peripherals to immerse the user in the game experience…

- The communications power of the internet…video conferencing… mobile communications… convergence of tv/internet/phone… interactive tv… human machine symbiosis… extra senses and modes of communication made possible through technology… humanizing machines… humans becoming machines… cloning…

From this list two lines in particular were focused upon, that which mentions alternate peripherals for video game-play and the idea of human machine symbiosis.

Drawing upon these influences it was decided to try to find a way of connecting people and computer technology harnessing the expressive properties of the hand. This goal was to be achieved through the following project proposal:

- To build a lo-tech but effective means of capturing finger/hand/arm movements through a worn peripheral (most likely in glove form)

- To reflect these movements and gestures in real time onscreen

- To enable the user(s) to interact with a video game through these movements, the video game is intended as a motivator for the user to explore the extent of the devices capabilities.

Exactly how to combine these concepts into an achievable, usable and enjoyable project was the next consideration.

# Chapter 2: Exploring glove interface technology

## 2.1 Glove controllers

In order to gain a better understanding of the areas of glove interface technology and alternate peripherals it was necessary to examine leading examples of what has already been developed in both the said fields.

The first task was to gather information on the different kinds of cyber glove developed. On advice from the project supervisor the 'Directory of Sources for Input Devices and Technologies' (http://www.billbuxton.com/InputSources.html) compiled by Bill Buxton of Alias Wavefront technologies was consulted. Surprisingly there are a relatively small amount of glove controllers available commercially. This would serve to reinforce the fact that these peripherals remain a niche product.

The following are examples of the differing approaches to this gesture capture technology, all unique in the technical approaches and intended application.

## 2.2 The Nintendo / Mattel Powerglove

The 'Powerglove' (Figure 2) was released in 1989 by Nintendo and Mattel. It is worn over the hand and forearm of the user and connected up to the computer through a cable. The glove contains ultrasonic sensors that detect the movement and relative position of the arm and fingers. These signals are instantly transmitted to the computer where the information is translated into a representation of the glove in the virtual space generated. Cost factors and alleged patent problems took the Powerglove off the market. The Powerglove has been a favourite amongst the adventurous developing 'homebrew' virtual reality systems.

**Figure 2.** The Nintendo Powerglove.

## 2.3 Didgiglove

The Didgiglove (Figure 3) developed by Australian company 3 Strings Pty. Ltd is designed to integrate with the 3d modelling and animation package 3d Studio Max to allow modelling and animation through the movement of the hand. The glove also provides an alternative to full body motion capture devices by allowing movements such as walk cycles to be programmed by 'walking finger' movements.

**Figure 3.** The Didgiglove.

## 2.4 5DT Data Glove 16

The 5DT Data Glove 16 (Figure 4) is a 14-sensor data glove that measures finger flexure (2 sensors per finger) as well as the abduction between fingers. This is achieved by measuring the amount of light passing through fiber optic cables running down the length of the finger segments.

**Figure 4.** 5DT Dataglove.

## 2.5 Pinch Gloves

The 'Pinch Gloves' (Figure 5.) by Fake Space Systems allow users to pinch and 'grab' virtual objects or initiate actions with natural hand gestures. This is achieved through Sensors in each fingertip that can detect contact between two or more fingers. However the glove does not have the ability to track motion, orientation or position.

**Figure 5.** Pinch Gloves.

## 2.6 P5 Glove

According to the sales pitch "The P5 is a glove-like peripheral that has been engineered to capture five-finger bend sensitivity enabling gesture recognition, combined with an optical tracking technology that will capture the movement of the hand in 3D space with six degrees of freedom (X, Y, Z, yaw, pitch and roll), without the use of the mouse, joystick, keyboard or the like."

Unfortunately despite the inviting specifications Essential Realities official site states that the P5 glove (Figure 6) will not be available until the second half of 2002.

**Figure 6.** P5 Glove.

## 2.7 Nostromo USB Speedpad

Not from Bill Buxton's list but an interesting item nonetheless. The Speedpad is a departure from the previous items because it is not really a glove but more a controller moulded around the hand. The Nostromo USB SpeedPad is a designed for use in first person perspective shooters in conjunction with a mouse. The Speedpad's 10 keys, a directional pad and a controller wheel are fully configurable so that the user can customise the unit to any game.


**Figure 7.** Nostromo USB Speedpad.

# Chapter 3: Arcade interface ingenuity

## 3.1 Arcade experiences

The next area to examine was that of arcade video games. In recent years coin-op manufacturers have attempted to create fun user experiences by placing further emphasis on how the user interacts with the machine rather than expecting gamers to be merely content with the same old games constantly rehashed with raised graphical and auditory resolution. Arcade game manufactures, under increasing competition from home video games consoles, are placing increasing emphasis on the games cabinet design in an effort to "offer the kind of things you cannot experience with a home video game experience" (Edge, A, 2000).

Since the emergence of Konami's 'Beatmania' in 1997, there has been an explosion of 'rhythm action' games into the arcade market. 'Rhythm Action' is a genre of games that require that the player(s) keep in time with the onscreen actions through a variety of actions. These games are usually based around a musical or sporting theme, from either strumming along on a pseudo-guitar to striking a series of punch-bags in sequential order.

The following games are notable examples from the last decade of innovation in arcade hardware developments designed to compliment the accompanying software and to enhance the overall gaming experience for the user.

## 3.2 Daytona USA
**(Sega, 1994)**

Whilst car-racing games are nothing new Daytona USA (Figure 8) introduced the concept of linked arcade cabinets to allow several players to race together at once. By networking several arcade machines the multi player excitement of the go-kart rally is brought to electronic racing entertainment.


**Figure 8.** Daytona USA.

### 3.3 Time Crisis
**(Namco, 1996)**

Before Time Crisis (Figure 9) there were several lightgun controlled games, but what makes Time Crisis notable is the added dept of game play it brought to the genre by introducing a pedal based control which when activated alters the players field of vision so that they duck behind objects to hide from enemy fire. When the players foot is released off the pedal the view returns to 'standing up mode'.


**Figure 9.** Time Crisis.

### 3.4 Alpine Racer
**(Namco, 1996)**

Alpine racer (Figure 10) is a basic skiing game that uses a two-ski-pole interface allowing players to employ 'real-life' skills to control the onscreen character. "The closest man has come to alpine skiing without all the frozen digits and broken limbs, Namco's Alpine Racer was one of the most innovative games in arcade history. And even though it generally cost more to play than most other games, it was still only a fraction of the cost of a lift ticket, equipment rental, and plane fare to Switzerland" (Yesterdayland.com, 2000).

**Figure 10.** Alpine Racer.

### 3.5 Neo Print
**(SNK, 1996)**

Neo Print (Figure 11) is a simple photobooth that allows users to modify their photographs and print them out as sheets of stickers. Prompted a worldwide craze. This coin-op led to the development of 'Chaku Melo', which allows users to purchase and download dial tones for their mobile phones.


**Figure 11.** Neo Print.

### 3.6 Beatmania
**(Konami, 1997)**

Beatmania (Figure 12) provides a simple turntable and mixer interface, allowing players to mix and scratch along to various dance tunes. The goal of the game is to keep in time with the beats, too many mistakes and its 'game over'. Beatmania is the first example of a 'rhythm action' video game. Game Otaku describes Beatmania as an "incredibly playable game that almost defies categorization" (Gameotaku, 2000).


**Figure 12.** Beatmania.

### 3.7 Fishing Controller

**(Sega, 1999)**

Quite why people might want to try and recreate the fishing experience on computer might confound some people but then again, why not? The Sega fishing controller (Figure 13) is designed to emulate an actual fishing reel. Technology wise the fishing controller contains a built a motion sensor to detect the players 'casting' power and also has a vibrate function to recreate the sensation of getting a bite on the virtual hook from a hungry fish.

**Figure 13.** Sega Fishing Controller.

### 3.8 Rap Freaks

**(Konami, 1999)**

In Rap Freaks (Figure 14) you attempt to become a pro rapper. The user places their hands onto 2 hand shaped controllers, and must attempt to match the beat by following the signals on screen while rapping into the microphone. "The player shakes and hits the controller as an input, which is much more interesting than normal button-pressing, yet another fascinating innovation for the music game genre to toy with" (Gamasutra, 1999).

**Figure 14.** Rap Freaks.

### 3.9 Fighting Mania
### (Konami, 2000)

Konami's Fighting Mania (Figure 15) features a series of pressure pads that the player must strike in accordance with the onscreen instructions. It is worth noting that the construction of the European version of this game differs from the Japanese version in that the cabinet has to be reinforced since as Andrew Muir of Konami states "European players are physically bigger, and there is not as much respect for property in Europe as there is in Japan" (Edge, B, 2000).

**Figure 15.** Fighting Mania.

### 3.10 Kart Duel
**(Namco, 2000)**

For Kart Duel (Figure 16) Namco takes what on screen is a technically competent but ordinary racing game and enhances the experience tenfold by placing the player inside a realistic hydraulic kart with movements that corresponds to the onscreen action.

Mike Nevin, managing director of Namco Europe sums up this experience over polygon count approach in an interview with Edge magazine when he states that "Kart Duel players will pay for the experience and not the high tech graphical content… In other words, what is the point in providing expensive, state of the art visuals when people simply want to sit in a damn kart" (Edge, B, 2000).


**Figure 16.** Kart Duel.

### 3.11 Samba De Amigo
**(Sega, 2000)**

Samba De Amigo (Figure 17) is a highly unique game: a maracas simulation. Game play is based around a special maracas controller that you use to interact with the music. The controller senses which region in space out of a possible 6 that the maracas are in. It also senses when the player shakes the maracas. As the music plays, the player must shake the maracas in the appropriate region with proper timing to progress. IGN.com described the Samba maracas as "the greatest innovation in game peripherals since the introduction of the analog controller."

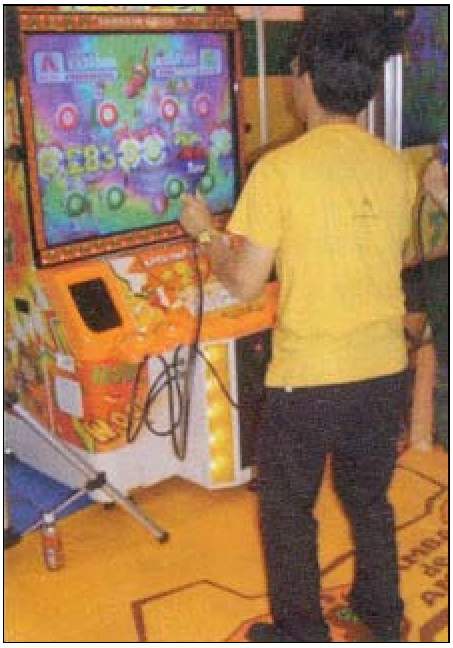

**Figure 17.** Samba De Amigo.

### 3.12 The V-Pick
### (MusicPlayground, 2001)

Although not an arcade game, the V-Pick (Figure 18) virtual guitar warrants mention since its technology is developed by a subsidiary of arcade game developers Namco called MusicPlayground. This plectrum shaped device plugs into the computers USB port and when strummed against an object (such as a tennis raquet) allows the user to interact with the MusicPlayground software (Figure 19). The software side of the product offers the choice to strum along to the guitar riffs of hit songs in a karaoke style, if the player does not keep in time with the onscreen prompt then the riff does not play. The system can also be linked up with other virtual instruments such as the V-Stix (Figure 20) virtual drum to allow collaborative play.


**Figure 18.**
The V-Pick.


**Figure 19.**
MusicPlayground.


**Figure 20.**
The V-Stix.

# Chapter 4: Bio-organic crossover

## 4.1 Human machine symbiosis

In “A Cyborg Manifesto” from 1991 Donna Haraway argues that our human essence is not defined wholly by our flesh and that humans merging with machines is a natural progression “Why should our bodies end at the skin, or include at best other beings encapsulated by skin?… machines could be animated - given ghostly souls to make them speak or move or to account for their orderly development and mental capacides. Or organisms could be mechan-ized - reduced to body understood as resource of mind. These machine/ organism relationships are obsolete, unnecessary. For us, in imagination and in other practice, machines can be prosthetic devices, intimate components, friendly selves.”

The very experience of engaging in a gaming experience with a piece of machinery standing six foot high comes across as a face-to-face showdown between man and machine. Upright standing opponents linked symbiotically, battling on equal terms.

The following chapter discusses a number of scenarios exploring the merging of sinew and circuitry, both in the realms of science fiction and science fact.

## 4.2 The hybrid

The concept of ‘The New Flesh’ is widely evident across science fiction, from the mad scientist ‘Rotwang’ (Figure 21) of German Director Fritz Lang’s 1926 movie ‘Metropolis’ to ‘Tetsuo’ (Figure 22) from Katsuhiro Otomo’s 1998 animated epic ‘Akira’. In both of these cases the human character with a mechanical arm serves as the link between the human and machine races.

**Figure 21.** Rotwang.

**Figure 22.** Tetsuo.

In ‘Metropolis’ Professor Rotwang has a cybernetic hand due to an accident that occurred at some point during the development of the Futura, the perfect worker: a machine laborer born of the machine culture. Rotwang’s metal hand is what marks him as the link between humankind and Futura, he is the halfway point between the two species, a bio-mechanical hybrid.

At one point in the movie 'Akira' the character Tetsuo has his arm blown off by the blast from a satellite weapon, to remedy the situation he uses his psychic powers to construct a new arm for himself from the mechanical wreckage in the battlefield around him. Through this act of will the distinction between the organic and non-organic are negated as both combine to serve as the vessel for the human consciousness born of the machine age.

The theme of technology and humankind merging has been taken to an extreme level in the filmwork of director David Cronenberg. In Cronenberg’s seminal work ‘Videodrome’ from 1982 the hand of the main character Max Renn becomes melded together with his gun (Figure 23) to become a twisting mass of wires and sinews. This combination of warm flesh and cold steel was brought to a graphic climax in Cronenberg’s 1996 movie ‘Crash’ in, a film that depicts a group of people who quite literally lust after cars and see the clash of metal and flesh of a car crash as an erotic experience.

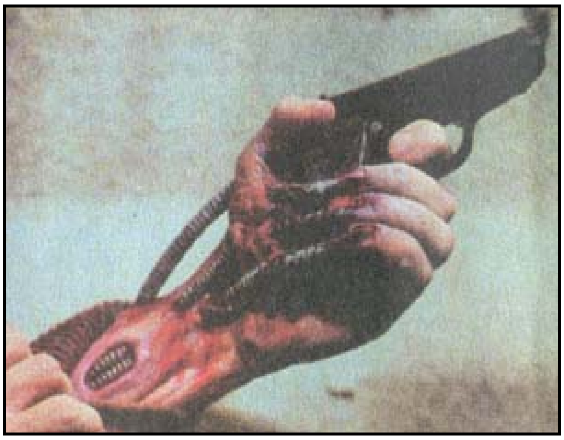

**Figure 23.** The Max Renn ‘Hand Gun’.

“That car crashes and personal injury were being used as metaphors for how humans have attempted to adapt to the technological age led to a number of people walking out of previews in disgust. What they missed was the chance to follow a trait which pervades much of David Cronenberg’s work, and which has, in turn, become part of a wider late-20$^{th}$ Century development in cinema – the interface of biology and technology, of man and machine: the new flesh.” (Martin Barola, 1996)

## 4.3 Mecha

The concept of Mecha from Japanese science fiction, and their influence on animation and video games was also of great interest. The ‘Land Mate’ (Figure 24) schematic style illustration by Shirow Masumune is an example of how such a piece of machinery would operate and how it would blend with its human component. Mecha are basically robotic exoskeletons that mirror and amplify the physical actions of their pilot.

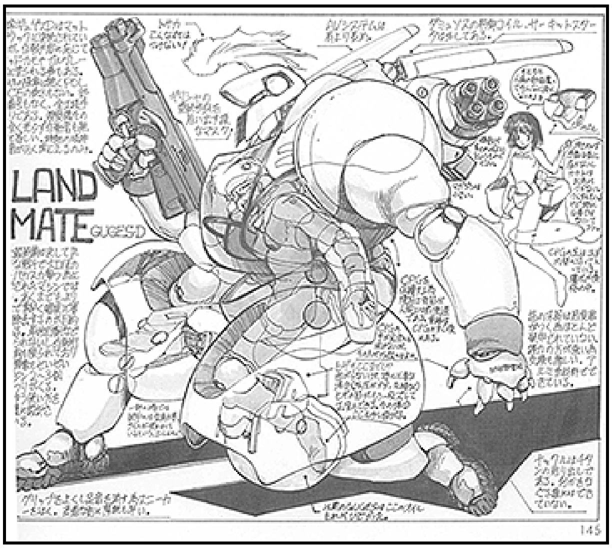


**Figure 24.** Land Mate.

This concept is also aptly illustrated through a short animation produced as a promotional tool for Microsoft's X-Box video games console. The animation shows a giant robot fly into the scene and land in a futuristic aircraft hanger. The human pilot then emerges from the robotic exo-skeleton and leaps to the ground where she performs a variety of martial arts movements (Figure 25). These actions are sent from the human to the Mecha through a hand and wrist mounted transmitter causing the pilot's exact motions to be duplicated by the robot, the movements of the human and robot completely synchronized.

**Figure 25.** X-Box promotional video.

## 4.4 SCARA

The expressive and gestural power of the arm and hand, capable of communication, creation and destruction, lends the appearance of 'life' to machines its principles are applied to. The hands can speak for us through mime "Miming allows for reasonably complex intentions and states to be conveyed to each other, even in the absence of language" (Donald A. Norman, 1993).

Car assembly line robots, one of the first widespread examples of robots taking over a humans job, are characterized by their mechanical arms that move and pivot with lifelike action but with a machine controlled accuracy and repetition. An example of such is the SCARA (selectively compliant articulated robot arm) robot (Figure 26) from Seiko Instruments USA, Inc. (Torrance, CA) that is "designed to provide motion that mimics that of a human arm. They incorporate both shoulder- and elbow-like movements as well as a "wrist" axis." (Colleen A. DeJong, 2002).


**Figure 26.** Scara 'Mongoose EL Series' Robotic Arm.

## 4.5 Asimo

Japanese company Honda, on a developmental tangent from their automotive products are developing a humanoid bipedal robot named 'Asimo' (Figure 27). Possessing lifelike fluidity of limb movement the agile robot can walk, climb stairs, negotiate corners, preform arm gestures and even dance. The robot is intended to act as a human assistant, hence its humanlike form and ability to convey body language gestures.


**Figure 27.** Asimo.

Asimo is a leading example of several humanoid robot technologies currently been developed in Japan. The amount of investment in this field has been spurred on by the statistic that "by 2005, 25 per cent of Japan's population will be over 65. Experts believe that by 2010, humanoids will be caring for Japan's elderly and, according to Hirochika Inoue of the University of Tokyo, buying one will be little different from buying a personal car" (Focus, 2002).

Further help to humankind may also come from Asimo's leg technology been adapted by Honda to "make devices that handicapped people or the elderly can strap on to assist them in walking" (Todd Zaun, 2001).

### 4.6 Stelarc

Outside of fiction, Australian artist Stelarc (Figure 28) has taken it upon himself to embody the physical ideals laid in cyberpunk literature by working in collaborating with scientists and doctors to connect his body up to a range of machinery through a nerve-muscle activated software known as Simbod. His works and performances though bizarre and at times disturbing bring to life a version of a biomechanical future that for now has only been imagined in science fiction.

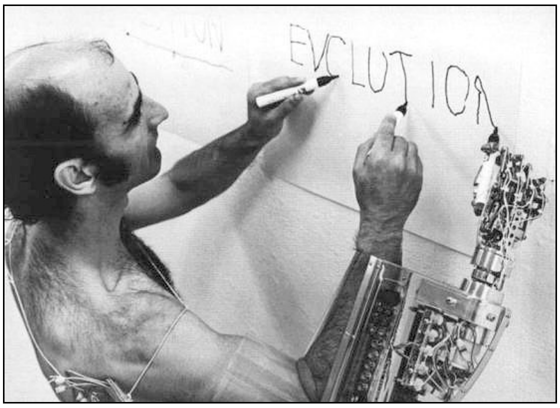

**Figure 28.** Stelarc.

"If Baudrillard's and Virilio's most extreme hypotheses argue that postmodern technology reduces the body to the condition of the handicapped, Marinetti, Chopin and Stelarc all demonstrate how technological modifications of the body reinforce the impact of installation art and performance art exploring (and manifesting) individual identity" (Nicholas Zurbrugg, 1999).

### 4.7 Direct human to machine interfacing

Although not the first attempt to directly interface the brain and computers, the research findings of bioneurologist Miguel Nicolelis represent a significant leap in bringing this technology to a level where it can be applied to humans. In research leading up to November 2000 at Duke University, North Carolina Nicholas implanted tiny electrodes into the brain of an owl monkey, and its brain signals were then analysed as it performed simple motor tasks, such as grasping for food. This technique called 'multi-neuron population recording' allowed scientists to record the signals given out by individual nerve cells, or neurons.

This data was then combined and analysed in order to better understand and predict how the nerve cells create arm movement. These actions were then mimmicked when scientists connected the computer to a robotic arm that duplicated the monkeys own arm movements. Then, to prove that brain signals can be transmitted across cyberspace, the data was sent over a standard Internet connection to a robotic arm at the Massachusetts Institute of Technology in Cambridge.

This type of technology could be used in humans to replace limbs of even supplement new appendages. "It would quite likely be possible to augment our bodies in virtual space in ways that we never thought possible" (Elizabeth A. Thomson, December 6, 2000).

# Chapter 5: Distillation of the idea

## 5.1 Considering the evidence

When considering the previously mentioned examples and the wealth of innovation that has gone into the area of peripheral development in coin-op gaming it would seem that nearly every interesting gaming concept that involves some manner of obscure hand operated device has already been explored. Determined not to be discouraged by this observation and idea was eventually arrived at that at the time seemed thoroughly original. What had been envisioned was a glove controlled video game that could educate as well as entertain; a system that would interpret and teach sign language. The idea was to have the user repeat whatever symbols the software instructed and to reward the correct sign usage with progression through the levels of the game.

However despite been restricted to the one handed Irish Sign Language alphabet (Figure 29) it was soon realized that this was a step beyond the resources and time available.

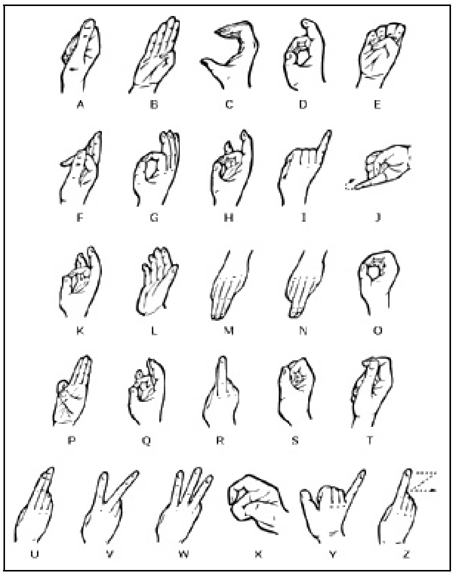

**Figure 29.** Irish Sign Language alphabet.

## 5.2 GRASP

The GRASP (Glove-based Recognition of Auslan using Simple Processing) by Mohammed Waleed Kadous at the University of New South Wales, Australia in 1995 shows the complexity involved in the building of such a system. GRASP was an experiment to see if individual Auslan (Australian Sign Language) signs could be recognized and interpreted using a low cost hardware and software setup (Figure 30). The input device used was a Mattel Powerglove, a relatively low cost ($100) control glove developed by Nintendo and Mattel in the early 90s for use with the 8 Bit Nintendo Entertainment System console. Out of the approximately 4000 Auslan signs this year of extensive research could identify 95 discrete signs with an accuracy of 80 per cent.

It was apparent that in the sub three-month time-span designated to research this thesis and implement the project that sign language alphabet recognition on this scale was beyond my resources. However, this didn't mean the idea of building a glove based control system for video games play would be abolished, merely that another scenario other than the sign language alphabet was required that would narrow down the amount of hand symbol permutations necessary whilst still producing an engaging experience.

**Figure 30.** The GRASP system at work.

## 5.3 M.A.D. Inspiration

Then inspiration struck from an unlikely source, namely an issue of M.A.D. magazine from 1995. In this particular issue was a series of visual gags entitled "Less than successful video versions of traditional kid's games". The set of cartoons in question took a tongue in cheek look at the emerging world of video games peripherals, except that among the twelve off the wall concepts were a few that could actually be adapted for real world use.

The traditional (American) kid's games that were adapted for video games use in this piece were Jump Rope, Gameboy Hopscotch, Cat's Cradle, Patty Cake, Pin The Tail On The Donkey, Dodgeball, Tag, Musical Chairs, Hide And Seek, Virtual YoYo, Odds and Evens (Figure 31) and Spin The Bottle.

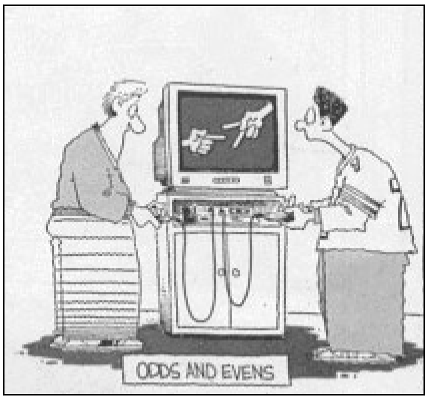


**Figure 31.** Odds and Evens.

The idea that struck me as the most practical and achievable was that of 'odds and evens' played over video games system. In Ireland the common variant on this game would be 'rock, scissors, paper'. Although the users in the cartoon are using joypad controllers to operate the game this was an appropriate and achievable game that could be used to prove the capabilities of a hand gesture capture device.

## 5.4 Why Rock, Paper and Scissors?

As a game, rock, paper and scissors offers a system of combat where all the moves offered are different but equal. The fact that each of the three Roshambo 'throws' has an advantage over one of the other two moves and a disadvantage to the other creates a balance within the game-play structure meaning that the weapons offered to each player are evenly matched, "the rock, paper and scissors approach is to create variety yet equality" (Blink Software, 24$^{th}$ November 1998).

Roshambo is an ideal game to develop a prototype glove based interface for since it poses the challenge of three hand and finger configurations, each considerably different. The signs of rock to scissors to paper are a gradual scale from fully closed (rock) to fully open (paper), with scissors as the in-between stage. To incorporate these three gestures into a glove controller would prove as an adequate foundation for similar devices spanning a broader arena of hand movement recognition.

## 5.5 What is Roshambo?

Roshambo is another term for the game 'Rock, Paper, Scissors', also known in Japan as 'Janken'. It is commonly used as a means of making a decision (similar to a heads/tails coin toss) or to peacefully settle a dispute.

A normal game of Roshambo begins with the players counting down from three to one at which point they reveal their chosen hand sign. The winner is the one with the symbol that is stronger than the other. If the result is a draw then another round is played. The overall winner is usually decided on the best of three rounds.

## 5.6 Guide to the Roshambo moves

**Rock:**

A clenched fist represents the rock (Figure 32). It defeats the scissors by blunting it but is susceptible to paper which wraps around it.

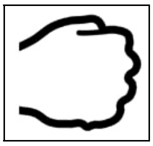

**Figure 32.** Rock symbol.

**Paper:**

The paper symbol (Figure 33) is conveyed by a flat, outstretched palm with the fingers held against each other. It defeats rock by wrapping around it but is beaten by the scissors that cut through it.

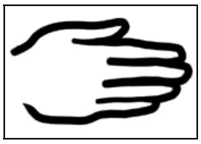

**Figure 33.** Paper symbol.

**Scissors:**

The scissor (Figure 34) is represented similar to the rock except that the index and middle fingers are fully extended towards the opponent, the space between these two fingers should be roughly 45 degrees. Scissors can defeat paper by slicing through it but are defeated by the rock, which dulls their blade.

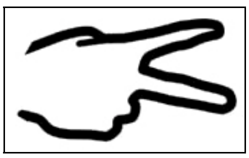

**Figure 34.** Scissors symbol.

## 5.7 VR Janken

During the early stages of project research a search was carried out on Google.com to see if anyone has already tried a rock, scissor, paper game controlled by a cyberglove type device and lo and behold there exists a game of glove controlled 'Janken' (the Japanese name for Rock, Paper, Scissors), albeit in a totally virtual environment.

VR Janken was developed by researchers at the Japan Advanced Institute of Science and Technology. The JAIST website does not divulge the technical details of how this game was built apart from the fact that a silicon graphics workstation was used to run the program and VR peripherals but what is clear from the visual information presented (Figure 35) is that it takes place in an V.R. setting where the users hand and arm movements are mirrored in virtual space. It was also evident that the hardware used was considerably high end, since Silicon graphics ONYX workstations are pictured on their project web page (http://norisuke.jaist.ac.jp:8000/hori-abe-lab/equipment/eq10.html) and described as "very ultra excellent super hyper high-priced machine that's used for Virtual Reality". So while this hardware was certainly out my budget it was interesting to see an approach to a glove controlled rock, paper and scissors game.

**Figure 35.** VR Janken

# Chapter 6: Technical challenges

## 6.1 Considering the input technology

In the early stages of this project there were several possible avenues considered regarding the functionality of the glove interface and just how these abilities could be technically realized. As mentioned in the part one the distillation from the initial brainstorming of ideas down to the final workable project came about through a gradual process of exploration and elimination.

The conceptual model of the glove interface started at the high end of the technological scale: a device able to capture the flexure of each finger and the position of the hand in 3d space. However while it was all very well to have an idea of the maximum that could be achieved through hardware technology it became clear that before diving into the deep end of electronics that this device had to be built to serve a specific task as efficiently as possible rather than setting out to build an elaborate device with no set aim.

Originally the 'Pico ADC' by Picotech (www.picotech.com) had been envisioned as the device that would connect the glove controller to the computer. The Pico is a device that plugs into the PCs parallel port and supplies eleven inputs. Through the appropriate software drivers the Pico can read the voltage sent into each of these ports, whether it is a straightforward on / off signal (i.e. zero volts = off, five volts = on) or a scale of voltages, such as the input from a light sensitive variable resistor.

Once it was established the gloves task was to recognize three distinct hand gestures; the 'rock', 'scissor' and 'paper' of roshambo the specifications of the glove became clearer. Also after discussing the game concept with the I-media class they had suggested that the game would be more enjoyable with the inclusion of a simultaneous two player mode, therefore requiring six possible input signals and the ability to send a signal from each glove through at the same time.

The three hand signals of roshambo are static and so required straightforward on / off circuits, negating the need for the measurement of the fingers as they flexed, only the position when the gesture was complete. This realization meant that the need Pico ADC was no longer necessary, thus opening up the opportunity to adapt the circuitry of more common PC input devices. Also a price tag of 200 euros added yet another factor for the dismissal of the Pico as a component for this project.

The remaining hardware candidates for examination and possible dissection were three of the most common input devices; the mouse, the joystick and the keyboard.

First up for consideration was the standard PC mouse. With two main buttons as standard it hadn't enough switches to hack although the xy rollers and mouse wheel could have been used to implement a rudimentary means of moving the entire hand itself in onscreen space though this was not a requirement for Bionic Roshambo so the mouse as a basis for the glove interface was disbanded.

The keyboard and joystick options both offered more than an ample amount of switches to build the roshambo glove. In the end the keyboard won because it did not require the installation of any new drivers and also due to the fact that the University had recently disposed of a skip-load of the said devices (because they did not carry the euro or windows keys) and they were free and available for research purposes.

### 6.2 Keyboard Hacking

From the selection of keyboards taken from the University skip a keyboard by Digital was selected (Figure 36). A Philips head screwdriver was used to remove the upper and lower outer casing. Revealed underneath was a circuit board attached by a ribbon cable to a keyboard matrix circuit. The keyboard matrix was sandwiched between a metal base panel and the plastic structure that holds the keys. These elements of the keyboard were unscrewed and removed leaving the keyboard controller module attached to the plastic matrix (Figure 37). The keyboard matrix was then removed leaving the keyboard controller board attached to the keyboard cable (Figure 38).

**Figure 36.**
PC Keyboard.

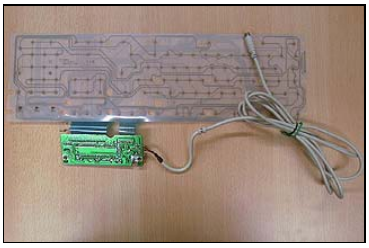

**Figure 37.**
Keyboard matrix.

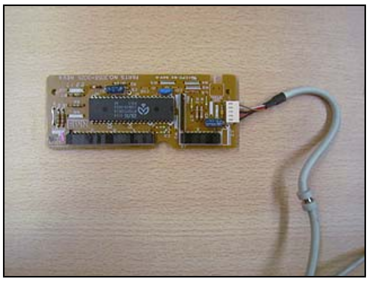

**Figure 38.**
Keyboard Controller.

The controller for the Digital keyboard has twenty-eight inputs, divided into rows of twenty and eight respectively. A connection of any input from the first row with any input from the second row results in a keyboard symbol been registered. The next task was to test these combinations and discover what key-presses they activated. While a goal of four switches had been set earlier (two for each glove) this number was raised to six to provide for the implementation of extra switches further down the development line.

The keyboard module was plugged into the PC and a freeware program called Keyboard Hook was used to find out which keys were activated by joining inputs from both rows with a single wire.

The following combinations were permanently connected to the plugboard (Figure 39) to allow the cables connecting the glove to be easily attached and removed.

| **Row 1** | **Row 2** | **Keypress** |
|---|---|---|
| 15 | 6 | F8 |
| 16 | 5 | 7 |
| 17 | 1 | b |
| 18 | 4 | e |
| 19 | 3 | s |
| 20 | 2 | z |

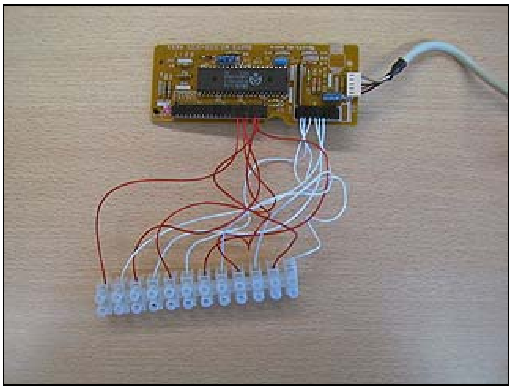

**Figure 39.** Keyboard controller wired to the plugboard.

### 6.3 Selecting the glove

In finding a suitable glove to incorporate the physical interface of the game into factors of fit and adaptability were taken into consideration. This meant that glove had to be ‘one size fits all’, allow maximum finger dexterity and lend itself easily to the incorporation of the required switches and wire cabling.

The first port of call was a local sports shop, which stocked a myriad of glove types designed for use across several sporting genres. A common problem amongst these sports gloves is that they are designed to serve as protection, and so are padded to such an extent that the digits are allowed very little movement.

A light cotton glove by O’Neills (Figure 40) designed for playing handball was eventually selected as the glove of choice. The glove is sized extra-large but still fits comfortably on smaller hands. The switches and wiring were secured in place using Velcro, thus allowing for these components be conveniently removed and replaced for switching the controller from a left to right hand and allowing the glove itself to be washed.

**Figure 40.** Handball glove.

## 6.4 Assembling the switches

In order to register a key-press, two contacts from the keyboard circuit board have to be joined to compete a circuit. The switches required to enable this connection needed to be flat enough so as to not impede finger movement. In keeping with the DIY ethos of the project the switches were built from cheap readily available materials, tin foil, Sellotape 'Sticky Fixers', insulating tape and remnants of the plastic 'Flimsey' salvaged from the keyboard.

The function of the pad is to act as a separator between the two tin foil contacts. Since the foam material of the pads easily contracts when pressure is applied and returns to its original shape when realized, thus forming an ideal basis for a pressure switch. The size of the sticky fixers (2.5cm x 1.25 cm) was left unaltered but a section of the pads centers (approximately 12mm by 7mm) were removed with a scalpel.

The modified Sticky Fixers then had the layers covering the adhesive sides removed and had tin foil pressed onto each side. A scalpel was used to trim the tin foil to the size of the pads.

2.5cm x 1.25cm sections from the plastic sheeting that had formed the keyboard matrix were used to reinforce the switch; these were bonded to the two tin foil sections with double sided Sellotape. Finally insulating tape was applied to each side and trimmed with a scalpel to complete the finish (Figure 41).

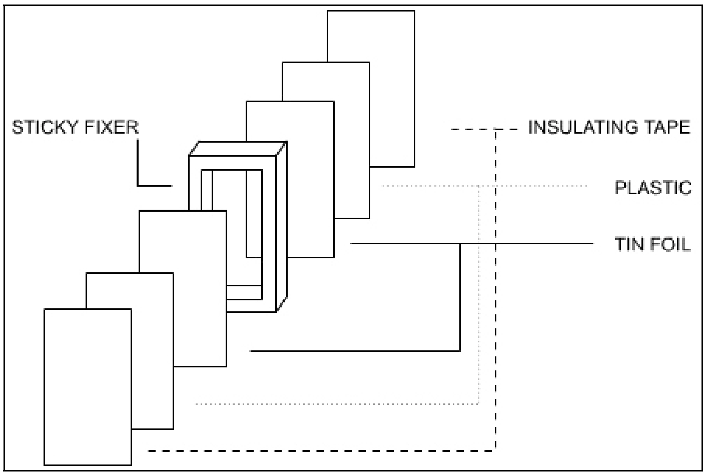

**Figure 41.** Pressure switch diagram.

### 6.5 Pressure switch limitations

Originally the gloves were built using three of these switches but early prototype testing revealed that the pressure switch was adequate only for the paper maneuver, since the two fingers that flex for the scissor move do not press into the palm far enough to bring the metal contacts together.

What was required was a switch that would activate when the fingers were partially curled. Using the same raw materials; wire ties, tin foil and insulating tape, a prototype piston type switch was built (Figures 42 and 43). The wire tie is flexible allowing to switch to bend under pressure, so ensuring that it will not snap in half if a user is places particular strain on it. An initial version of the switch was attached directly to the hand with double sided tape and its position moved until the position best suited for its operation was found.

Four completed switches were then built and affixed to the gloves with Velcro, replacing the 3rd and 4th finger switches for each hand.

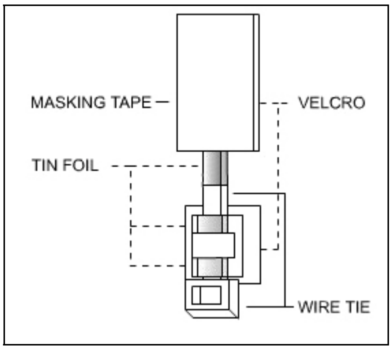


**Figure 42.** Flex switch diagram.

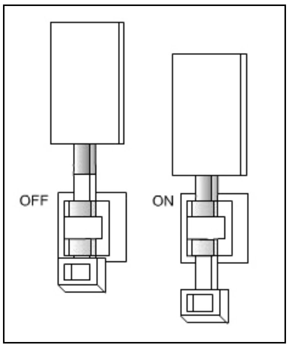


**Figure 43.** Flex switch operation.

## 6.6 Glove circuit

Each roshambo glove contains three switches that activate two keyboard buttons (Figure 44)

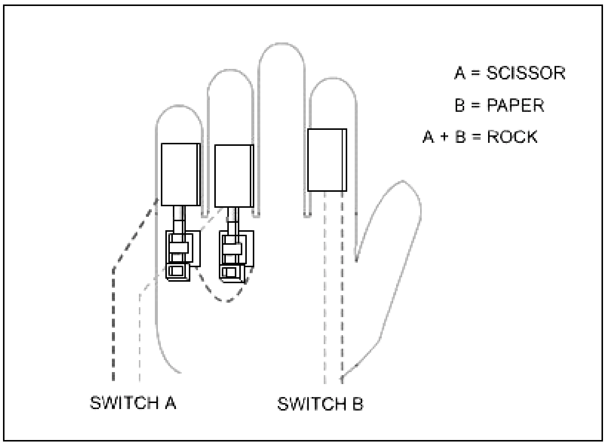


**Figure 44.** Glove Circuit.

The button between the first and second finger is activated when the hand is formed into the flat ‘paper’ move.

In order to form the ‘scissor’ sign the user inevitably curls the third and fourth fingers, when both of these fingers press inwards the key for ‘scissor’ is activated.

The ‘rock’ sign is formed when both buttons are pressed, the combination of these two key-strokes is interpreted as by Macromedia Director as ‘rock’.

The gloves were connected to the plugboard through two metres of cables, each with four strands to accommodate the two keypresses activated by each (Figure 45).

**Figure 45.** Gloves connected to the keyboard circuit and plugboard.

## 6.7 Software used

Without a piece of software to interpret the signal from the roshambo gloves they would serve no practical use. Macromedia Director was chosen as the environment in which to construct the Bionic Roshambo game. It was chosen both for the ease of use of its lingo scripting language and the fact it caters for the importation of a wide range of media.

The first version of the game was text based, functioning as a test of the gloves capabilities. When the code was working correctly the next stage was to add graphics, sound and animations to bring the aesthetic quality of the game to arcade quality. The game characters were drawn and animated in Macromedia Flash whilst the backdrop graphic was drawn in Adobe Photoshop.

Whilst modern pc soundcards can play back any sampled sound at CD quality it was decided that the music and sound effects for the game would be mostly synth sounds similar to those from early video gaming consoles. This was decided upon since most people associate this style of digital audio with video games. Sampled sounds were taken from a number of games on eight and sixteen bit systems, sequenced in Fruityloops and outputted as wav files.

### 6.8 The Game

Since Bionic Roshambo is inspired by the merging of humankind and technology it was decided that the graphical theme of the game and its characters should follow a similar vein. The stars of Bionic Roshambo are a couple of cyber-enhanced infants (Figure 46) that walk around their planet in robotic exoskeletons that they operate through glove controllers. The look of the game was based around arcade fighting games such as Capcom's 'Pocket Fighters' (Figure 47) featuring colourful, cartoon style visuals.

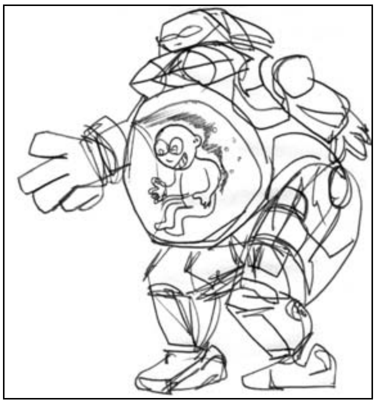

**Figure 46.** Bionic Roshambo Kid.

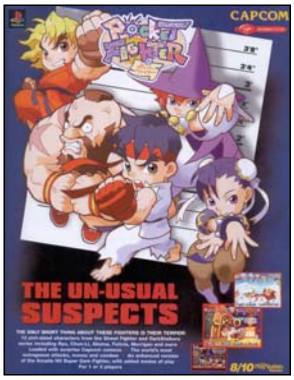


**Figure 47.** Pocket Fighters.

When a player makes the representation for rock, scissor or paper (Figure 48) with their glove controller their onscreen character will duplicate this (Figure 49). Depending on the combination of symbols chosen, an appropriate animation is shown, such as a scissors cutting a piece of paper. This animation is accompanied by a sampled sound representing the action that is taking place.

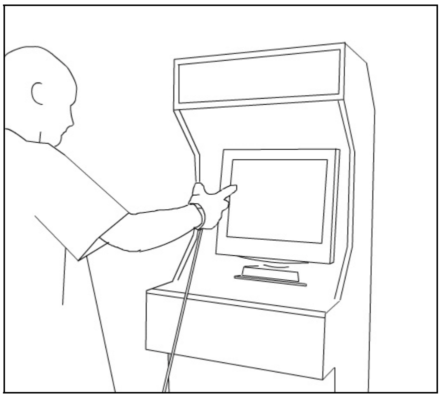

**Figure 48.**

Player creating 'scissors' sign.

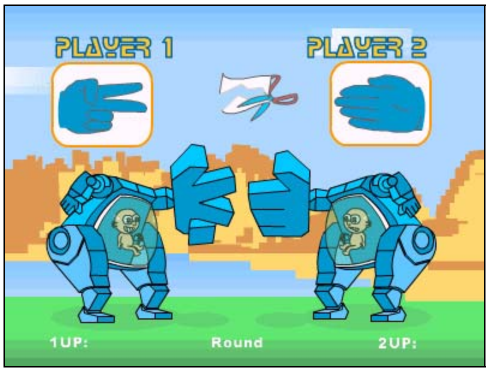


**Figure 49.**

Screenshot of scissors cutting paper.

The winning character is shown in a victorious stance while the loser is portrayed in a slightly dejected state. The overall winner is the player who reaches two wins first, after which a screen is shown naming which player won and the amount of rounds taken to reach that point. After the game over sequence the winning player can enter their initials for display on the games high-score board.

## 6.9 Gameplay modes

At the game title screen (Figure 50) the player(s) is presented with three options. These are one-player mode, two-player mode or training mode. These are activated by the rock, paper and scissors moves respectively.


**Figure 50.** Bionic Roshambo title screen.

One player mode pits a human opponent against the CPU. It can be operated through either glove controller A or B. The onscreen character that represents the player is chosen depending on which glove controller the gamer is using. If the player is using glove A then he or she is represented by the character on the left side of the screen (player one). Likewise if glove B is used to select one player mode then the character on the right (player two) will be the player character.

The 'training mode' option provides a brief overview of the rules of Roshambo and how the moves of rock, paper and scissors are activated through the glove controllers.

When the game is not in operation an animated sequence explaining the games scenario (about two cyber enhanced kids in outer space) commences, this sequence is followed by a view of the high score table and a display of the rules of rock, paper and scissors.

# Chapter 7:  Aesthetics

## 7.1 Presentation considerations:

Originally the project was going to be presented using a large color television with the electronics encased in a box in the style of a home video gaming console. The pc itself was to be hidden underneath the table supporting the television.

However as time passed during the development of this project it became more and more apparent that since Bionic Roshambo is predominately inspired by innovations in arcade gaming that it was appropriate the game experience itself should reflect the arcade gaming experience as closely as possible. In other words the game would be presented in the form of an arcade style cabinet.

Google.com was consulted to check if anyone had already attempted to construct a similar homebrew arcade cabinet. It turned out that there are numerous examples of such projects, most of which were designed specifically to house computers running the arcade emulation software M.A.M.E. (Multi Arcade Machine Emulator).

Several home arcade projects were examined, one of the most straightforward and accurately illustrated was at "Kevin's Build Your Own Arcade Machine" site (http://members.shaw.ca/kevinu/arcade/). This was used as a rough basis for the Bionic Roshambo cabinet design (Figure 51) but was changed considerably, most notably with a reduction in the cabinet's dept (since a flat-screen LCD monitor was used) and the addition of a game title set behind Perspex.

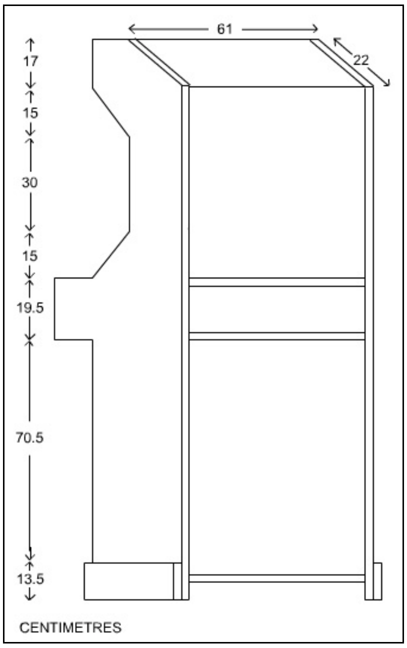


**Figure 51.** Bionic Roshambo cabinet design.

### 7.2 Materials and construction:

The panels and shelves of the cabinet was cut from two sheets of MDF Fiberboard, with the area behind the monitor and game title sealed off with plywood. Counter sunk woodscrews were used to hold the panels together. The screw tops were concealed with timber filler and smoothed off with sandpaper (Figures 52 and 53).

**Figure 52.**
Assembled cabinet, back view.

**Figure 53.**
Assembled cabinet, front view.

When fully assembled the cabinet was coated with 2 layers of MDF Undercoat and Sealer. A matt black look was decided on for the cabinet, this was achieved by applying two coats of Rustin's Blackboard Black paint.

Two 15 watt push switch lamps by 'Eterna' designed for illuminating medicine cabinets were placed in the top shelf over the monitor area to provide lighting for the Perspex title sign (Figure 54). The plywood behind these lamps was perforated to allow sufficient cooling and was made easily removable for the adjustment of the lamps.

**Figure 54.** Cabinet lighting.

A frame was built to contain the Perspex sign containing the game logotype. These were then attached to the top shelf with woodscrews, the traces of which were filled in with timber filler.

A circular hole measuring 5.5 centimeters was cut out of the shelves holding the monitor and game controller (Figure 55); this was done to allow for the cables from the monitor and controller to be conveniently connected to the pc on the bottom shelf.

**Figure 55.** Cabinet Shelving.

## 7.3 Combing the cabinet, computer and controller

A black Philips 'Brilliance' 18" LCD monitor was used as the display unit for the cabinet. This monitor had the advantage of a small width and built in stereo sound, so negating the need for external speakers.

The keyboard controller and plugboard were fixed into position on the middle shelf. From here the cables controlling the keyboard were fed out through holes drilled in the bottom of the 'joystick' shelf. The holes were drilled diagonally to help the cables curve round. Velcro once again came into use to secure the gloves to the top of the controller shelf when not in use.

Finally the pc itself was housed on the bottom shelf of the cabinet. Both it and the controller shelf were not sealed off at the back. This was done in the interest of keeping the computer from overheating and also so that the internal workings of the cabinet were easily available for inspection and if necessary, repair.

# Chapter 8:  Usability Analysis

## 8.1 Intro

The goal of this study was to find out how people would react to the experience of playing a video game using the experimental Roshambo Glove controller. It was necessary to conduct this research to find out what the users considered were the strong and weak aspects of the overall design and to gain feedback concerning what aspects of the system they would change to enhance the user experience. The "thinking aloud" method was used in which the participants are asked to make spoken comments as they work on a task.

## 8.2 User Group

The user group was three made up of two people, aged 22 and 23. These users each had a moderate amount of experience playing video games.

## 8.3 User Briefing

It was explained to the participants that they would be filmed with a Sony MiniDV camera whilst the game was played in order to record their feedback. Following from this the rules of rock, paper and scissors were explained to the users.

## 8.4 Procedure

For the demonstration version of Bionic Roshambo the game was installed on a pc and the glove controller was plugged into the keyboard input. While the demo version was not displayed in an arcade cabinet the monitor was placed on a high table and the users asked to stand whilst playing to appropriate the feel of the finished version.

The given task was to play a simultaneous two-player game. Both users put on their gloves controllers and started the game (Figure 56). Whilst the game was in play the users were prompted to describe what they were thinking in order to find out what they thought of the system as a whole.

## 8.5 Results

Overall the reaction to the game was positive "this feels like an arcade game", although three suggestions were made by the users to improve the game. The first of these changes concerned the speeding up of the countdown to add immediacy to the games pace, "the hands are moving too slow". It was also noted that at the point where the countdown reaches 'one' there was no visual prompt to perform the hand signals, "what do I do now, do I make the sign?", this was remedied for the final version. Finally it was expressed that the ability was needed to skip the animation sequence for a round result if desired, "the animations are good but it would be handy to bypass them when you want", this feature was also added to the exhibition version.

**Figure 56.** Bionic Roshambo test session.

# Discussion

Taking into consideration the game types examined in chapter three, it can be seen that these games are versions of tried and tested real world experiences, the game-play fundamentals of which have been taken and placed in (often abstract) computer generated worlds. So too Bionic Roshambo takes a tried and tested game concept and transfers it to the realm of the arcade.

Another factor that separates the aforementioned arcade games from the norm is their unique approaches to user participation offered through unique control interfaces. Bionic Roshambo attempts to follow this lead by allowing the experience of interaction through an interface style normally associated with high end virtual reality and science fiction, albeit a highly economized and customized interpretation.

Also like the arcade experiences detailed in chapter three the Bionic Roshambo system is relatively low end in its hardware and software requirements. The onscreen visuals whilst appealing are not given higher status over the control method and cabinet. What results is a unique experience that concentrates the user not just on screen but also in how they relate with the machinery as a whole.

## Future possibilities:

The technology behind the Bionic Roshambo interface could be easily adapted and developed to expand its ability.

The most obvious expansion opportunity lies in the glove itself, which could have every digit equipped with switches to detect if the fingers are flexed and whether the finger sides are together or parted. An upgrade of this manner would allow a greater degree of hand gesture permutations to be recognized and so expand the applications of the device beyond rock, paper and scissors.

Exactly how these extra switches would be exploited is through the software. Keeping in an arcade amusement setting a simplified sign language recognition game using a partial section of the Irish sign language alphabet could be developed along the lines of Sony's 'Parappa the Rapper' (Figure 57). Parappa is a game that requires the user to click specific symbols in time with the onscreen character in order to progress to the next level. If this game-play methodology could be applied to a game requiring the user to create specific sign language gestures on prompt then the result would be educational, socially enriching and fun.

**Figure 57.** Parappa the Rapper.

To expand beyond the on and off nature of the Roshambo glove's switches the glove structure would need to break free from the keyboard controller and instead be connected to a device that could measure variable inputs such as the Pico ADC. The use of variable resistors in the form of flex sensors in tandem with the Pico would allow the software to reflect the degrees of flexure of the digits and not just whether they are fully closed in or fully pointed outwards.

A defining aspect of the Roshambo glove is that it was designed for a specific number of hand gestures and so cuts down the hardware requirements to the bare minimum. If improving it were only done through bolting on extra sensors then it would mutate into a technological duplicate of many of the glove controllers already available.

Also if the low cost of the glove survived the translation to a commercial, mass-produced product for hobbyists the Bionic Roshambo could serve as an inexpensive glove controller for games and hobbyists. The system could allow the addition of extra switches and sensors as the user sees fit, so allowing him or her to build a customized controller to suit their specific requirements.

# Conclusion

In the initial development stages of this project the task was set to find a way of connecting people and computer technology using the expressive properties of the hand. Originally it was envisioned that a product that could capture hand gestures was going to require complex electronics and be considerably intricate.

However as the research progressed it became clear that the solution to the glove interface was to improvise and find the simplest method rather than immediately delve into high-end technology and become entangled in it to the point of confusion.

Also it was essential that in order for any real progress to be made the exact task for the input device had to be determined, only then could the development of a system specifically tailored for its needs commence.

The end result was a system that is low cost and relatively low tech but ultimately proves effective at its designated task, the interfacing of person and machine through hand gesture recognition as the control aspect of an arcade videogame.

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