

# ITB Journal



**Issue Number 16, December 2007**

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## Editorial

I am delighted to introduce the **16th edition of the ITB Journal**, the academic journal of the Institute of Technology Blanchardstown.

The first paper '*Be aware with a Honeypot*' by Meyer, Smyth, Cummins and Keane addresses the uncomfortable fact the Internet has become a hostile environment for computers, especially when they are directly connected with a public IP address. In their research, they created an ITB Honeypot that recorded over a thousand reconnaissance attacks seeking unauthorised entry onto the private network. They report on the nature of the intrusion scans and vulnerability attacks that were used and investigate the processes that targeted vulnerable ports and access points on the network. A related paper '*Computer Forensics and Irish Law*' by Anthony J. Keane, examines the situation that exists regarding computational and network forensics within Irish law. His important paper provides a discussion of the Irish legislation that can be applied to computer activities and how "computer crime" is dealt with in Irish law courts.

The third paper, from Curran and Mc Glinchey, is concerned with '*Vertical Search Engines*'. This very topical paper outlines the growth in popularity of vertical search engines, their origins, the differences between them and well-known broad based search engines such as Google and Yahoo. They discuss vertical search engines use in business-to-business operations, how they are marketed and related advertising costs. They also consider the users and the revenue streams generated by vertical search engines. In the forth paper on '*Digital libraries and their use in e-learning*', O'Nualláin examines the intersection of the present state of elearning and the need for digital repositories of learning objects that may be deployed for curriculum delivery. In his research he highlights the need for elearning practitioners to develop content optimised for size, richness and personalization. He makes the interesting point that there are millions of duplicating courses covering the same material across the world, which cannot be re-used or shared. These challenges should be addressed by use of digital libraries populated with high-quality learning objects and suitably tagged according to an agreed global digital library standard. In '*The Importance of Play*' by Corbin, our fifth paper, the author argues that play makes an important contribution to the social development of people in society. Play is argued to allow the individual to gain personal knowledge of other people; permits important social skills to be practiced and helps the individual to establish long-term friendships.

The sixth paper by Ferns '*Investigating the feasibility of creating a piece of software for practical electrical classes that engages learners of different learning styles*' critically examines the feasibility of creating a piece of software for practical electrical classes that engages learners of different learning styles. In his research, Ferns evaluated the preferred learning style of the typical apprentice learner by using a learning style questionnaire based on the Vark model which encompassed the four learning styles visual, auditory, reading/writing and kinaesthetic. The results motivated the design of a workshop interface to suit the learner's particular learning style. The interface was evaluated by 28 electrical apprentices and six lecturers within a practical workshop setting.

We hope that you enjoy the papers in this issue of the ITB Journal.

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**Be aware with a Honeypot**  
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**Abstract**

*The Internet has already become a hostile environment for computers, especially when they are directly connected with a public IP address. We have experienced this hostile activity where on an average day; the ITB Honeypot recorded over a thousand reconnaissance attacks seeking unauthorised entry onto our private network. Our Honeypot is a basic PC running Windows XP with no services offered and no activity from users that would generate traffic. The Honeypot is running in a passive state on a stub-network where all inbound and outbound traffic is recorded at the bridging computer to the WAN. We report on the majority of scans and vulnerability attacks that were used and investigate the processes that targeted vulnerable ports and access points on the network.*

Keywords: Honeynet, Honeypot, Honeywall, Internet monitoring, Cyber attacks

**Introduction**

It is generally accepted that the average time for an unprotected computer to be compromised on the Internet now less than two hours. Here we investigate this claim by recording uninvited network activity implemented against our computers that are connected directly to the Internet and constitute our Honeynet [1]. As a Honeynet is an unadvertised network and does not run applications that initiate Internet traffic, then all traffic on a Honeynet is considered malicious and goes through a data control firewall that tracks inbound and outbound connections and an intrusion protection system (IPS) to prevent any compromised Honeypots from being used to initiate attacks by dropping or modifying malicious traffic originating from them.

**Vulnerabilities in Networks**

In general, computer networks are composed of devices, applications and protocols. The typical devices are switches, routers, servers and client computers. The applications are network and client operation systems, web and email services and many other application services that vary depending on the business using the network. The communications between devices and applications use standard well known protocols [2], many of which have little or no security ability built-in to them. Individually and together, these component parts of the network provide a wide ranging array of weak points (vulnerabilities) that hackers probe and attack in order to gain access and eventually take over computers on the network [3].

Typical points of attack in a network are:

1. Poor configuration of router access controls lists that allow leakage through ICMP, IP, NetBIOS and can lead to unauthorised access to DMZ servers
2. Poorly secured remote access points

3. Excessive trust relationships in a Domain provide hackers with unauthorised access to sensitive information
4. User or test accounts with weak passwords and excessive privileges
5. Unpatched, outdated software, default configurations
6. Lack of accepted and well defined security policies, procedures and guidelines
7. File and directory access controls
8. Unauthorised services and programs on hosts
9. Weak passwords on workstations
10. Misconfigured Internet server applications and services
11. Misconfigured or poorly updated firewall
12. Running unnecessary services like NetBIOS can compromise network
13. Information leakage can provide attacker with OS type, versions, zone transfers, running services, etc.
14. Inadequate monitoring and detection capabilities at all levels

These are illustrated in figure 1, which shows a typical configuration of a network.

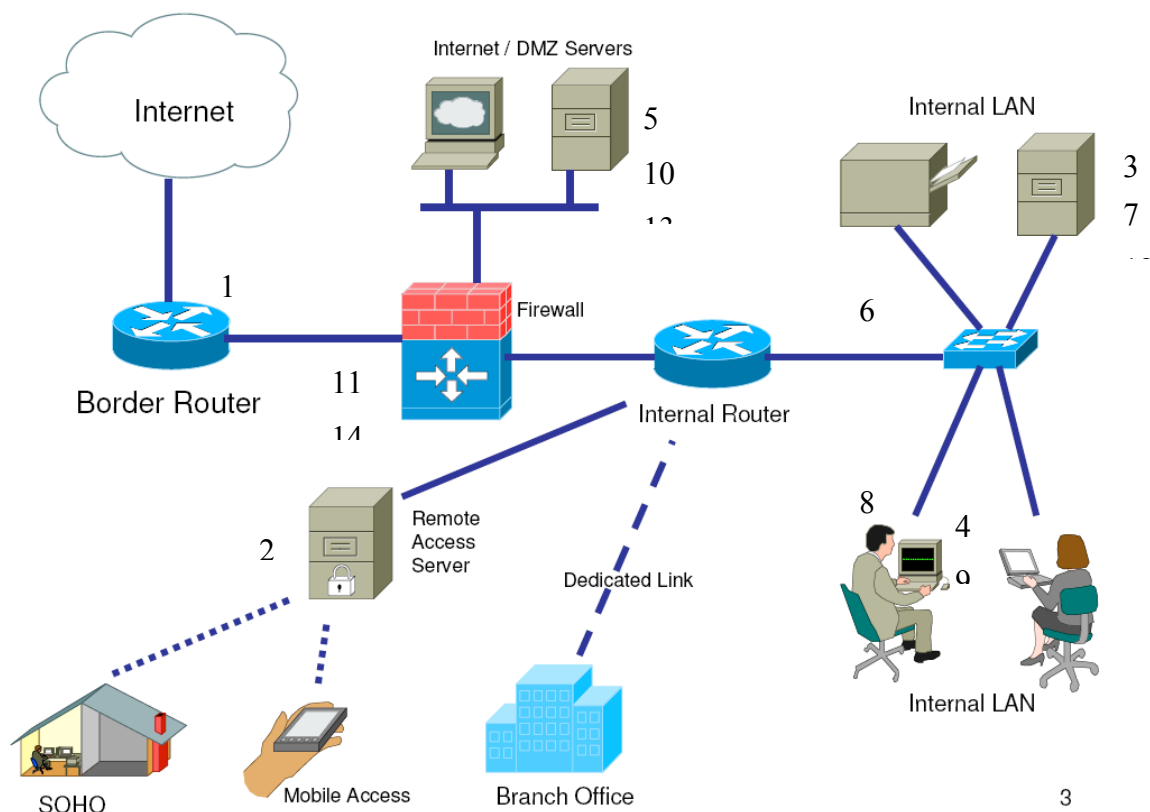


Figure 1: Typical topology of a network with possible weaknesses indicated by numbers.

The steps used to exploit a system follow the general methodology of first conducting an Active Reconnaissance of the network with the aim of *gaining access* by attacking the operating system or conducting an application level attack, scripts attack or targeting default or misconfigurations on the network. Once inside the attacker will try to *elevate the privileges* of the account to allow them to install a backdoor program that will allow future access. Finally they will *cover their tracks* in the system by cleaning

up log files to remove evidence of their presence. If an attacker fails to gain access to the system, they may initiate a Denial of Service attack to prevent anyone accessing the system at all.

### **Why we need to protect the Network**

Networks are pathways to computers and people use computers to store stuff like personal identity, bank, credit card details and purchases made on the Internet. Computers store information ubiquitously on people and companies operate their businesses with and on computers. Two recent reports have highlighted concerns with the way information is treated on computers and the new threats to businesses.

Researchers at RITS Information Security performed a study in how the Irish population dispose of their computers [4] and during this study analysed the contents of recycled hard disks bought openly on the market. The RITS survey found the following:

*Organisation Identifiable:* In the sample, 33% of the disks originated from the corporate sector ranging from large financial institutions, marketing consultancies, auctioneers, utility organizations, legal solicitors and mobile communication companies. Information included customer's names and addresses, invoices, financial records of past jobs, emails, organisation charts and other relevant documents relating to the organisation.

*Personal Information:* 62% of the disks were identified as personal computers or home user computers and from half of these could identify their previous owner. This included names, addresses, phone numbers, date of birth and in some cases even bank records and PPS numbers. 10% of the disks contained PPS numbers.

*Financial:* 24% of the disks contained credit card information. Alarmingly one of these disks contained a spreadsheet of at least 300 credit card details along with expiry numbers, names and addresses.

*Passwords:* 48% of the disks contained passwords. These ranged from passwords to online sites, email sites, mobile phone sites, etc. These passwords were easily retrieved. No brute forcing of passwords took place.

*Illegal Material:* 57% of the hard disks contained illegal material.

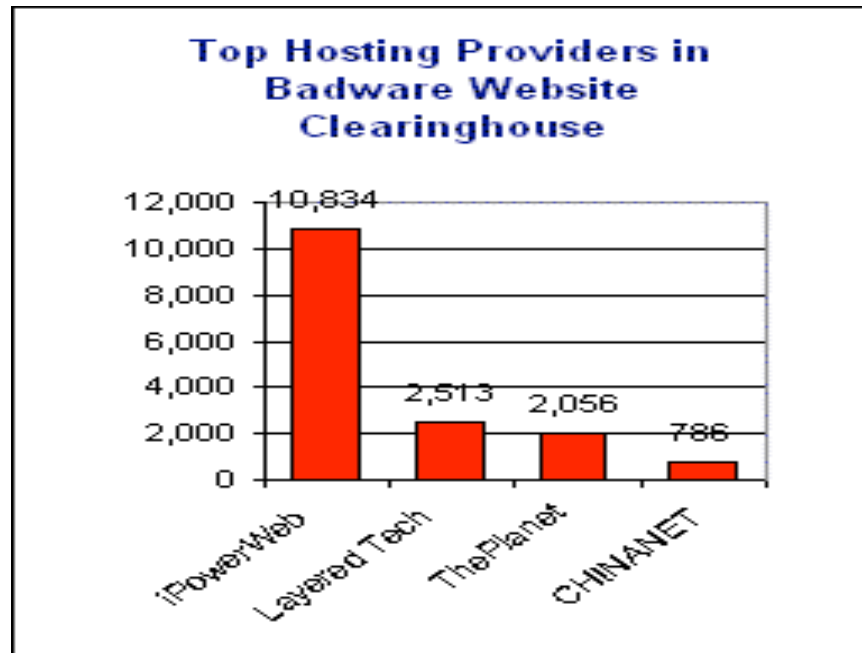
In the Symantec Internet Security Threat Report 2007 [5] they make the following statements: "The current threat environment is characterised by an increase in *data theft* and *data leakage* and the *creation of malicious code* that targets specific organisations for information that can be used for financial gain" and that "Attackers are now *refining their methods* and *consolidating their assets* to create global networks that support coordinated criminal activity"

This heightened activity in criminal behavior on the Internet is fuelled by the ability to purchase web vulnerability kits and customize them for your exploits.

### **Be Skeptical: if it is too good to be true, then it usually is**

Web vulnerability kits [6] allow an attacker to gain control over client computers when they innocently access web sites hosting the malicious web exploitation kits. The web servers are usually offering free software or games and more often than not, *appear to*

*be too good to be true* offers. The web server will return malicious malware as part of the innocent response expected by the client. The newly downloaded malware will begin a process of installing itself and may access other malicious servers to get more malware. Now the attacker is in complete control of the client machine and is able to steal personal information from the client and may add the client to a botnet for attacking other computers, possibly in a denial of services attack.



**Figure 2: Web Vulnerability Kits have infected many popular websites [6]**

### **IDS – This will protect us, surely?**

Intrusion detection systems and firewalls are essentially a detection technology to keep attacks out of your network. They *Detect and Alert* when there are unauthorised access and malicious activities detected in a network. The problems with IDS systems is that it relies on a signature of an attack before the attack can be detected so this can lead to false positives and false negatives, a situation where network traffic is mistakenly blocked or permitted. Also IDS system relies on being able to examine packet headers and payloads in the network traffic, but if encryption is used then it can not be read. Also hackers are constantly using new sophisticated evasion techniques to evade the network security systems.

## Honeynets Overview

### Motivation

The primary motivation to set up and run a Honeynet is to gather data from attacks and to try and understand the attacks. The main issues are what tools are used, how are they used, by whom and why. What are the tactics and motives of the hackers?

### Honeynet Types

There are basically four types of Honeynet deployments; the high interaction Honeynet uses a real network of computers covering a wide variety of operating systems and architectures. The low interaction Honeynets focus on a particular issue like a service attack while virtual Honeynets use a virtual network of computers to simulate a real network. Finally distributed Honeynets are an amalgamation of several Honeynets geographically dispersed to study global attacks.

### History of Honeynet Project

The Honeynet Project [7] began in 1999 by several security geeks (as they describe themselves) to investigate the activities of the “bad guys”. Their goals were to learn about tools and techniques and develop new monitoring and counter-attack tools. So much data was gathered that they found it difficult to find time to analyse it all so they created the “*Scan of the Month challenge*” and offered the data openly for anyone to have a go at investigating it. This was so successful that they also created the “*Reverse Challenge*” competition which requires competitors to reverse engineer binary code to analyse malicious applications and code. The Honeynet Project has grown into the Honeynet Research Alliance, a consortium of different academics and professionals that cooperate worldwide in the goals of the Honeynet project.

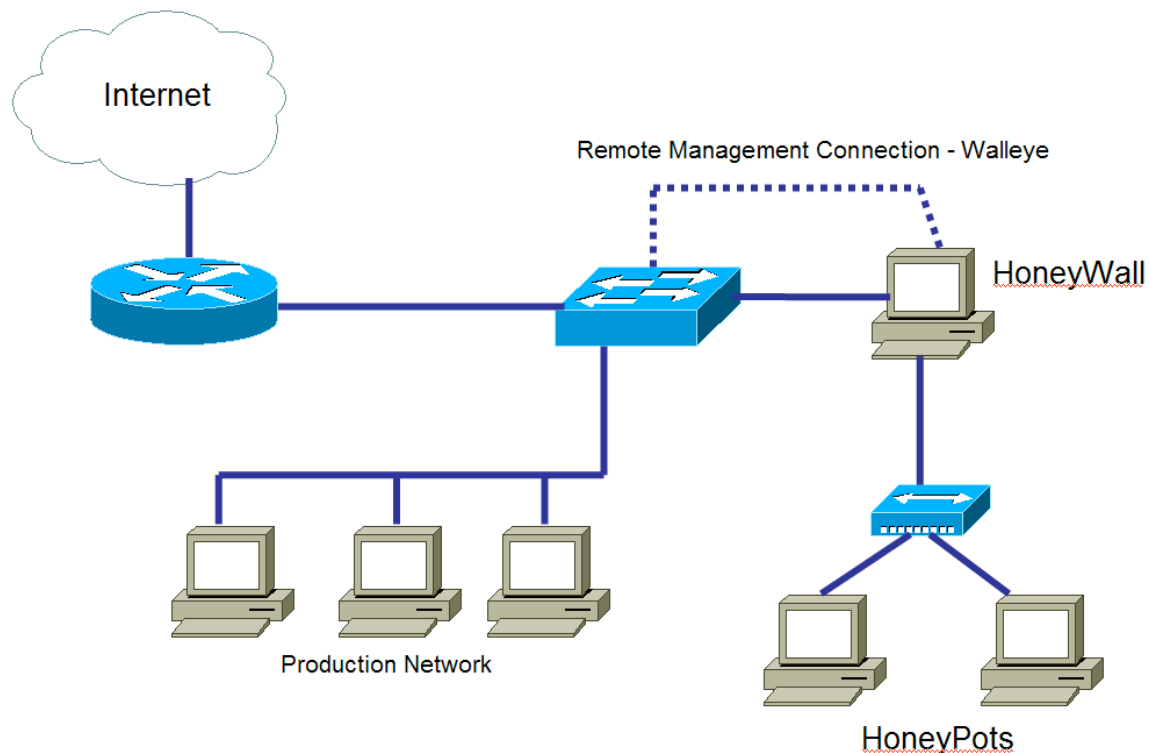
### Brief history of the Honeynets

The Honeynet Project has further developed tools and methods from generation one (Gen-I) to the generation two (Gen-II (2002)) versions and freely distributed this software from their website. The Gen-II tools have significant improvements and together with the benefits of running a Honeywall as a bridge with filtering intelligence give the following features: new tools like SNORT-INLINE, Sebek, rc.firewall, Virtual Honeypots, user interface for management and free bootable CD-ROM images, version 1.1 and mostly recently (June 2007) version 1.2.

The main advances in Honeynets are that as all traffic is suspicious, we have no false positives or false negatives, allow the collection of small data sets, allow the capture of encrypted activity, will work with IPv6, is highly flexible and requires minimum resources to setup and operate.



## Honeynet Architecture



*Figure 3: One possible layout of the Honeynet*

## Honeynet Configuration

Important configuration issues are the mode and IP information for the Honeywall, which is set to operate in bridged mode with identification as to which interface is operating as the external and internal bridge interface. The IP address of the Honeynet, the LAN broadcast address and the LAN CIDR address is also needed.

For remote management of the Honeynet, you need to enter the IP address and subnet of Honeypots, the Gateway address, Hostname, Domain name and DNS (if available), the manager IP address and any restriction on inbound / outbound traffic. Finally the Walleye needs to be activated.

## Honeynet Operation

The two essential parts of the Honeywall is data control and data capture. Data Control is being able to provide containment of activity, to monitor inbound/outbound connections, have automatic alerting and the ability to block outward bound activity. Finally all the activities of the Honeywall must be difficult for attackers to detect.

For Data Capture we require monitoring and logging of all activities and data with the challenge to collect as much data as possible without being detected. The Honeywall is layered with the firewall provided by IPTables and the IDS storing full binary data captured of the network traffic using Snort-Inline. When a Honeypot becomes infected, the attacker's keystrokes are captured and stored on the Honeywall using Sebek.

Before implementing a new Honeywall on a live Internet connection, the following steps should be followed with an offline network to check if Honeywall is working properly;

1. Check if the IPTables logging mechanism is running correctly. You can use a production host to open a telnet connection to the Honeypot. Check to see if the connection recorded. If so, now enable LAN blocking and try connection again.
2. Check if IPTables are limiting outbound connections. Make several HTTP connections to outside world and check the /var/log/messages file on Honeywall. There should be entries with limits noted. Try UDP and ICMP protocols as well.
3. Check Snort-Inline. Use the test.rules file and include it in the configuration file and restart IPS. Now open external telnet session, an HTTP connection and send pings. Check snort-inline alert file for entries and note the dropping of packets and check snort in IDS mode (read data with tcpdump). Finally check for email alerts (if set).

### **Results from the Honeynet**

The ITB Honeynet was setup and configured in June 2007 with Honeypots running standard Windows XP and 2000 client installations. We have found that the Honeypots get compromised very easily and often have to be replaced in the Honeynet so further forensics analysis of the exploit can be made offline.

In this section, we present in detail the data from a typical day of activity on the Honeynet showing the large quantify of data that gets recorded and to give some idea of the types of processes used in an attack.

A summary overview from the Walleye of the 24 hour period of activity is presented in figure 4. It shows the following details:

1. the identity of the Honeywall, date and time of activation and various other localisation information.
2. the top 10 Honeypots
3. the top 10 remote host connections
4. the top 10 source ports and destination ports

This summary information is taken from the recorded pcap packets recorded on the bridge between the Honeynet LAN and the Internet. It is a snapshot of the activity on the Honeynet where no activity should be taking place. The top 10 remote hosts are represented by IPv4 addresses so we can trace them on the Internet. They are unlikely to be the real IP addresses of the attacker because he will have used a compromised computers to do his dirty work for him by activating it remotely and thus avoiding leaving a trail of evidence to him directly.

Honeywall Details for 3238119782						
Sensor ID:		3238119782		Sensor Name:		Honeywall: ITB-AJK1
Install Date:		Mon Jul 2 10:37:37 2007		Last Update:		Mon Dec 3 20:57:14 2007
State:		online				
Country:		IE		Timezone:		0
Latitude:				Longitude:		
Network Type:		com				
Notes:						
Activity Report						
Top 10 Honeypots				Top 10 Remote Hosts		
Flags	Host	Connections	IDS events	Host	Connections	IDS events
	193.1.201.99	345	0	218.15.222.251	3	3
	193.1.201.102	16	0	202.101.235.100	3	3
				61.153.194.138	3	3
				202.99.11.99	3	3
				218.106.91.25	3	3
				63.199.210.165	4	1
				221.209.110.7	8	0
				193.194.85.74	6	0
				193.213.34.40	4	0
				221.208.208.94	4	0
Top 10 Source Ports			Top 10 Destination Ports			
Port	Connections	IDS events	Port	Connections	IDS events	
1231	3	3	1434	23		15
1046	3	3	135	59		1
1143	3	3	1026	449		0
1084	3	3	1027	395		0
4431	3	3	1028	365		0
31093	2	1	138	205		0
138	205	0	137	121		0
137	119	0	0	66		0
0	66	0	445	24		0
31074	26	0	80	20		0

**Figure 4: Summary of Honeynet Activity for 24 hours**

Taking for example the traffic summary report for the 24 hours from the 2<sup>nd</sup> December to the 3<sup>rd</sup> December 2007 for detailed analysis, we find that 8,008 packets were processed with a total of 145 IDS events being recorded. The total inbound and outbound packet count is summarised in table 1.

Connection Type	Count	Packets In	Packets Out	Bytes In	Bytes Out
Inbound	1256	1328	0	539359	0
Outbound	8	16	16	0	0

**Table 1: Packet Count for 24 hours**

The IDS on the Honeywall is configured to limit the number of packets allowed out from the Honeynet from a compromised Honeypot computer. This prevents the compromised Honeypots from engaging in attacks on other computers while still allowing us to examine the attack process in action.

Remote IP	Packets	Bytes	Conns
207.145.74.21	16	0	8
218.10.137.139	7	3199	7
24.64.24.51	6	2904	6
221.208.208.94	6	2742	6
82.71.9.231	10	0	5
221.209.110.50	5	2285	5
62.193.242.99	6	4	4
74.86.42.113	5	0	4
87.67.249.225	4	0	4
220.104.255.79	8	0	4

**Table 2: Top 10 Remote IPs:**

The source IP addresses were recorded from the packets and these are summarised in table 3. We can trace the origin of these IP addresses using *whois* utility on the Internet. This shows that China and America are the most frequent sources of attacks.

Remote IP	Country
207.145.74.21	United States of America
218.10.137.139	China
24.64.24.51	Canada
221.208.208.94	China
82.71.9.231	United Kingdom
221.209.110.50	China
62.193.242.99	Netherlands
74.86.42.113	United States of America
87.67.249.225	Belgium
220.104.255.79	Japan

**Table 3: Countries of origin**

The total number of ports scanned (destination ports) was 27 with details of the top ten scanned ports given in table 4 while in table 5 we can see the corresponding applications associated with the ports. Typical attacks are on NetBIOS ports and HTTP ports as well as ping sweeps and MS-SQL attacks. Table 7 and figure 5 show the complete range and frequency of activity on each of the ports. UDP ports of 1026, 1027 and 1028 contain the highest quantity of packets/bytes and connections. The port of 1026 is used by the calendar access protocol and one can suppose that the attacker is trying to use some exploit in applications that use CAP to gain access to the Honeypot.

Port	Packets	Bytes	Conns
udp/1026	418	196110	418
udp/1027	361	174164	361
udp/1028	340	164560	340
icmp/0	101	4197	54
tcp/135	65	9	53
tcp/139	29	0	14
udp/1434	16	4516	14
tcp/22	16	0	11
tcp/445	16	0	8
tcp/80	9	0	4

**Table 4: Top 10 Scanned Ports:**

Count	SID	Alert Description
4	2	(spp_stream4) possible EVASIVE RST detection
99	384	ICMP PING
2	483	ICMP PING CyberKit 2.2 Windows
2	525	BAD-TRAFFIC udp port 0 traffic
12	2003	MS-SQL Worm propagation attempt
12	2004	MS-SQL Worm propagation attempt OUTBOUND
2	2049	MS-SQL ping attempt
12	2050	MS-SQL version overflow attempt

**Table 5: All Snort Alerts**

### Suspicious Connections:

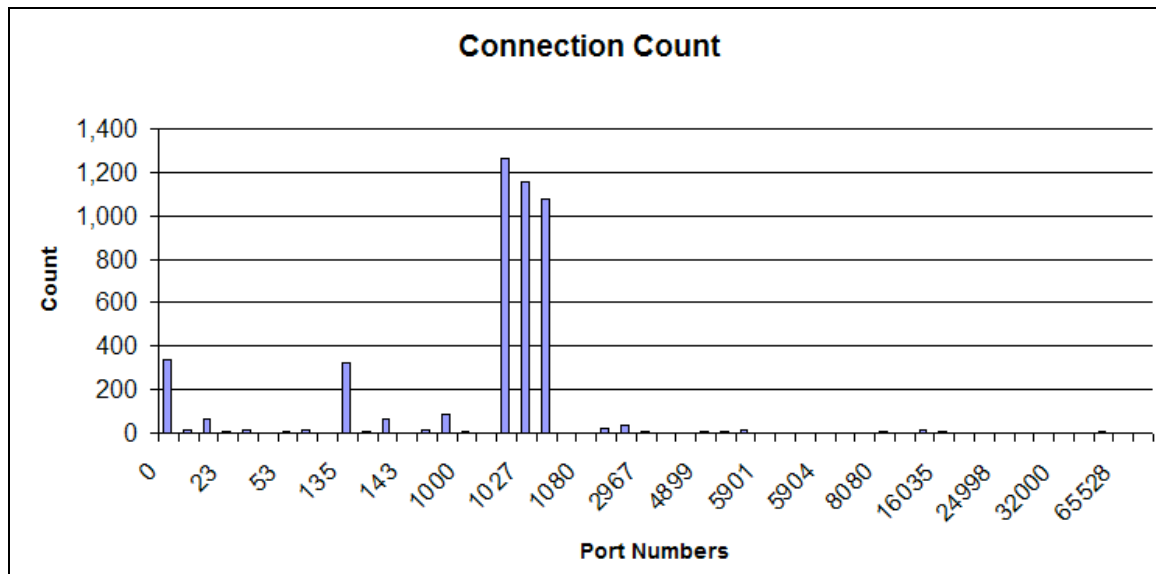
There is some evidence that the Honeypot has been compromised and has launched attacks on the other computers in the LAN. This is indicated by suspicious activities taking place on the Honeypot even though no users or application services are using the Honeypot. Some activity can be identified as belonging to operating system services that broadcast packets of notification and this can be easily identified and discarded. Other types of activity will require further forensic analysis. Table 5 lists the serious activities on the Honeywall that have been detected by the intrusion detection system, Snort. This list is typical of reconnaissance and footprinting activity performed by hackers. The MS-SQL activity is also typical of a hacker trying to gain access to the system where they would try to download Malware or hacking tools to escalate privileges to account access and take over control of the computer.

## Analysis of data for one week (2<sup>nd</sup> December to 9<sup>th</sup> December 2007)

Details of the ports used in the Honeynet attacks.

Port	Packets	Bytes	Connect	Shirt	Pocket	netTunes.	Shirt	Pocket
0	602	13,425	334	launchTunes.				
21	24	0	13	FTP, File Transfer Protocol, control.				
22	90	0	64	SSH.				
23	17	0	7	Telnet.				
25	27	0	13	SMTP, Simple Mail Transfer Protocol.				
32	4	0	2					
53	5	0	5	DNS, Domain Name System.				
80	28	0	17	HTTP, HyperText Transfer Protocol.				
110	6	0	2	POP, Post Office Protocol, version 3.				
135	466	15	326	DCE endpoint resolution				
137	19	200	6	NETBIOS Name Service.				
139	140	0	65	NETBIOS Session Service.				
143	3	0	3	IMAP, Interactive Mail Access Protocol.				
443	23	0	14	HTTPS, HTTP over SSL/TLS.				
445	141	0	85	Microsoft-DS.				
1000	6	0	4	cadlock2				
1026	2,093	1,095,178	1,264	CAP, Calendar Access Protocol.				
1027	2,120	923,663	1,156	ExoSee.				
1028	1,965	860,552	1,074					
1070	4	0	2	AT+C License Manager.				
1080	0	3	0	Millicent Client Proxy.				
1433	46	0	25	Microsoft-SQL-Server.				
1434	64	13,164	37	Microsoft-SQL-Monitor.				
2967	8	0	5	Symantec System Center agent.				
3306	4	0	2	MySQL.				
3389	0	2	0	MS WBT Server.				
4899	5	0	5	RAdmin Port.				
5168	7	0	7	SCTE30 Connection.				
5900	25	0	13	VNC Server.				
6101	2	0	1	SynchroNet-rtc.				
8080	16	0	6	HTTP alternate.				
8999	4	0	2	Brodos Crypto Trade Protocol.				
10000	17	0	15	NDMP, Network Data Management Protocol.				

**Table 6: List of ports used for attacking Honeypot**



**Figure 5:** Plot shows the frequency of activity on each of the port numbers

### Conclusions and Future work

We have shown how easy it is to setup a Honeynet using the Honeynet Project image software and we have collected data that has demonstrated how frequently a computer is attacked and through the suspicious connections we have shown that the basic operating system became infected and compromised on the first day of being connected.

Under Irish law and International law, if your computer is used to attack another computer and gain unauthorised access, then you are responsible and libel for prosecution. So it is important that we are aware of the dangers of being connected to the Internet and how these attacks are conducted and how to safeguard our computers from being compromised.

When we compare our finding with the experiences of other Honeynets, for example the HEAnet Honeynet, we see much of the same activity on the detection level. We are currently working on the forensics analysis of the compromised Honeypots where we are looking for answers to the questions like the following:

- Is the attack real?
- Who is committing the attack?
- What is the timeline?
- Identify all the malicious traffic involved in the attack for offline analysis
- Is there a pattern to the attack?
- What commands / tools were used?
- Was a rootkit used?
- Was an IRC channel used?
- What exploits were used?
- Was the honeypot comprised and used to initiate attacks?

We hope to have completed this work in a few months time and will follow up this paper with the results.

### **Acknowledgements**

The authors would like to thanks the Informatics Department at ITB for the use of their equipment and research network facilities. We would also like to acknowledge the help received from HEAnet in the duration of this project.

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<http://www.ritspondera.com/>
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**Abstract**

*They say that ignorance of the Law is not a defence but how many people could really say that they have any idea of the legislation regarding compute use. The answer is not many and therefore most computer users do not know if their activities are considered illegal or illegal, other then the obvious ones that appear from time to time in the news media and normally involve fraud, theft or child pornography. This paper is a short overview and discussion of the Irish legislation that can be applied to computer activities and how “computer crime” is dealt with in Irish law courts.*

**Introduction**

The Internet is a communications system that allows access to resources and people throughout the World. It has been adopted by business as a means of increasing their customer base and improving their ability to provide their service. Criminals have not been slow to take advantage of the anonymity that the Internet offers and to use the Internet to commit fraud and theft in many highly imaginative ways. The mechanism of the Internet is based in technology protocols, many of which are open standard and easily available, so with a little effort in educating one self on the inner working of the Internet, the criminal mind can conceive ways of misrepresenting themselves and trick the remote user into divulging their personal details, financial details, user access codes and passwords. Who hasn't received a spam email asking for bank details, offering to get large amounts of money for a small deposit, and similar type get rich quick schemes. Other tricks are not illegal but border on being so and are defiantly unethical, are the selling of special drugs reporting that they can satisfy some social desire on the part of the customer.

In the 1990s, the business of computers involved moving business practices from paper based systems to computerised networks. This was also the age when security became a necessity to protect the data on computers and ensure its integrity. It was not until the advent of World Wide Web and MS-Windows 95 with built in web browser application that the exponential growth in the Internet took place. Now every business wanted to be on the Web and every user wanted to have email. It is estimated today that they are over 1 billion users on the Internet and many of them are targeted everyday to relieve them of their cash and identity. According to the results of “The ISSA/UCD Irish Cybercrime Survey 2006: The Impact of Cybercrime on Irish Organisations” report<sup>[1]</sup>, Irish organisations are significantly affected by cybercrime where virtually all (98%) of respondents indicated that they had experienced some form of cybercrime with losses of productivity and data being the main consequences.

It is from the explosion of growth in computer use that a new field of computer science has emerged to deal with computer related crime and it is called Computer Forensics. It was initially developed by police enforcement agencies, like FBI where techniques,

tools and best practices were needed for information in a crime to be extracted from computer storage devices and used as evidence in the prosecution of the case. Today the Computer Forensics field has many contributors with propriety application tool kits for analysing storage media, open source tools, academic research groups, professional companies specialising in Security and Forensics and law enforcements agencies.

There are three areas of demand for the services of a computer forensics professional, the criminal area, the corporate requirement, the private / civil area. Here we look at the criminal area and concentrate on the legislation in force in Ireland that is available for prosecution of computer related crimes. We ask the following questions: How is the legislation framed and what computer related activities are considered illegal?

## Irish Legislation

Most of the computer crime related offences are handled by the Criminal Damage Act, 1991<sup>[2]</sup>, Section 9 of the Criminal Justice (Theft and Fraud) Offences Act 2001<sup>[3]</sup> and the European Convention of Cybercrime<sup>[4]</sup>.

### **Criminal Damage Act 1991, Section 5**

(1) A person who without lawful excuse operates a computer—

( a ) within the State with intent to access any data kept either within or outside the State,

or

( b ) outside the State with intent to access any data kept within the State,

shall, whether or not he accesses any data, be guilty of an offence and shall be liable on summary conviction to a fine not exceeding £500 or imprisonment for a term not exceeding 3 months or both.

(2) *Subsection (1)* applies whether or not the person intended to access any particular data or any particular category of data or data kept by any particular person.

The unauthorised access to information (data) is handled by the Criminal Damage Act, 1991 and is supposed to safeguard the possibility where a “hacker” has not committed any damage, fraud or theft but has tried or succeeded to gain access to a computer system.

O’Brien<sup>[5]</sup> has the following interpretations regarding this part of the legislation:

- In procuring a conviction, it is not necessary to establish a mens rea, provided the offender intended to access some data. The actus reus is satisfied when a person interacts with a computer, for example the pressing of the “return key” would be sufficient for the offence to occur, whether or not that person intended to access any authorised data.
- The offence is further expanded by criminalising attempted access regardless of whether any data is successfully accessed, for example an offender has been repealed in their attempt to breach a network security system.

- O'Brien suggests that the scope of this offence is so wide it can encompass any activity involving the use of a computer, for example if an honest user attempts to login to their email account and accidentally input the incorrect password, then under the Act, they have committed an offence.

When a system is damaged, then Section 2 of the Criminal Damage Act, 1991 is used. This creates the offences of intentional or reckless damage to property. While the wording of the Act does not explicitly use computer terms like virus, O'Brien suggests that this offence could be applied to damage caused to a computer system by a virus or similar attack. Reckless damage under section 2 has as the penalties a minimum fine of €12,700 to a maximum imprisonment for a term not exceeding 10 years or both.

Section 6 of the Criminal Damage Act, 1991 deals with the phrase "without lawful excuse". O'Brien interrupts this to mean anyone accessing any type of data from their PC or a network where they have authorised privilege to use, is not committing a crime. In the UK, the courts have ruled that authorised access of some data could not exonerate those who committed an unauthorised access of other similar data, however it still remains to be tested in Irish courts to see if they will adopt a similar approach.

One of the problems with the legislation is the poor definition of computer terms, for example data and computer. The reason given for this approach is to prevent the legislation from becoming obsolete by the rapid advancement of technology. However the range of meaning of data could lead to a scenario outlined by Karen Murray<sup>[6]</sup>,

*"The Criminal Damage Act 1991 has sought to avoid ambiguous definitions by avoiding a definition at all. This may have bizarre results; the human memory is undoubtedly a "storage medium" for 'data'; if a hypnotist causes a person to forget something, have they committed criminal damage?"*

Murray argues that such vagueness may be subject to a Constitutional challenge in Ireland under the doctrine where *"the principle that no one may be tried or punished except for an offence known to the law is a fundamental element of Irish and common-law system and essential security against arbitrary prosecution"*.

In other words, if there is no way of determining what the law is, there is no crime" .

#### **Criminal Justice (Theft and Fraud) Offences Act 2001, Section 9**

(1) A person who dishonestly, whether within or outside the State, operates or causes to be operated a computer within the State with the intention of making a gain for himself or herself or another, or of causing loss to another, is guilty of an offence.

(2) A person guilty of an offence under this section is liable on conviction on indictment to a fine or imprisonment for a term not exceeding 10 years or both.

In the year 2000, the Electronic Commerce Act was signed into force by the President of Ireland and created the legislation framework for conducting commercial transactions online. This was soon followed in 2001 by the Criminal Justice (Theft and Fraud) Offences Act in which section 9 has provision for "unlawful use of a computer".

However, O'Brien claims the scope of the offence is too broad having the possibility of criminalising anyone who made a gain by the use of a computer. He said that it "*may be impossible to know where free-market capitalism ends and dishonesty gains begin*". However he also prides the Act for use to combat hacking activities like denial of service attacks where a loss of business is possible.

### **The European Convention on Cyber-Crime<sup>[7]</sup>**

Since 1995 the EU has been trying to get a consensus on how to tackle cross-border Internet related criminal activities. In 2001 it finally got an agreement to what has become known as the Convention on Cybercrime. Ireland became a signature to it in 2002 but it only came into force on 1<sup>st</sup> July 2004. The cybercrime convention represents the first international attempt to legislate for cross-border criminal activity involving computers. In the broad definition of computer crime, the term cybercrime is viewed as a subcategory and generally associated with the Internet. The Convention on Cybercrime covers the following three broad areas:

- All signatures criminalise certain online activities
- States should requires operators of telecommunications networks and ISPs to institute more detailed surveillance of network traffic and have real-time analysis
- States cooperate with each other in an investigation of cybercrime by allowing data to be shared among them "but with an opt-out clause if investigations of its essential interests are threatened".

As the legislation reflects the needs of law enforcement rather than public interest groups, opponents of the Convention have cited the lack of privacy issues and forced cooperation clause as endangering the right to privacy for citizens in the EU.

### **Some Closing Comments**

Before leaving you with the Tsunami case to ponder, it is evident that from this paper that cyber criminals and ordinary computer users can be prosecuted under various Acts but the success of the case may depend on the interruption of the law to that particular crime, at that time, "*Laws which are not specifically written to prohibit criminal acts using computers are rarely satisfactory*"<sup>[8]</sup>.

### **The Tsunami Case**

In 2005 a college lecturer and security consultant, Daniel Cuthbert was moved by the devastating images of the Asian Tsunami disaster and donated money via a charity website. He entered his personal details like name, home address and credit card details but after a few day he became concerned that he had given his details to a spoof phishing site run by criminals. In an attempt to find out more about the site he did a couple of very basic penetration tests. If they resulted in the site being insecure as he suspected, he would have to contact the authorities. The first test he used was to type the (dot dot slash, 3 times) `../../../../` sequence into his web browser. This is part of a command to exploit a bug in some web servers that allows you to see parts of the site that are not normally available to the public. As this is not a complete attack as that would require a further command, but merely a light "knock on the door". Having tried this twice and received no response, he assumed the site was ok and went about his

normal work. There were no warnings or dialogue boxes showing that he had accessed an unauthorised area but he had triggered a intrusion detection system (IDS) at the company that ran the site and they called the police. A few weeks later he was arrested at his place of work and had his house searched. He was prosecuted under the UK Computer Misuse Act 1990<sup>[9]</sup> and the relevant section of the Act is Section 1 states:

- (1) A person is guilty of an offence if –
- a. he causes a computer to perform any function with intent to secure access to any program or data held in any computer;
  - b. the access he intends to secure is unauthorised; and
  - c. he knows at the time when he causes the computer to perform the function that this is the case.

Due to the wide scope of the Act, the Judge, with ‘some considerable regret’ had no option but to find Daniel Cuthbert guilty under the Computer Misuse Act 1990 and he was fined. He was also dismissed from his job. While this is English law and we don’t have an equivalent Irish case, as yet, it does highlight the care needed when performing a penetration test if you are to be confident that you are not acting illegally.

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**Abstract**

*This paper outlines the growth in popularity of vertical search engines, their origins, the differences between them and well-known broad based search engines such as Google and Yahoo. We also discuss their use in business-to-business, their marketing and advertising costs, what the revenue streams are and who uses them.*

## **1 Introduction**

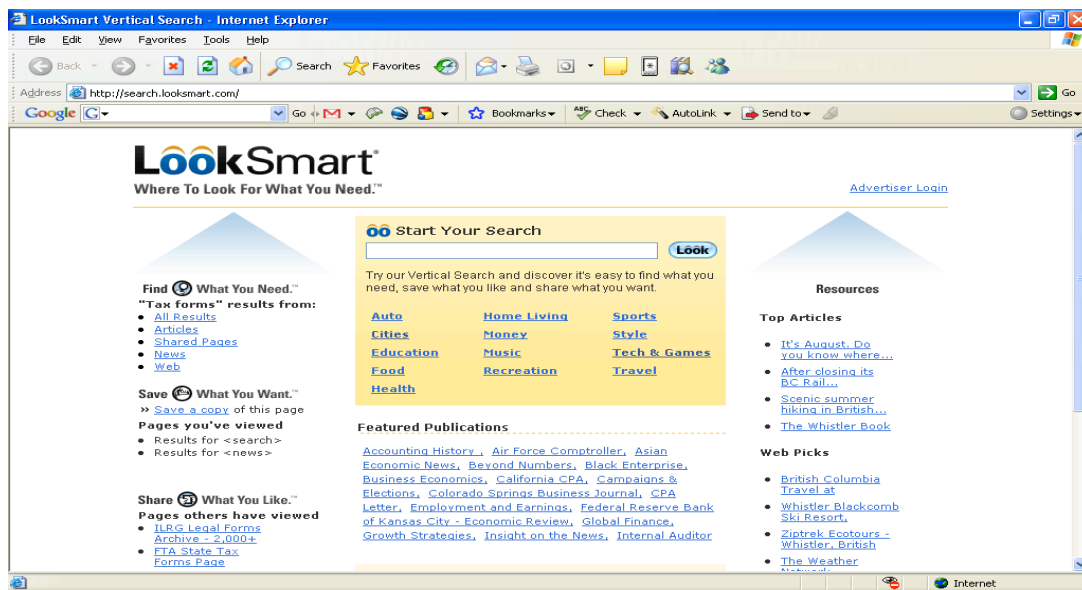
A search engine is a program that will search for keywords in documents and then return a list of the documents that contained those keywords. Typically, it works by sending out a “spider” or “web crawler” that returns all the documents it can find. Each returned document is read and indexed based on its word content by a program known as an “indexer”. The indices are created using an algorithm so that in most cases only results that are relevant for the query are returned. The Interactive Television Dictionary & Business Index [1] defines vertical search engines as,

*“Web sites which focus on particular topics and which especially allow you to search for information relating to those topics. The “vertical” term comes out of the idea that these are places where instead of searching horizontally, or broadly across a range of topics, you search vertically within only a narrow band of interest.”*

A *Vertical Search Engine* can be defined as one that only contains content gathered from a particular narrowly defined web niche therefore the search results will only be relevant to certain users. Vertical search engines are also referred to as vertical portals - vortals, specialty search engines and topical search engines. When we think of a search engine we automatically think of a “broad-based” search engines such as Yahoo, Google, MSN, Altavista, Ask and Dogpile. Currently, these engines dominate the online search market however specialized search engines for niche markets are increasing in popularity. One of the biggest specialized engines at present is LookSmart (see figure 1).

While vertical search engines are not new, what has changed is their increased popularity. Like consumers, businesses use the Internet for a variety of needs. Sometimes they are looking for all the information they can get, and for that the likes of Google and the Yahoo search engines are used. More often however, they are looking for something very specific related to their businesses. That is where vertical search sites come in. Vertical search engines deliver to businesses what the big sites cannot without the use of complex keyword combinations. This results in relevant and essential content rather than an exhaustive return of information. Some examples of vertical search engines include

- **Jobs** - SimplyHired.com, Indeed.com, Eluta.ca , Recruit.net
- **Travel** - Sidestep.com, Kayak.com, Mobissimo.com, Pinpointtravel.com, Farechase.com
- **Health** - Amniota.com, GenieKnows.com, Healia.com, Healthline.com, MammaHealth.com
- **Classifieds** - Edgeio.com, Oodle.com
- **Blogs** - Technorati, Bloglines, Blogger Search, Sphere, Feedster
- **Source Code** - Koders.com, Krugle, Google Code
- **Academic/teen** - Answers.com, Teenja.com, Gradewinner.com, Scholar.google.com.
- **People** - Zoominfo.com, Ziggs.com
- **Shopping** - Become.com; Oodle.com, PinpointShopping.com.



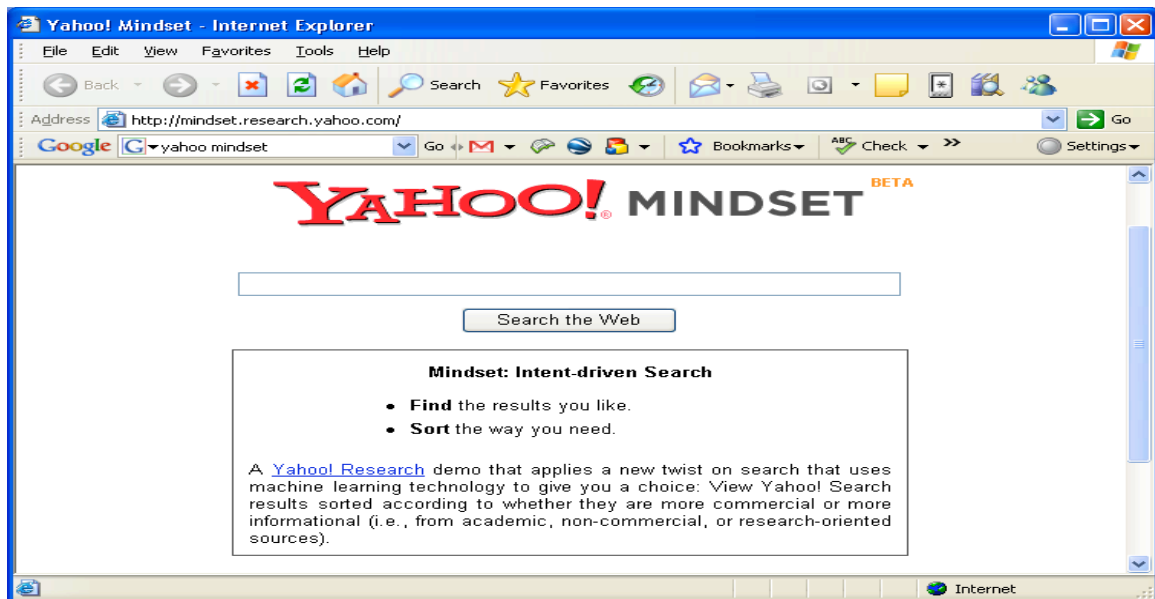
*Figure 1: LookSmart*

## 2 Vertical & Broad-Based Search Engines

Broad based search engines such as Google are not the ultimate for web searching as they are cluttered with all the returned information that matches the words in the requestor's query however relevant or irrelevant they are to what they want. There is a typical search failure rate of 31.9 percent on broad based search engines among business users [2]. It has also been demonstrated that the professionals using broad based search engines were unable to find important work-related information because they were not trained in their use and the broad based search engines were not designed as business tools. This resulted in a low business user satisfaction rating of forty percent for broad based search engines.

Additionally for businesses the broad based search engine has resulted in lower productivity from the failure of users to find critical information, however this has created a gap that is being filled by vertical search engines which the advantage because they can serve highly relevant results [3]. Second generation broad based search engines have tried to overcome this productivity loss by ranking using various

human element factors. Yahoo Mindset<sup>1</sup> allows the user to set the bias of commercial vs. non-commercial bias on the returned results by the use of a slide rule (see Figure 2)



**Figure 2: Yahoo Mindset**

As broad-based search engines are getting broader, so too have their search results, therefore users, particularly business users are starting to make the switch to vertical search engines. Consider the example of a dentist who is looking for information on ceramics, a common material used in dental work. If the dentist performs a Google search on the keyword “ceramics,” Google will serve up millions of results, but most of the entries on the first few pages will concern hobbies like pottery. On the other hand, if the dentist performs the same search on DentalProducts.net Web site, it will return much more relevant results. It would appear that Web users are starting to access / use the Internet the way they do multi channel television namely opting for specialized channels that give them the specialized information that they want e.g. a child wanting to see cartoons will go directly to the cartoon channel.

### 3 Vertical Search Engine Advertising

Vertical search engines are attracting professionals and business users searching for niche topics and are providing them with a satisfactory user experience. The high cost of advertising on the mainstream search engines is causing those in marketing to switch to vertical search engines because the space inventory is less crowded and they can negotiate better rates, possibly get better conversions and receive a better return-on-investment (ROI) for their marketing campaigns. Trends to consider include:

- \$7.4 billion was spent on search engine marketing in 2005 (16% of which was b2b).
- More than 40% of the average marketer’s budget is devoted to search.
- Nearly 38% of Yahoo’s and 50% of Google’s advertisers are defined as b-to-b.
- Nearly 64% of search engine users search for business information first. [4]

<sup>1</sup> <http://mindset.research.yahoo.com/>



Local online advertising is on the upswing. eMarketer's current estimate shows the U.S. local online ad spend at \$1.3 billion in 2006, representing 7.9 percent of a total U.S. online ad spend of \$16.7 billion. If the local online ad spend were to double this year to \$2.6 billion, it would still represent roughly 10 percent of the estimated \$20.3 billion total ad spend for 2007 [2]. A cost-effective way for smaller businesses to compete in pay-per-click (PPC) advertising is through Vertical Search engines. Broad based search engines such as Google and Yahoo! have mainstream advertisers like Amazon who spend millions each week on search advertising, buying every possible term related to their strategic keywords. That prevents smaller businesses from competing for these key terms.

For instance, a search on Google for the term "wholesale toys" will feature results such as AOL and the Discovery Channel. AOL and Discovery are not wholesalers however they will buy every term that people use to buy toys as it attracts traffic and they can quite simply afford it. This creates a problem for smaller advertisers. When companies like AOL and Amazon start bidding on search terms without regulation, the bid price and ability for real businesses to compete get distorted, making it difficult for small businesses to buy these terms. While many small businesses might actually be the most relevant source for a term like "wholesale toys," they can never compete with those 50-million-dollar-a-year search budgets. That is the primary reason why vertical search engines are gaining a toehold and are becoming known as category killers. A vertical in a small niche can become the information super highway on a specialized topic. Many vertical search engines have forums, blogs, fresh content and huge networks set up around a niche topic, providing many attractive promotional opportunities for advertisers. The cost to compete on a VSE is much lower than on general search engines, and marketers can expect much higher clickthroughs and conversions on their search ads, as well as a higher return on investment on their marketing campaigns. There are many benefits of advertising on vertical search engines versus Google AdWords if you pick the right vertical for your product or service. Examples showing how vertical search engines can be used to good advantage [2] are:

- **Clickthrough rates:** You can get higher clickthrough rates (CTRs) because the audience is segmented and highly qualified
- **Banner ads:** You can request custom positioning for your banners on vertical search engines. Most verticals offer users highly relevant content with targeted banners.
- **Direct links:** Link directly to the client's site or requested URL which gives the advertisers an SEO benefit because engines can now associate the advertiser with a highly ranked vertical search engine.
- **Special ad placement:** Verticals can accommodate a client's request quickly and on the fly. Vertical search engines are lean and versatile; they can react quickly to changing market conditions and industry trends.
- **User-generated media:** Vertical search engines cover issues related to specific topics or industries. Therefore, they can enable customers to blog on their sites, encouraging industry participation. Blog and story links provide great SEO benefits if a customer is linked to them.
- **Email marketing:** Many verticals have email lists, and these databases consist of recipients interested in the niche. These opt-in email lists can be more relevant than any mass-market offerings. Users look forward to receiving weekly newsletters with stories on the industry.

- **B2B ad advantage:** The big difference is that vertical search engines provide an ad advantage for B2B marketers because their ads are exposed to a highly motivated, targeted audience. Clickthroughs can be fewer, saving you money and conversions can be higher [2].

Research analysts at Forrester Research, Jupiter Research and Marketing Sherpa have identified a new tier in search dubbed “specialized search,” which includes “local,” “topical” and “vertical” search. [4]

- **Local** - This is geographic or place based relevance e.g. [www.chicago.com](http://www.chicago.com)
- **Topical** - This is about consumer niches such as travel, golf, hobbies etc e.g. [www.kayak.com](http://www.kayak.com)
- **Vertical or B2B** - This is about search engines designed to serve the needs of businesses in specific industries. In terms of design and implementation, several models are emerging in vertical search they include
  - **The vertical search engine as a destination or “portal”:** Example [www.VetMedSearch.com](http://www.VetMedSearch.com). Often media companies that own these destination sites optimize them and buy keywords on Google to drive their audience to visit.
  - **Vertical search as a complementary Web site application:** This model entails embedding a search engine on an existing, already trafficked site e.g. [www.CertMag.com](http://www.CertMag.com).
  - **Parametric search:** This tool, more prevalent in engineering and other product-specific, information-intensive, procurement-driven industries, often allows for face-to-face product and manufacturer comparison.

In terms of revenue that these vertical search engines generate, a variety of advertising programs are gaining favor, including *cost per click*, in which the advertiser pays only for each time that a user clicks on its ad; *Cost per action*, an emerging model in which the advertiser pays, not on click, or for impressions, but only if the consumer performs a specific action, such as purchases a good and finally, *Flat fee/fixed fee* which is the most popular early ad model for most of the vertical search engines.

With the vertical search engine advertising revenue expected to reach \$1 billion by 2009 [5] and their continued growth rate it would not be unexpected that the vertical search engines become more important due to their specialised nature than the broad based engines such as Google unless search engine companies fight back with some form of content control much more advanced. As it is virtually impossible to have a vertical search engine for every speciality, and it is highly likely that vertical search engines specializing in shopping, financial services, media and entertainment, and travel have the best chance of survival, therefore it is not a large surprise to find that advertisers are already spending large amounts of money within these sectors [6].

### 3 Conclusion

A Vertical Search Engine contains content gathered from a particular narrowly defined web niche so that the search results will only be relevant to specific users. Vertical search engines are also referred to as vertical portals or topical search engines. Broad-based search engines include Yahoo, Google, MSN, Altavista etc. Currently, these engines dominate the online search market however specialized search engines for

niche markets are increasing in popularity. Broad based search engines such as Google are not the ultimate for web searching as they are cluttered with all the returned information that matches the words in the requestor's query however relevant or irrelevant they are to what they want. One of the biggest specialized engines at present is LookSmart. The cost to compete on a vertical search engine is much lower than on general search engines, and marketers can expect much higher clickthroughs and conversions on their search ads, as well as a higher return on investment on their marketing campaigns. There are many benefits of advertising on vertical search engines versus Google AdWords if you pick the right vertical for your product or service.

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# Digital libraries and their use in e-learning

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#### Abstract

*How e-learning providers do business and produce content has changed dramatically over the past few years. Technology advancement and increased use of broadband coupled with the need to develop content optimised for size, richness and personalization have been key drivers. Due to the high costs associated with producing content, much progress has been made adapt old material to courses that may apply a different style guide. The fact that there are millions of duplicating courses covering the same material across the world, which cannot be re-used or shared, is an issue we discuss in this paper in the context of elearning and digital libraries. We look at some of the ways in which this can be addressed and some of the problems associated with the area such as cost, re-creating material to the new standards and good meta-tagging for particular communities of practice.*

## 1. Background

The focus of nearly all e-learning material to date has been linear, by which I mean it starts at point A and progresses to point Z without exception. In the current evolving learning environment there are many changes taking place in terms of the quality and richness of learning objects with a user focus. The legacy e-learning curriculum has become dated with little scope and ability to change and reflect the requirements of the user or even assess the user effectively. Ubiquitous computing has also brought with it many more challenges which it is thought the use of digital libraries can address due to the ability to effectively store and accommodate varying learning object types.

In this paper we illustrate one of the evolving processes whereby learning objects should be able to be shared and collected by digital libraries whether they be academic or industry based. There are other issues being targeted here in the area of dynamic creation of courseware with optimal learning objects to facilitate the blended learning environment. There is now more of a technology drive than a pedagogy drive. This is aided by the fact the technology is being driven currently by WEB 2.0, is heavily supported by the pedagogy models and the theories of the Social Constructivists including Vygotsky. This now facilitate a user driven collaborative approach applied.

## 2. What is the Problem?

There is no one problem! There are several major challenges to be overcome in order to get digital repositories initiated, built, collaborating and updating digital objects. This will include metadata standards, which must be driven by:

1. Real sharing potential of learning objects and metadata: It is essential that developed learning objects must be sharable and re usable to a high degree.

2. Digital Library standards: It is essential a standards based approach be applied to this area similar to that for e-learning.

There are several terms that are used to describe and define a digital library; they are often used interchangeably and we list some of these below with some background to their origins.

These are:

1. Digital Repository Definition:  
This is where digital content like pictures, notes, mp3 files etc are stored in an ordered manner so as to allow import, export and storage.  
<http://www.jisc.ac.uk/media/documents/programmes/digitalrepositories/repositoriesbp2005further.pdf>
2. Eportfolio:  
An eportfolio can be a web-based information management system that uses electronic media and services. The learner builds and maintains a digital repository of artefacts, which they can use to demonstrate competence and reflect on their learning. Having access to their records, digital repository, feedback and reflection students can achieve a greater understanding of their individual growth, career planning and CV building. Accreditation for prior and/or extra-curricular experiences and control over access makes the eportfolio a powerful tool. (<http://www.danwilton.com/eportfolios/whatitis.php> )
3. Digital Library Definition:  
A digital library is a collection of documents in organized electronic form, available on the Internet or on CD-ROM disks. Depending on the specific library, a user may be able to access magazine articles, books, papers, images, sound files, and videos.  
([http://whatis.techtarget.com/definition/0,,sid9\\_gci750204,00.html](http://whatis.techtarget.com/definition/0,,sid9_gci750204,00.html))
4. Digital Portal Definition:  
There is no common agreement as to what a portal is. Many point out that the word means doorway (often taken to be a grand doorway such as that found at the main (west) door of a cathedral), with the implication that a portal is simply a way of accessing a number of services, but as Strauss has stated “*A Home Page Doth Not A Portal Make*”. By which he means that it is not enough to simply bring a number of different channels or information sources together on a web page, there is a need to provide some degree of integration and customisation. He goes on to describe a portal as a “*Customized Personalized Adaptive Desktop*” and it is worth exploring what he means by each of these terms before looking at some of the implications for how one might build a portal, and equally how one can set about shifting the entire organisation from where it is now to having a portal.
  - *Customised* – The portal adapts to the user, and the more it knows about the user the better it should be able to adapt to their needs, whether the user is a member of teaching staff, administrative staff, a researcher, a student or a prospective student (or someone who occupies several of

those roles – for instance a post-graduate student who also teaches). It should also be able to adapt to the type of hardware that the user is currently using (PC on a LAN, PC on a dial-up line, Personal Digital Assistant (PDA) or smart phone). This should be done as the user logs into the portal.

- *Personalised* – Allows the user to change the portal's interface and behaviour to meet the user's needs and preferences. This would include the appearance (colours, fonts, size), channels subscribed to and their location on screen.
- *Adaptive* – Changes its behaviour depending on context. Many people will have multiple roles, and will present information or channels depending on activity. It will also have an understanding of time and be able to support workflows for example around marking exam papers.
- *Desktop* – It replaces the desktop environment, hiding the operating system by providing access to all applications and information that the user needs regardless of whether these are local or networked.  
(<http://www.franklin-consulting.co.uk/PortalDefinition.html>)

5. Digital Collections Definition:

This is an electronic Internet based collection of information that is normally found in hard copy, but converted to a computer compatible format. Digital books seemed somewhat slow to gain popularity, possible because of the quality of many computer screens and the relatively short 'life' of the Internet.  
(<http://www.africandl.org.za/glossary.htm>)

6. Learning Objects Definition:

Learning objects are digital content that can be used and reused for teaching and learning. They are modular, flexible, portable, transferable (interoperable) and accessible. Learning objects may be used to teach a particular skill or concept, or to provide stimulating thinking and learning experiences for the teacher or student. A learning object, as defined by SCORE, includes digital content, practice activities and assessment tools that are linked to one or more educational objectives and classified in a plan that allows information about the content to be stored and retrieved (metadata schema). For teaching and learning purposes, effective learning objects use documents, interactivity, graphics, simulations, video, sound and other media tools that go beyond static textbook presentations to engage students in real-world content.  
(<http://www.sreb.org/programs/EdTech/pubs/PDF/05T03-PrinciplesEffectiveLO.pdf>)

7. Ontology Definition:

In information technology, an ontology is the working model of entities and interactions in some particular domain of knowledge or practice, such as electronic commerce or "the activity of planning." In artificial intelligence, an ontology is considered the specification of conceptualizations, used to help programs and humans share knowledge. In this usage, the ontology is a set of concepts - such as things, events, and relations - that are specified in some way

(such as specific natural language) in order to create an agreed-upon vocabulary for exchanging information.

([http://whatis.techtarget.com/definition/0,,sid9\\_gci212702,00.html](http://whatis.techtarget.com/definition/0,,sid9_gci212702,00.html) )

### 3. E-learning Standards

It is essential that we have standards in place in e-learning so that we can apply and create quality content and to that extent we identify a number of relevant standards.

These are:

1. SCORM:

The Sharable Content Object Reference Model (SCORM) was first developed by the U.S. Department of Defense (DOD) to address training development and delivery inefficiencies across its service branches.

(<http://sorubank.ege.edu.tr/~e190411147/scorm/scorm4.pdf>)

2. LOM:

Any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning. Examples of technology-supported learning include computer-based training systems, interactive learning environments, intelligent computer-aided instruction systems, distance learning systems, and collaborative learning environments. Examples of Learning Objects include multimedia content, instructional content, learning objectives, instructional software and software tools, and persons, organizations, or events referenced during technology supported learning.

(<http://www.ibm.com/developerworks/xml/library/x-think21.html>)

3. AICC:

The Aviation Industry CBT Committee was originally designed to standardize instructional material for aircraft manufacturers and buyers. AICC covers the way in which content units (learning objects) communicate with learning content management and Learning Management Systems.

[http://www.centre-inffo.fr/pdf/adapt/adapt2001\\_chap4\\_angl.pdf](http://www.centre-inffo.fr/pdf/adapt/adapt2001_chap4_angl.pdf)

4. ISM:

The Instructional Management System has been working as a group for four years. The oldest section covers metadata tagging i.e. the tagging and identification of content. Other specifications include enterprise, content packaging, user profiles and question and test. The IMS Metadata specification may soon have the distinction of being the world's first official e-Learning standard since it has also been included in the IEEE and ISO standardization process.

[http://www.centre-inffo.fr/pdf/adapt/adapt2001\\_chap4\\_angl.pdf](http://www.centre-inffo.fr/pdf/adapt/adapt2001_chap4_angl.pdf)

5. CANCORE:

The CanCore guidelines for the implementation of learning object metadata provide an element-by-element guide to interpreting the semantics and syntax of all elements in the IEEE LOM. The aim is to simplify and interpret this standard in order to help implementers and record creators with design, development, and indexing work. If CanCore's recommendations are used as a basis for LOM



interpretations and implementations generally, the potential for the interoperability of LOM implementations will be greatly increased.

The main problem with the standards that have evolved is that developers and academics must for the most part conform to one as they are all different and one cannot switch between standards easily if at all. There is an additional problem with standards and that is to what extent a standard is applied. To that end we examined six leading e-learning companies who advertised their content as conforming to SCORM. However, the SCORM standard is huge and developers seem to only apply part of the standard or part of LOM, itself a subset of SCORM. This leads to the illusion of having applied a standard when in fact no standard was applied completely. So what quality mark should these products have or be allowed to advertise? Who knows for sure, but there seems to be a level of compliance accepted in the industry (<http://standards-catalogue.ukoln.ac.uk/index/CanCore>).

#### **4. Digital Library Standards**

We hoped, with the many standards that exist in e-learning content development, that the digital library standard practitioners would have learned a lesson and have one world wide accepted standard, but this is not the case. We find several examples exist which were all developed in isolation with little or no consideration for other standards that exist currently. Some of these examples around instructional digital libraries came about from what was initially a standalone system, which never envisaged the possibility of interlibrary cooperation and sharing digital media. More information may be found at [www.ifla.org](http://www.ifla.org) (2005). As yet I have not found any digital library standard which can clearly stand out as a defacto standard, so it would seem a lot more work will have to go into this evolving area.

This has been a steep learning curve with regard to what is expected in the digital library and what we have included. As things stand, we are still refining our digital library model and will continue to refine it until we are happy with what is currently being stored and what indexes are used so as to allow us to have all data related to objects captured sufficiently.



---

***Sample Digital Library Structure and content for an e-learning package***

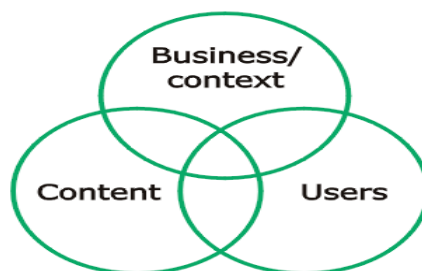
---

1. Topic
  2. Description
  3. Sections
  4. Media
    - a. Source
    - b. Options for reuse and existing places used.
    - c. Proof of availability
    - d. Ownership
    - e. Licensing
    - f. Cost
    - g. Payment Method
    - h. Optimum speed of access and use
    - i. Ability to apply Style guide
  5. Types supported currently and in the future as yet not known
  6. Handles or tags: Specific topics covered
  7. Context
  8. Modality for Delivery
  9. Format
  10. Conversion speed
  11. Assessment of topics
  12. Assessment of Specific areas (level 1-10)
  13. Depth of assessment
  14. Level of adaptability
  15. Feedback
  16. Author
  17. Version number
  18. Date Created
  19. Where Used
- 

*Figure 1: The above fields were the starting point for the digital library we created from scratch. Initially we had 90 fields but very quickly found the majority were unsuitable for the purpose intended.*

## **5. Information Architecture**

The initial information which aided us in our research to structuring and consideration came from Arms (1997), Hastings and Tennant (1996), Roberts (2005).



*Figure 2: The Information Architecture of a Digital Library*

The issues to be addressed in structuring information within a digital library include the following:

- Digital materials are frequently related to other materials by relationships such as part/whole, sequence, etc. For example, a digitized text may consist of pages, chapters, front matter, an index, illustrations, and so on. In the World Wide Web, a typical item may include several pages of text, with embedded images, and links to other information. A single computer program is assembled from many files, both source and binary, with complex rules of inclusion. Materials belong to collections. These may be collections in the traditional, custodial sense; they may be the on-line groupings provided by a publisher; or they may be the pages maintained by a Webmaster.
- The same item may be stored in several digital formats. Sometimes, these formats are exactly equivalent and it is possible to convert from one to the other (e.g., an uncompressed image and the same image stored with a loss-less compression). At other times, the different formats contain different information (e.g., differing representations of a page of text in SGML and PostScript formats).
- Because digital objects are easy to change, different versions are created continually. Indeed, some organizations change their Web home page several times per month. When existing material is converted to digital form, the same physical item may be converted several times. For example, a scanned photograph may have a high-resolution archival version, a medium quality version, and a thumbnail.
- Each element of digital information may have different rights and permissions associated with it.
- The manner in which the user wishes to access material may depend upon the characteristics of computer systems and networks, and the size of the material. For example, a user connected to the digital library over a high speed network may have a different pattern of work from the same user when using a dial-up line (<http://www.dlib.org/dlib/february97/cnri/02arms1.html#info-arch>).

A digital library (figure 3) and its subcategories could facilitate context, different devices of differing characteristics, modality. They may require objects, standards notes or even notes in different languages.

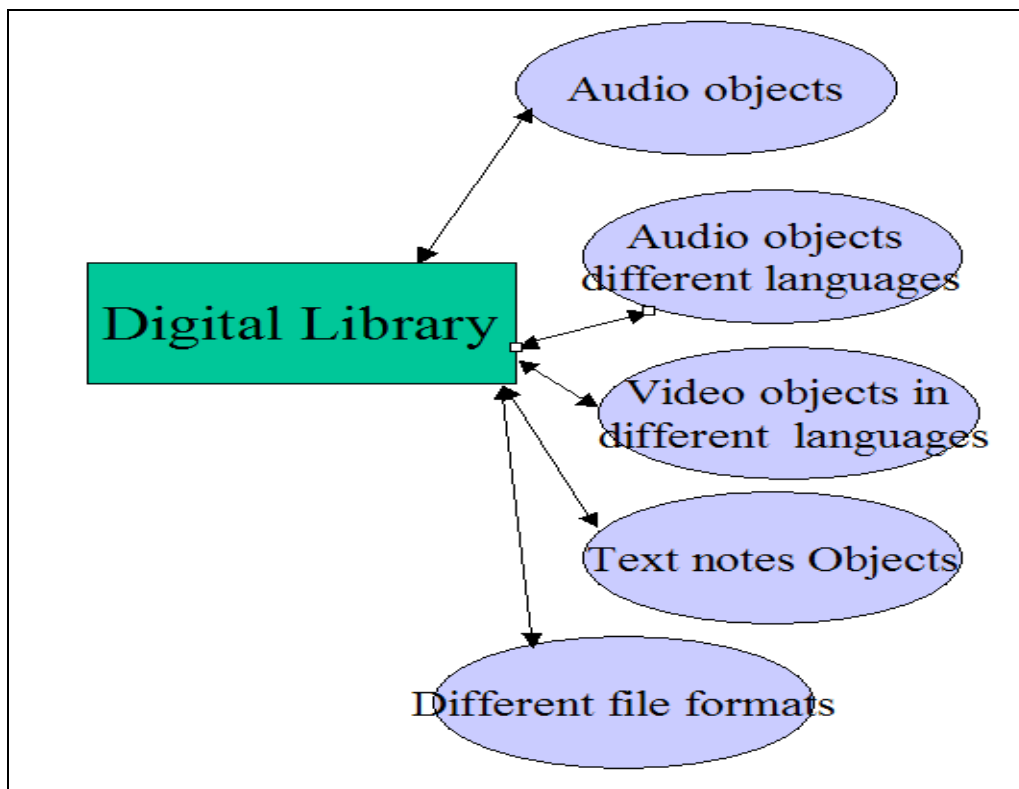


Figure 3: Simplified outline of a Digital Library and subcategories

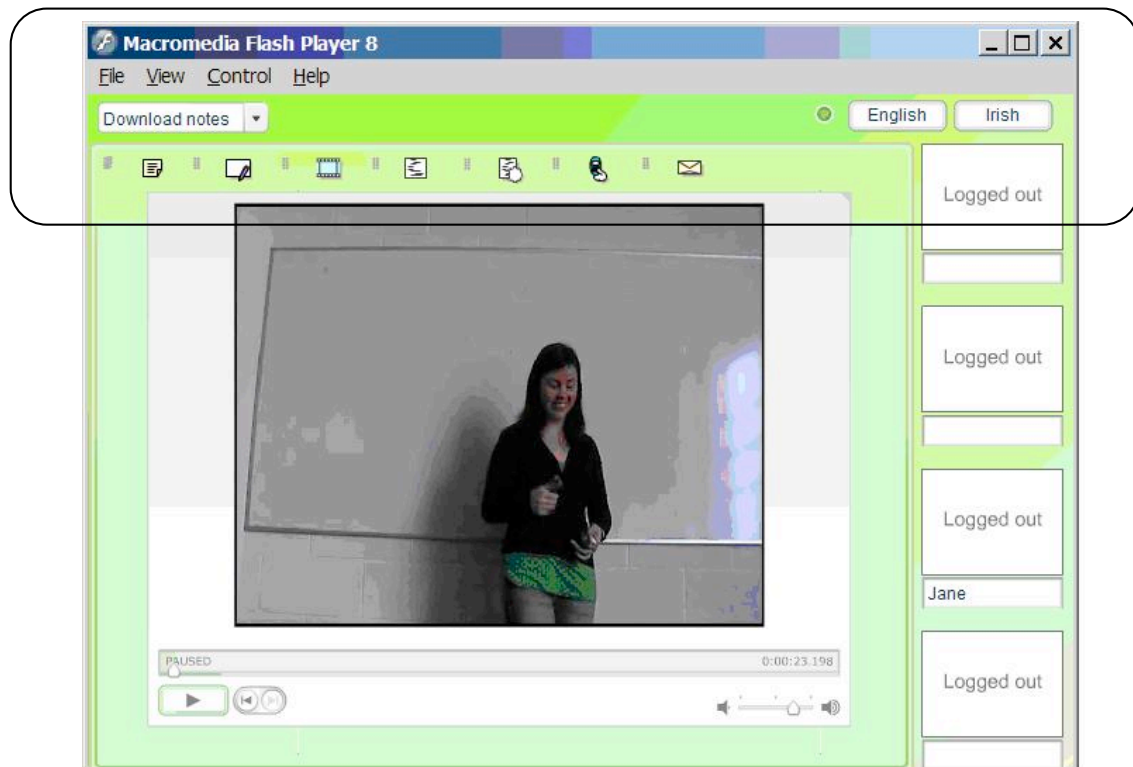
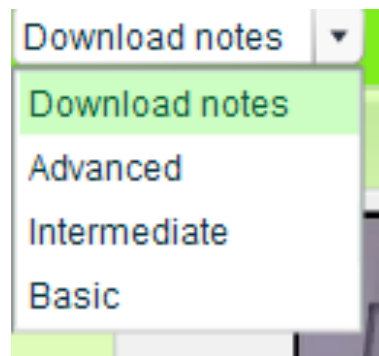


Figure 4a: The above screen is designed to help students with Dyslexia use the system.

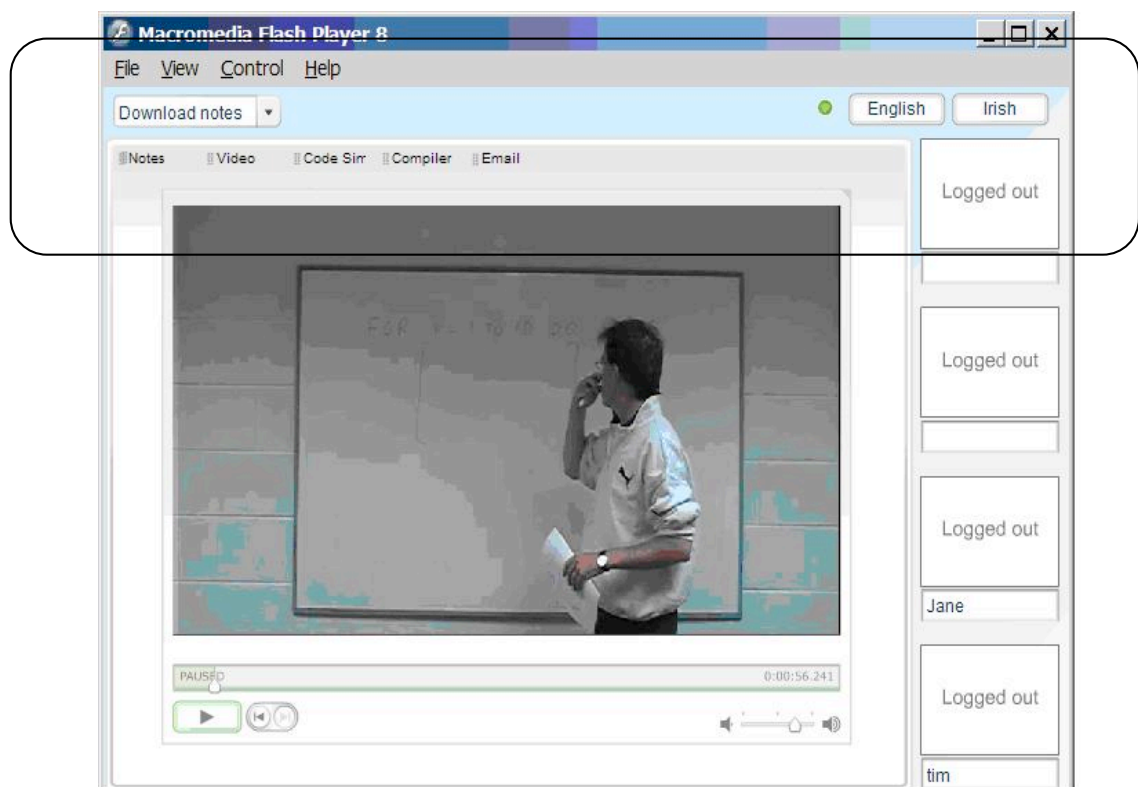
As can be seen clearly in figure 4a, there are intuitive icons; the screen indicates the modalities available that someone with Dyslexia can best avail of and learn from. Dyslexia is very complex so we have had to make some appropriate assumptions in our research. What was achieved was the optimisation of the UI in this context by the changing of the interface colour to one that suited the users preferences plus much text was removed as possible from the menus.

We also provided three versions of the notes.



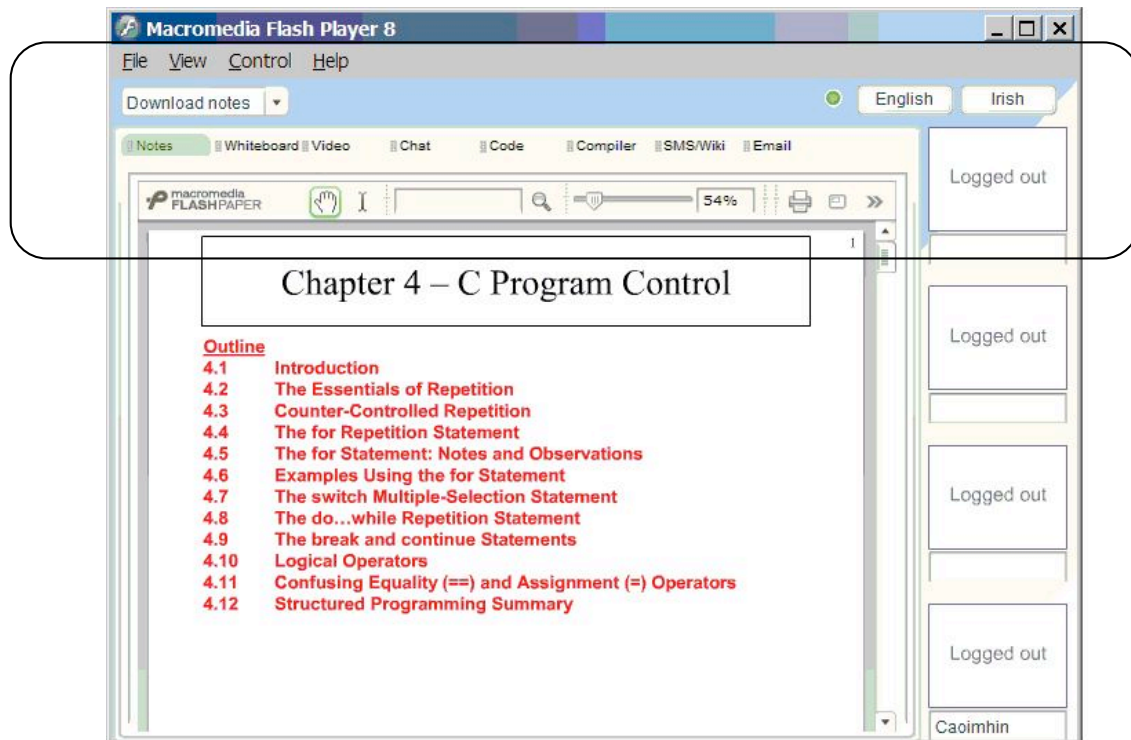
*Figure 4b: Screen indicating the additional types of notes available to users depending on the level of detail or text required.*

Our intention is that the ‘levels of information’ is the same within both the set of notes and the bullet point versions. One set of notes with bullet points, as in PowerPoint slides, would also be preferable to this type of user as well as being used as study notes for all students. There were also more media rich options here than in other individual profile types, plus easier access to the media rich wiki and blog.



*Figure 5: Application screen from our profile-based digital object based system*

The screen in figure 5 came from an application within our profile-based digital object system that user surveys indicated would suit mature students and their particular needs. The modalities available in this example (figure 6) are different from the modalities in the other screens (figures 4a and 5).



*Figure 6: The screen for the non-Dyslexic and non-Mature student*

The screen in figure 6 indicates the screen that would normally appear for the non-Dyslexic and non-Mature student.

The three versions of the application were only possible through the existence of a sizable digital library and use of profiles, where we can change all test notes depending on the type of student, languages and context required. We have language support for Irish, English, French, German and Swedish. This requires additional object categories and specific digital libraries relating to vocabulary, video, audio etc. The first screen, which was for the Dyslexic student, was created for a female student who specified they wanted their lecturers to be female also, so we had to have a complete set of learning objects for that subject done by a number of female lecturers to be able to deliver in the languages supported in this element of the research. This had a major effect on the storage required and the file formats for different types of video. All of these are aspects and considerations to be taken into account when building a digital library. This gave us some idea of the storage structures that we would need to support additional objects for mobile devices like laptops and mobile phones and handheld tablets. Ultimately much time and space could be saved if one format could be used in all situations or adapted to facilitate the different situations and contexts.

Figures 4a, 5 and 6 represent device or user specific examples of screens that illustrate dynamic screen creation for specific users with different learning styles based on a profile and used in conjunction with a digital library. The screens are from our application that allows dynamic screen generation. This application could, from our experiences, do with more extensive objects in our digital library so as to make the application more scaleable (Wiley 2002) and better reflect the user context.

The complexities associated with placing a photo on a screen in a course must be addressed. There are issues and challenges to do with the types of object created, or searched for across the Internet. Complex search must be achieved very quickly to allow even basic dynamic screen generation to take place. Additional complications will also be present when some objects are created with Flash, Java Script, Java or any of the arrays of tools for creating web content like Dreamweaver etc. These different types of object may not work well together and could well cause transition and integration problems. Ideally, we must not distract the user and cause them to lose concentration. There are many courses on the web like those offering, for example, C programming, and have hundreds of learning objects available from all over the world. We need to be able to use the 'handles' or tags to limit our search. Another issue in this area is the diverse use of tags to describe an entity. This can cause many problems when trying to find suitable objects. We may have to actually physically check the suitability of an object before deployment. It is hoped that a means of solving this issue can be done using new Web 2.0 technology.

These objects must not only be suitable in terms of content, context and user but must be ultimately able to fit into the environment framework.

## **6. Our rules governing addition of new objects and resources**

The important contribution we make to this area is in putting forward our own '*selection and addition*' process to maintain quality of our resources and learning objects along with quality in the links to other libraries. We do this to provide the most suitable and effective resources. Some of our considerations are:

1. The tag must match the description of the subject matter being collected to a high degree and provide sufficient detail for an easy decision to be made
2. The creation date of the objects must be stated.
3. The expiry date must be stated.
4. The file formats must be known
5. The size of the object must be known and usable
6. The time to play must be acceptable so as to fit into our course seamlessly
7. The style guide of the objects must be capable of adapting so as to create a standard style guide which applies our instructional design.

## **7. Problems with using digital libraries**

Just as when creating a library, we have several considerations before we can start to populate a library. As with a standard library, these relate to the media and whether they are fiction or factual, and within the fiction categorisation the books are in one of the many areas like murder, comedy, mystery, adventure etc. Digital Libraries are no

different and practitioners who have created databases will need to have considered much of the same structure issues.

Most of these issues relate to:

1. How best to store similar topics together in the one place
2. How to find books which match your criteria best and in the shortest possible time. The time and searching aspect are most important when trying to create courseware from multiple libraries instantly.
3. Objects offering different perspectives of the proposed profile based material which can reinforce the information and lessons learned.

Important headings relating to digital object storage in a digital library include:

1. Sharing
2. Tagging
3. Content Descriptions
4. Ownership
5. Licensing
6. File formats
7. Seamless Integration

With digital libraries, an individual can:

- Gain access to the holdings of libraries worldwide through automated catalogs.
- Locate both physical and digitized versions of scholarly articles and books.
- Optimize searches to simultaneously search the Internet, commercial databases, and library collections.
- Save search results and conduct additional processing to narrow or qualify results.
- From search results, click through to access the digitized content or locate additional items of interest (based on information from Sun website).

## **8. Possible Need for Digital Librarians**

The role of the librarian is changing in traditional libraries and with the introduction of the digital library there is a real need for a digital librarian with specific skills additional to the skills of a traditional librarian. The major challenge for this librarian is to keep the library up to date with good objects and be constantly on the look out for more (distributed) resources which match the requirement for a specific learning object. This will also require a means of having objects flagged which are not meeting expectations or are no longer suitable for our needs. Another problem to be solved, or at least aided by the librarian, is to be able to support the different formats of the learning objects. This is not straight forward and needs thought and work in order to facilitate Flash, and similar objects, created by different means but which cover the same curriculum as other learning objects in a different media format. Storage is a related issue that the digital librarian will have to manage. The work carried out by this function must conform to the highest standards for the benefit of the digital curriculum to ensure coherence and flow.

## 9. Requirement to Evolve and Change

The repositories and digital libraries we are using for the most part are suitable for educational instruction but must also have the potential to facilitate business use where appropriate. However, both types of focus have greatly differing needs and the contexts of information they need, along with the types of problems they must solve vary considerably. Additional to that is the need to be able to adapt to change. This may involve the structure and content of the required objects (Lynch 2003).

## 10. New Technology and Terminology

There is constant change in the types of media available for the many varying types of platform to which educational content must be delivered. So, as a result, we want to make the system as open and expandable as possible, and future proof the digital libraries, to the greatest extent possible, to best cater for future eventualities. We see the need for an ontology that can be utilised in future developments.

We are ever mindful of making our library as open as possible. Firstly, we make the resources freely available to everyone on the web but secondly, available to be accessed by as many types of devices as possible. In the creation of the library all objects have already been verified with our model for assessing instructional design and learning potential. This model, motivated by our earlier research, is suitable for use in the digital library model and can play a significant role in the structure of the library and the quality of objects stored.

The main digital library participants' worldwide include:

1. National Digital Learning Repository NDLR (IRL)  
This project is an Irish multi-campus attempt to create an educational digital library which will solve problems specifically in the Irish educational context and structure. Learning objects and resources are for the most part freely available to individuals who provide their objects to add to the NDLR.
2. MIT:  
MIT were one of the first digital library developer and research groups to make their libraries open access to all users who wanted to find learning objects. The digital library created by MIT is called DSPACE.
3. Open Archive  
The Open Archives Initiative (OAI) develops and promotes interoperability standards that aim to facilitate the efficient dissemination of content. OAI has its roots in the open access and institutional repository movements. Continued support of this work remains a cornerstone of the Open Archives program. Over time, however, the work of OAI has expanded to promote broad access to digital resources for eScholarship, eLearning, and eScience (<http://www.openarchives.org/>).
4. The Canadian ARL (CARL) Institutional Repository Pilot Project  
In the summer of 2002, CARL launched the Institutional Repositories Pilot Project. Institutional Repositories (IR) are digital collections, indexed in a standardized way and searchable using one interface, which capture and preserve the intellectual



output of a single or multi-university community. The CARL IR project is a national initiative that will test the feasibility of the IR concept. The project aims to facilitate discussions of lessons learned and best practices for implementing institutional repositories. Thus far, several libraries have implemented IR platforms, while other participants are at various stages of planning.

([www.carl-abrc.ca/projects/ir/index.htm](http://www.carl-abrc.ca/projects/ir/index.htm))

#### 5. The Flexible Extensible Digital Object Repository Architecture (FEDORA)

Fedora open source software gives organizations a flexible service-oriented architecture for managing and delivering their digital content. At its core is a powerful digital object model that supports multiple views of each digital object and the relationships among digital objects. Digital objects can encapsulate locally managed content or make reference to remote content. Dynamic views are possible by associating web services with objects. Digital objects exist within a repository architecture that supports a variety of management functions. All functions of Fedora, both at the object and repository level, are exposed as web services. These functions can be protected with fine-grained access control policies. This unique combination of features makes Fedora an attractive solution in a variety of domains. Some examples of applications that are built upon Fedora include library collections management, multimedia authoring systems, archival repositories, institutional repositories, and digital libraries for education (<http://www.fedora.info>).

#### 6. Harvard Digital Repository

The Digital Repository Service (DRS) provides Harvard affiliated owners of digital material with a storage and retrieval system for their collections. Digital repository services and facilities typically include:

- An electronic storage facility within which the digital objects created or purchased by Harvard agencies reside
- Management of administrative and structural metadata associated with stored objects,
- Preservation policies and procedures to ensure the continued usability of stored objects, and
- Delivery of an object to a registered or known software application (e.g., an online catalogue).

#### 7. University of Southampton *EPrints* initiative

### 11. Lessons Learned From Creating a Digital Repository or Archive

It can be a very daunting task to attempt to progress an instructional digital library in an elearning context. The lessons we have learned over the course of this research relate to issues of storage and categorisation structure, compatible and transferable file formats, the life span of objects, content and context, interoperability, timing, library structure and searching capability. Internationally, we note that research (Hastings and Tennant 1996; Chaudhry and Khoo 2006) has started to address these areas.

### 12. Summary

Digital Libraries have the potential to solve many of the problems we have experienced over time within our research. Resolution of the important issues of global standards for digital libraries will hopefully lead to a limited number of robust, interoperable

standards to mirror the e-learning standards. Ultimately, we can look forward to an interesting time ahead with many fruitful developments for research in e-learning and actual digital libraries available for use in elearning.

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# **The Importance of Play**

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*“Play makes an important contribution to the social development of an infant. It allows the individual to gain personal knowledge of other group members; permits certain social skills to be practiced, such as fighting, without risk of injury; and helps the individual to establish long term friendships.” Vince Smith (2003: 86)*

#### **1. The relationship between culture, language and mind**

Culture, language and mind are all inter-related. Indeed, human language by its very nature is unique, brilliant, an accomplishment which has allowed for our species to communicate world wide, forever expanding the frontiers of our learning opportunities. It has aided humanity to preserve its history, albeit a subjective one. It promotes a sense of identity, comradeship and is absolutely necessary in order for a member of any human culture to function and survive adequately within a given society. However, it is also limiting, in that it confines our understanding of the world and of ‘the other’, be they from another cultural group or, dare I say, a non-human social group, towards its specific understanding that its cultural language can discern. It is flawed, in that it is interpreted by humanity, undeservedly, as a means of making us superior to all other life forms on earth. It is arrogant, in that during the course of cultural and language development humanity as a species have come to regard itself as superior to any other species, including of its self at times as the many conflicts between people, groups, and inevitably nations that both World Wars in the 20<sup>th</sup> Century alone has attested to. Thus, the point of view developed does not by any means preclude the possibility of the growth of speech being in high degree dependent on the development of thought. As Sapir states:

*“We may assume that language arose pre-rationally – just how and on what precise level of mental activity we do not know – but we must not imagine that a highly developed system of speech symbols worked itself out before the genesis of distinct concepts and of thinking, the handling of concepts. We must rather imagine that thought processes set in, as a land of psychic overflow, almost at the beginning of linguistic expression; further, that the concept, once defined, necessarily reacted on the life of its linguistic symbol, encouraging further linguistic growth. ... [Thus], language is primarily an auditory system of symbols [!]*” (1949: 16-17)

Thus, communication is only effective when the hearer’s auditory perceptions are translated into the appropriate and intended flow of imagery or thought or rather, both combined. Therefore, the essence of language consists in the assigning of conventional, voluntary articulated, sounds or of their equivalents, to the diverse elements of experience.<sup>1</sup> Inevitably, language just falls too short of the proverbial mark, leaving too many gaps, too many questions, too much room for fault to properly analyze and discern the concept of communication and culture. It is a tool, a very sophisticated tool, but nevertheless, had whatever conditions that had been present during its conception been absent, it is just as likely that humanity could have easily

developed another form of communication based on an already existing mode of thought and language, or rather protolanguage. According to Goodenough (1964) it is tool making and protolanguage that share the same processes. In assuming that protolanguage was used since the very beginning, there were in fact two obstacles to the use of this channel by earlier species than *Homo sapiens*; he states:

*“One was the degree of cortical control over vocalizations, the other the structure of the vocal tract. Cortical control is required if vocalizations are to be voluntary, but it is not needed for the giving of alarm calls. Indeed, for alarm calls cortical control might be dysfunctional – if a creature, [including a human] (insert mine), takes time to ponder whether to call or not the delay could be fatal. However, cortical control is essential for linguistic utterances...! Control of vocalizations is indeed more strangely established in humans than in apes, but the difference now seems to be the scalar rather than absolute.” (1964: 142)*

Indeed, Goodenough surmises that tool making and language developed side by side, however, one must adhere to the logic that it was in fact through observation that culture could have been sustained. A system of behaviour patterns, instincts, and proto language all must have played an important role in the socialization process, albeit a much more rudimentary form than that of the one discussed above. It is likely that this innate ability was crossed well in advance of articulated speech, probably by the time of *Australopithecus Afarensis*. As Goodenough surmises, *Afarensis* was much smaller and lighter than *Homo sapiens* at a time when predators were larger than they are today. Thus, if the performance of modern apes is anything to go by, according to Goodenough, *Afarensis* descended from a line in which certain vocalizations such as alarm calls when spotting predators and food barks on the discovery of food were automatic and nearly impossible to suppress! Recall Jane Goodall’s telling anecdote of the ape that discovered a supply of bananas and, although anxious to keep them to itself, inadvertently gave away their location by its unsurpressible food barks.<sup>11</sup> Thus, it wasn’t until *Homo Habilis*, according to Goodenough, when the ability to suppress such vocalizations, a voluntary silence if you prefer, did purposeful protolanguage develop.

Such evolutionary adaptations occurred usually as a result of changes in the environment. These changes take many forms, they may be as a result of climatic change or the inter-mingling of different social groups as well as different species be they potential prey or predators from other areas. Alternatively, an existing prey species may acquire a new defence mechanism, undoubtedly the use of tools, stone axes and spears may account for such an evolutionary shift as well. Nevertheless, these factors serve to answer how language developed, even at its basic level, but fails to take into account in greater detail how, as already mentioned above, observation plays a role in developing culture. Vince Smith (2003) attempts to bridge an understanding by demonstrating how primates, particularly chimpanzees, communicate through gestural signals, however, as he states:

*“Humans also use gestures in their every day speech. These allow extra information to be passed... Language may have emerged not from vocalizations but from manual gestures, and switched to vocal mode more relatively recently in hominid evolution, perhaps with the emergence of Homo Sapiens. It is*

*interesting that human babies are able to make complex gestures before they have learned to speak, and children who make referential gestures at an early age tend to speak at an early age.” (2003: 56)*

Contrary to conventional belief, it is humans, and not apes, who have the greater ability to ‘ape’ another’s behaviour. In a study on how children and chimpanzees communicate and learn from others, it was found that human children were much better at imitating than chimps. Children tended to copy the way that adults performed certain actions, even when the techniques used were relatively inefficient; the chimpanzees, by contrast, tended to observe the action and then tried to improvise their own strategy. Although the chimps’ approach appeared more creative, the children were taking advantage of important skills and knowledge learned from others.<sup>iii</sup> Although chimpanzees are incapable of complex speech, like humans they are nevertheless able to communicate through a simple repertoire of sounds, such as pant hoots, lip smacks and various grunts, and through non-verbal gestures. According to Smith:

*“They vary the pitch, rate and volume of their vocalizations to convey different meanings in a variety of circumstances. The chimpanzee’s ear is similar to the human ear and can accurately differentiate far more sounds than the animal can produce. Unlike humans, chimpanzees lack the necessary anatomy for complex speech. In the chimpanzee, as in most mammals, the larynx is high up in the throat and serves as valve to stop water entering the windpipe when drinking. It is believed that some 100,000 to 150,000 years ago the human larynx descended, creating a gap in the throat, termed the pharynx or voicebox. This allowed sounds to be resonated, which in turn increased the clarity and variety of sounds that could be produced. The tongue also altered, becoming thicker and more muscular, and this allowed more rapid and precise control of the tongue’s shape, which further broadened the range of sounds produced. ... Although structurally similar, the human brain is about twice the size of that of the chimpanzee. A large brain is fundamental for the production of complex language. The human brain is asymmetrical. The left side is slightly larger than the right and is believed to control language. There are two areas on the left side of the brain, Broca’s and Wernicke’s areas, which are known to be responsible for producing and comprehending language respectively. Chimpanzees appear to lack Broca’s area in their brain, but have Wernicke’s area. This may indicate that, although chimpanzees are unable to produce vocal language, they appear to have the capacity for processing complex language – maybe not verbal language but a non – verbal one consisting of sounds and body gestures.” (2003: 55)*

It is true that human culture varies enormously in such patterns as language, diet, dress, art and numerous other social traits. And it is beyond question that humans express culture more than any other species, and that this, coupled with our ability for language, sets us apart from all other species. However, equally, it is wrong to suggest that all traces of culture and language are unique to humans alone. After humans, chimpanzees demonstrate the most cultural variation, albeit on a much more rudimentary level. There have been documented as many as 39 different behaviours that vary culturally across different chimpanzee communities.<sup>iv</sup> These include behaviours such as tool use, feeding, grooming, and manners of courtship that are expressed in some root communities but not in others. As Smith illustrates:

*“In the Tai Forest, in the Ivory Coast, chimps use stone tools to break open certain hard shelled nuts from species such as Coula edulis and Panda oleosa. They use a hammer and anvil technique: the hammer usually consists of a small rock or piece of wood, and the anvil is the larger hard surface, such as a rock or the root of a tree. The nut is placed in a depression in the anvil and hit with the hammer, until the outer shell is broken. The skill is learned by the infants through direct observation of the adults. A chimpanzee’s intentional use of tools to direct one’s attention to his or her desire to be groomed is a preverbal effort at communication with a human – a process of communication defined as ‘Proto-Imperative’. ... Barook’s (a chimp with which Smith worked closely with) thought process was complex and could clearly be broken down into several components. He saw a human and wanted that human to groom him. Being incapable of speech, he needed to find a way of communicating his intent, and so went to find a sign that the human would recognize. After shaping the sign into something symbolizing his desire for grooming – a grooming tool – he showed this to the human. Realizing that the human had seen the sign, he went to the only place where the human could groom him – inside the building. Before entering, he gave the human an encouraging ‘follow me’ glance. Then he entered and waited for the human to join him. Whereupon he gave the grooming tool to the human and pointed to where he wanted to be groomed.” (2003:193-195)*

As we have seen, apes are capable of communicating using quite complex language, albeit non-verbal, and there is much cultural variation among chimpanzee communities in the type of tools and the manner of their use. And if culture is defined as a trait that is transmitted throughout a population through social or observational learning, then, according to Smith so must chimps transmit their own cultural behaviours from one generation to the next.<sup>v</sup> Gestural communication is not unlike how humans in this day and age communicate still. Indeed, primates such as Gorillas have been successfully taught sign language and in so doing, provided evidence that cross species communication is quite possible. Despite not having the capacity for complex speech, the fact that apes are capable of learning complicated human sign language serves to illustrate further their capacity to learn our spoken language. It also underlines the value of focusing on their strengths rather than their weaknesses, for although apes may lack the anatomy for complex speech, they don’t necessarily lack the intelligence. Smith suggests further that chimps have the ability to invent their own personal sounds, using particular grunts to mean certain things. As he states:

*“... I believe Sophie’s (Sophie lived with Smith for years as a result of her mother rejecting her at birth) use of a particular grunt to mean bed time was evidence of a chimpanzee’s ability to use what are called ‘protowords’. I also believe that, had I been able to imitate this sound, we would have been taking our first steps towards creating a common rudimentary language.” (Insert mine) (2003: 64)*

Whether or not this seems feasible to some, whilst to others preposterous, matters little as empirical evidence has already begun to substantiate the capability of primates to comprehend language. Thus, a goal to survive, a way of life must exist between several beings, a system of shared understanding; however rudimentary needs to be in place.

Then and only then can culture exist. With regards to language, allow us to turn our attention to what has only been briefly mentioned; not of that regarding observation, for though it undoubtedly makes up much of the way in which humans and animals alike learn how to conduct themselves, socially as well as personally, it requires another vital ingredient, namely the act of *playing*.

## 2. Play in Residential Care

The thought of play may conjure up memories of childhood games with your brother(s) and sister(s) or with friends you went to school with and neighbours who lived nearby. It may bring you comfort and a sense of longing for times that seemed so simple compared to the hectic pace of the lives which we lead as adults. A notion which, although humans share with all other animals, can differ from person to person, animal to animal, depending on their particular circumstances whilst growing up. Unfortunately many children and animals share a similar, unfortunate fate and do not have an easy start in life. Whatever the reasons may be, a point only important in that it may aid in better understanding and assessing the need of each individual child, adolescent, or animal - nevertheless children often find their way into residential homes incapable or unwilling to play as a result of their past. Often, the grim reality is that many children end up in residential units due to abuse, neglect and simply because they have become a danger to others as well as to themselves. Whether it is a process of bad parenting or something more, these youth often lack guidance and understanding of the world into which they have been thrust.

It is an interesting example to compare and contrast what has been discussed thus far, for like the Feral Child, or the bewildered chimpanzee caught between two worlds, that of humanity and the wild due to encroachment upon their natural habitats, children and adolescents in residential homes lack many of the social graces that allow them to communicate effectively in society. Understandably mistrusting of adults and even of their peers, often more times than not many children and adolescents lose out on those years that are essentially vital to helping them develop into emotionally stable and mature adults. Thus, something as seemingly so simple as play can have tremendous effects on their lives. However there is more to playing than meets the eye and the following will discuss in detail both the different kinds of play that exist and the way which it helps develop the inter-personal skills needed to function within society and indeed, get through what is the difficult process of residential care. To begin with we have to understand what exactly is play? According to Healthguide<sup>vi</sup>:

*“Play is a state of mind that is safe, inquisitive and exists in the moment. It is also a bodily state of relaxation and an uplifting and engaged emotional state. Some say play is a spiritual state of profound connection and joy. Play can be something we do by ourselves or with others, but it is also something we can watch others do. Play is often described as a time when we feel most alive, yet we often take it for granted and may completely forget about it. Play can be entirely positive, or have a negative.”* (Healthguide: 2004)

As adults we tend to forget, however unintentional on our parts, how important playing can be not only for ourselves but for those children and adolescents in care within residential units. Over time we sometimes become guilty of believing that it is

unproductive and even can be seen as counter productive to obtaining the life goals set out for our children. As Healthguide shows:

“New research on the brain contradicts this cultural dismissal of play, by emphasizing the importance of feelings and the necessity of feeling safe and relaxed *in order to think clearly and productively*. Play teaches us how to manage and transform our “negative” emotions and experiences; it supercharges learning, and is a foundational factor in good mental and physical health. *And*, it can make work more pleasurable.” (2004)

Thus the benefits of play transcend childhood even to adulthood, yet as adults we might often dismiss this as exactly that, child’s play! Psychiatrist and writer Mihaly Csikszentmihalyi<sup>vii</sup> describes playing as a “*flow state*”. Within the flow state we feel:

- **Involvement** – Complete focus and concentration, either due to innate curiosity or as the result of training.
- **Delight** – A sense of bliss and positive detachment from everyday reality.
- **Clarity** – Great inner clarity and a built-in understanding about the state of affairs.
- **Confidence** – An innate sense that the activity is doable and that your skills are adequate to the task. Additionally, you don’t feel anxious or bored.
- **Serenity** – A sense of peace and an absence of worries about self.
- **Timeliness** – Thorough focus on the present and a lack of attention to the passing of time.
- **Motivation** – Intrinsic understanding about what needs to be done and a desire to keep the moment of play moving. (Helpguide: 2004)

Why is playing an important part of our lives? One would be hard pressed to find any species of animal, including the vast cultural and ethnic differences of the human race alone that did not fall upon or require the explicit instruction of play as a basis for culturally transmitting the information we need to not only to defend ourselves<sup>viii</sup>, but just as importantly how to behave socially. A female chimpanzee’s maternal skills, for instance, are not innate – they need to be learned through observation and personal experience over a period of time.<sup>ix</sup> An adolescent female may get the opportunity to practice her maternal skills by carrying a younger sibling or the baby of a close ally much in the same way a little girl carries a doll in a toy carriage, complete with matching milk bottle and nappies to change the doll when it mimics urination. According to Smith:

*“There have been many studies on the effects of maternal deprivation in non-human primates and in humans. It was found that in infant rhesus macaque monkeys, aged between 18 and 32 weeks, a temporary separation from the mother of just a week could still be detected in the behavioural responses of the infant up to two years later. Most notably, these infants showed a greater fear of strange objects. Animals that were reared in complete isolation tended to have difficulties interacting with other adults and were often inefficient mothers, failing to rear their own young. Isolated chimpanzees frequently console themselves with actions such as rocking and self-clutching, as Sophie did. The loss of the mother often results in the orphan becoming depressed, insecure and more vulnerable to aggression. Males, especially, have fewer friends, suffer more harassment and receive less support during aggressive encounters. Their social and sexual behaviour can be*



*affected, and sometimes this leads to their being sexually retarded. In a study of 71 chimpanzees reared in isolation with human care-givers, only 30 per cent became sexually competent as adults.” (2003: 82)*

Thus, beyond words, beyond any act of vocalization comes socialization. Play provides this outlet, giving the chance to members of a particular cultural group, be they animal or human an opportunity to test the waters, so to speak and learn the social graces and etiquette that is expected of them within their particular society. By our very nature we are designed to play as it serves as an inborn ability that is hard wired into our genetic code. As Csikszentmihalyi surmises:

*“Play is part of how humans have adapted and survived everywhere on Earth, from the tropics to the great deserts to the Arctic Circle. We want to play because it is instinctive and fundamental to our existence; it is one of the evolutionary mechanisms that enabled us to develop as a species. Playing helps us survive by connecting us to other human beings and to sources of energy and excitement within ourselves. Play is simultaneously a source of calmness and relaxation, as well as a source of stimulation for the brain and body.” (Helpguide: 2004)*

Smith further illustrates this point by giving particular attention to grooming amongst chimpanzees. According to Smith grooming takes two forms: self-grooming and social grooming. He states that:

*“Self-grooming serves mainly a hygienic function, keeping the body free from dirt, dead skin and ectoparasites, and is believed to be innate. [However,] social grooming serves many functions. As well as for cleaning the body, it is also used in a number of social activities, such as relieving stress and establishing and maintaining harmonious relationships between members of the community. Unlike self-grooming, social grooming is learned and perfected over time.” (Smith, 2003: 67)*

You may be wondering whether; if humans and chimpanzees are so closely related, why we don't groom each other, like other primates. According to Smith, we do, and have largely replaced the subtleties of physical social grooming with a vocal equivalent. It is believed that because humans live in large groups, effective grooming became inefficient as a means for servicing partners and maintaining social bonds. However, by gossiping – essentially vocal grooming – humans were able to maintain social ties with several people at the same time.<sup>x</sup> However, it is important to distinguish the different types of play than when talking about play amongst children. As any social care practitioner will tell you it is their responsibility by leading as an example of what appropriate play constitutes. What does this mean exactly? The social interaction between children is vital to the structuring and maintenance of social ties as well as aiding the process of learning what the rules of culture is. By simply adhering to and understanding the need and function of playing, children, like chimpanzees become productive members of their community. We want to play because it is instinctive and fundamental to our existence; it is one of the evolutionary mechanisms that enabled us to develop as a species. Playing helps humanity survive by connecting humans to other human beings and to sources of energy and excitement within ourselves. Play is

simultaneously a source of calmness and relaxation, as well as a source of stimulation for the brain and body.

Play will be important to our future. Some futurists have said that we'll need to be more inventive, creative, and flexible to handle the tasks, flow and rhythm of life in this century and beyond.

In essence then:

*“Play is a state of mind that is safe, inquisitive and exists in the moment. It is also a bodily state of relaxation and an uplifting and engaged emotional state. Some say play is a spiritual state of profound connection and joy. Play can be something we do by ourselves or with others, but it is also something we can watch others do. Play is often described as a time when we feel most alive, yet we often take it for granted and may completely forget about it. Play can be entirely positive, or have a negative.”* (Healthguide: 2004)

There is a unique pattern of brain wave activity during the perception of humour – a pattern that organizes the brain and enables us to act more intelligent. When two people experience the same emotions, they are in synchrony and create a context of resonance, which is now thought to play a fundamental role in brain organization. Humour perception involves the whole brain and serves to integrate and balance activity in both hemispheres. Play is essential to successful attachment bonding between infants and those that care for them. Interactive play – playing together for the fun of it – brings about self-regulation in the infant and sets the stage for self-awareness, self-confidence and trust in self and others. Aggression, anxiety, mixed signals or indifference from parents, social care practitioners, and teachers stops the development of optimism, hope, and playfulness in children and leads to depression, fear and disillusionment in adults. Play and playing together for the fun of it is a powerful resource for creating emotional wellbeing and which transcends all species. Within residential units, for instance, the benefits of play can be found via the child's, or adolescent's, ability to develop social skills. Thus, developing skills of communicating trust and pleasure allow for children to refine their innate concepts of verbal and body language.

As well, notions such as safety and danger, freedom and boundaries, empathy, compassion and inevitably the capacity for intimacy all make up the emotional intelligence necessary for these children to develop relationships amongst their peers and with their families. It also eases their understanding of what they think they know of the world around them into what the reality of the situation is, empowering them to re-integrate back into society as productive members. Personal strengths, the ability to learn, their health, perseverance and even joy and happiness have been intrinsically linked to the act of playing. In essence it can be argued that language may facilitate culture, however it fails to grasp the essence that only play or physical acting can transmit. Playing in itself can help children, especially within residential care, to avoid such feelings as loneliness, isolation, anxiety and depression. When we play vigorously, we trigger a mix of endorphins that lift our spirits and distractions that distance us from pain, fear and other burdens. And when we play with other people, with friends and child care workers, we are reminded that we are not alone in this world. We can connect to others in delightful and meaningful ways that may ease the feeling of loneliness, if not dispel it entirely. Play acts as a remedy to violent tendencies and is a

powerful catalyst for positive socialization. Those who avoid or have never learned to play may become lost in the world of fear, rage, and obsessive worry.

The therapeutic benefits of laughter cannot go un-mentioned and have been studied by Dr. Lee Berk and fellow researcher Dr. Stanley Tan of Loma Linda University in Californiaksi. They have been studying the effects of laughter on the immune system and in so doing have come upon some interesting results. The following is a summary of this research, taken from an interview published in the September/October 1996 issue of the Humour and Health Journal.

*“Laughter activates the immune system – In Berk's study, the physiological response produced by belly laughter was opposite of what is seen in classical stress, supporting the conclusion that mirthful laughter is a eustress state -- a state that produces healthy or positive emotions.” (Helpguide: 2004)*

Research results indicate that, after exposure to humour, the activity in the immune system increases. Laughter appears to tell the immune system to “turn it up a notch.” Laughter causes increases in:

- Number and activity level of natural killer cells that attack viral infected cells and some types of cancer and tumour cells.
- Activated T cells (T lymphocytes). There are many T cells that await activation.
- Antibodies IgA (immunoglobulin A), which fights upper respiratory tract insults and infections.
- Gamma interferon, which tells various components of the immune system to ‘turn on’.
- Antibodies IgB, the immunoglobulin produced in the greatest quantity in body, as well as an increase in Complement 3, which helps antibodies to pierce dysfunctional or infected cells. The increase in both substances was not only present while subjects watched a humour video; there also was a lingering effect that continued to show increased levels the next day. (Helpguide: 2004)

After all, what you may not realize is that playing can also act as a bandage to help heal emotional wounds. Healthguide states:

*“When adults play interactively together for the fun of it, they are engaging in exactly the same patterns of behaviour that positively shape the brain and predict emotional health in children. And there is reason to believe that these same playful behaviours may also impact the adult brain and lead to positively changed behaviour. The brain, we now know, remains flexible throughout life and is most amenable to change in contexts, especially those contexts that involve others, feel safe and are emotionally rich. Studies show that an emotionally insecure individual can replace negative beliefs and behaviours with positive assumptions and actions by living with a secure spouse. Close, positive and emotionally fulfilling relationships heal and create emotional resiliency. Play provides a safe and joyous context for the development of such relationships.” (2004)*

We find ourselves on a daily basis subconsciously reading each other’s body language not unlike the way primates size each other up in a manner of pant hoots and lip smacks. Play, like social grooming amongst chimps, constitutes an intricate role in

developing a greater understanding of each other and of ‘*the other*’ than language itself could ever possibly hope to demonstrate on its own. We are animals, a species of primate, a biological phenomenon dominated by biological rules, like any other species on planet earth. As Desmond Morris (2002) surmises:

*“Human nature is no more than one particular kind of animal nature. Agreed, the human species is an extraordinary animal; but all other species are also extraordinary animals, each in their own way, and the scientific people-watcher can bring many fresh insights to the study of human affairs if he can retain this basic attitude of evolutionary humility.”* (xvii)

### 3. Conclusion

It may be that social scientists and animal behaviorists will never agree as to whether or not culture, language and mind are solely a human construct or whether or not all animals, be it at different and varying meta-cognitive levels possess culture. A system of communication which although may not appear as intrinsically complicated as that of human language, nevertheless exists within all species. Human curiosity vs. human arrogance has to this day been unable to decipher this system of communication. We have examined the very nature and core of *culture*; we have torn apart and put back together the notion of *language and mind*; and finally we have examined how the basic function of play and social grooming amongst children and chimpanzees respectively allows for cultural information to be transmitted that inevitably becomes vital to their mental wellbeing and basic social acceptance within and amongst a group and inevitably society. Insufficient evidence exists still to determine whether thought determines language or rather language determines thought however culture in and of itself can function with or without language. Like our animal brethren we are linked to certain fundamental biological truths that can not be ignored if we are truly ever going to be able to comprehend the needs of *the other*, let alone provide adequate services to help them function within society.

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- VI. <sup>1</sup> *Playing Together for Fun: Creative Play and Lifelong Games* in Helpguide: The Center for Healthy Aging. Santa Monica, CA. December 15, 2004
- VII. <sup>1</sup> Pronounced "*chicks send me high*" Csikszentmihalyi studied play in Sidney, Australia and described it as a flow state that requires just the right balance of challenge and opportunity. If the game is too hard or too easy, it loses its sense of pleasure and fun. Csikszentmihalyi research has been undertaken and confirmed in several countries, and now reaches 250,000 surveys. (Helpguide 2004)
- VIII. <sup>1</sup> Animals like the wolf for instance use mock playing as a means of teaching pups how to fight and defend themselves from potential predators. Not unlike humans do when they teach their children, often via role playing, how to avoid strangers, including screaming out loud to avert attention to their predicament. Indeed, courses designed for women's self-defence particularly rely on the use of role playing and helps to bond the members of their course in a game where through these exercises they are also having fun participating together in an activity that, like the above two examples, could potentially literally save their lives one day.
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- X. <sup>1</sup> Smith, Vince. 2003. Sophie's Story: Raising a chimp in the family. Butler & Tanner Ltd, Frome, Somerset; Great Britain. 68
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# **Investigating the feasibility of creating a piece of software for practical electrical classes that engages learners of different learning styles**

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## **Abstract**

*This paper looks at feasibility of creating a piece of software for practical electrical classes that engages learners of different learning styles. Traditional practical electrical classes are usually delivered using text based resources, but due in part to the advances in technology it is possible to provide information in a variety of formats. The starting point of this research was to evaluate the preferred learning style of the typical apprentice learner by using a learning style questionnaire based on the Vark model. The Vark model represents four learning styles Visual, Auditory, Reading/Writing and Kinaesthetic. The results from the questionnaire then influenced the design of a workshop interface to suit the learner's particular learning style. The final design was influenced by expert opinion in the area of learning styles as well as subject area experts. The interface was evaluated by 28 electrical apprentices and six lecturers who all agreed that the interface presented a new and innovative approach to delivering information within a practical workshop setting. The study concludes that it is possible to create a workshop interface that engages learners of different learning styles.*

**Keywords:** electrical; information communication technology; learning styles; virtual learning environment; WebCT.

## **1 Introduction**

### **1.1 Introduction**

The major technological advances of the last few decades are beginning to have an impact on adult education throughout the world including Ireland. The use of Information and Communication Technology (ICT) is now encouraged (to various degrees) by the stakeholders of the adult educational community as a tool to improve education and to help attain the objective of 'Life Long Learning' and 'Second Chance Education'. These major technological advances along with a greater understanding of how learners learn and the importance of delivering information in various forms have posed the question, how do we harness these newly presented opportunities? With the development of a new electrical workshop, it is hoped to leverage the advantages provided by these new technologies.

Most research in the area of Learning Styles and ICT has focused on using new technology designed with learning styles in mind, in a typical classroom or as part of a Virtual Learning Environment (VLE)/Distance Learning Project. The objective of the research was to develop a learning interface for use in a new practical workshop within the electrical apprenticeship area. This interface will be designed to help prepare the apprentice for the Motor Control and Wiring exam at Phase 4 level. It is also hoped to allow or show greater consideration of the learners' learning styles.

In this paper we use the following abbreviations:

BUA: A partnership between National Learning Network, the Discovery Centre in Cardiff, and the Institute of Technology Blanchardstown

HMI: Human Computer Interface

ICT: Information and Communication Technology

ITB: Institute of Technology Blanchardstown

Vark model: Visual, Auditory, Reading/Writing and Kinaesthetic learning styles

VLE: Virtual Learning Environment

## 1.2 Context background

In order to understand the benefits to be realised through the use of Information and Communication Technology (ICT) it is important to understand what it means as it has come to acquire a variety of meanings. Hennessy seems to capture the broadest sense of what is meant by ICT when she writes that:

*The term ICT encompasses the range of hardware (desktop and portable computers, projection technology, calculators, data logging and digital recording equipment), software applications (generic software, multimedia resources) and information systems (Intranet, Internet) (Hennessy et. al 2005)*

This will be the definition of ICT used through out this paper. The use of ICT is of particular relevance to future electricians. Engineers Ireland believes that it is essential in the practice of engineering (Engineers Ireland, 2003).

## 1.3 Apprenticeship in Ireland.

In Ireland, Fás the department, with legislative responsibility for training introduced a standards-based apprenticeship system in 1991. Prior to this there was no formal mandatory apprenticeship system. The standards based apprenticeship system is a competency-based system which is divided in to seven phases. The odd numbered phases 1-3-5-7 are the On-the-Job phases. These consist of working with an employer over a four year basis. The even-numbered phases 2-4-6 are the Off-the-Job phases. These consist of 22 weeks within a Fás training centre for Phase 2 and 11 weeks in an Institute of Technology for both Phase 4 and Phase 6. The purpose of the Off-the-Job phases is to deliver the theoretical components of the trade as well as to allow for the practice of specialised craft skills. (Fás, 2001)

## 1.4 Motor Control and Wiring Module

The Motor Control and Wiring Module on which this research is focused, was delivered during Phase 4. This module is delivered in a workshop, which is timetabled for seven hours a week. By the end of this module the learner must be able to:

1. Select and install the panel wiring cables, accessories and protective devices required for 'star-delta' and 'rotor resistance' starting of induction motors.
2. Install the control circuits required for 'inch/jog' and 'forward-reverse'.
3. develop and interpret schematic diagrams of the listed motor power and control circuits. Fás (2001).

At the end, these objectives are measured by a three and half hour practical exam. The practical class in preparation for this exam operates as follows:

1. An Overall Health & Safety Talk
2. Word document made available similar to what would be presented as per the exam.
3. Introductory talk on the circuit to be constructed on that day highlighting specific points of notes i.e. safety considerations, or common mistakes special considerations.
4. The Learner would then construct the circuit with little or no interaction with the lecturer.
5. Testing of circuit carried out in conjunction with the lecturer.
6. After the circuit has been tested it is then stripped out.

When this is completed the apprentice is finished for the day. If the apprentice does not complete the circuit before the day is over he/she must still remove any work already completed as another class uses the workshop later in the week. It is hoped that with introduction of this interface, incorporated into the newly designed workshop, apprentices will be able to work at their own pace and select tasks in the order that makes most sense to them.

## **1.6 National BUA Centre**

The National BUA Centre was established in 2003 as a result of a unique partnership between National Learning Network, the Discovery Centre in Cardiff, and the Institute of Technology Blanchardstown. It provides assessment and support to people across the full spectrum of Specific Processing/Learning Difficulties (SPLDs). The National BUA Centre promotes inclusive education nationally through the development of its unique screening facility together with comprehensive educational, vocational and functional activity support services for third level students and adult learners with Specific Processing/Learning Difficulties. (BUA, 2007) The screening process that BUA (2004) employed was designed to highlight learning styles/channels associated with individual students. They categorised the styles/channels in the following way:

- |                                  |                         |
|----------------------------------|-------------------------|
| 1. Visual learners               | 6. Meticulous learners  |
| 2. Auditory learners             | 7. Approximate learners |
| 3. Kinaesthetic learners         | 8. Group style learners |
| 4. Creative/Imaginative learners | 9. Solo learners        |
| 5. Logical learner               |                         |

A screening process was carried out on a group of 32 electrical apprentice students during term 3 in 2005. It was found that Apprentice students can be generally classified into two main learning styles/channels: Visual Learners and Kinaesthetic Learners.

Following on from this introduction, section two reviews the writings of accredited researchers in the field of learning styles and theory's as well as interactive multimedia systems. Section three then describes the research methodologies used and supporting reasons for selecting them. Section four details the findings of the research and discusses the implications of the full development of the workshop interface. Section five discusses the conclusions from the research and presents a list of recommendations



for the full implementation of a workshop interface for use with electrical apprentices that takes consideration of their learning styles.

## 2 Literature Review

### 2.1 Introduction

This review creates an awareness of the issues concerning the creation of a workshop interface, with specific attention to learning styles and the techniques and methodologies used to develop a workshop interface. The literature review is divided under these two sections and is sub-divided as can be seen below. Firstly learning styles is described and two of the most common models VAK and Kolb are illustrated. This section then explains Gardners' theory of multiple intelligences and how he believes that there are eight different forms or modes of intelligences. Particular attention is paid to the two intelligences most closely aligned to Visual and Kinaesthetic learners. This section concludes with a literature review of the two main learning theories Behaviourism and Constructivism. This section of the research paper gives an overview of the leading research in the development of the interface. The primary methodologies utilized are discussed, which include analysis of needs, purpose of the interface, collection of resources, design and creation of interface, and evaluation and revision of the creation of the interface.

### 2.2 Learning Styles

A learning style is a specific way in which a person learns. Cooke defines it as, *"a student's way of responding to and using stimuli in the context of learning."* Keefe (1989) (quoted by Griggs, 1991) further defined it as;

*"Composite of characteristic cognitive, affective and psychological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment."*

Although most people have a combination of styles, a certain type is usually dominant and the student will learn better using that particular style. Kirkwood (1998) believes an individuals learning style is the most influential factor in determining how they learn that. There are in excess of seventy instruments, which are used to categorize learning styles.

### 2.3 VAK or VARK

The VAK model is the most common learning style model. VAK stands for Visual, Auditory, and Kinaesthetic and refers to how people take in information. Occasionally, an additional learning style category of Reading/Writing is included.

Visual learners learn by seeing things. They respond well to the written word, visual presentations, graphs and charts, displays, videos, and computer based presentations. Most people are categorized as dominant visual learners. This may be reinforced by teaching methods in secondary education that rely on writing down notes from a chalkboard, reading, and more recently the use of computers.

Auditory learners are best suited to activities involving listening or dialogue. They prefer discussions, debates, lectures, and rehearsing. This style of learning is often reinforced in higher education. The third style of learner, Kinaesthetic, learns best by

doing and activity based learning. They prefer moving, role play, and repetition of action. They should be encouraged to take breaks and move around rather than sitting still for too long. They prefer practical tasks/approaches rather than theoretical exercises. Learners who feel they learn best by processing text are categorised under the heading Reading/Writing. They find the best way to internalize information is by reading text and then writing about what they have learned. Some people are referred to as multi-model learners because they have more than one strong (dominant) learning style. One of the best known instruments using the VAK model has been developed by Dunn and Dunn. (Fleming 2007)

## 2.4 Kolb based experiential learners

The Kolb model develops a theory of learning that combines a four tier learning cycle with learning style inventory that classifies learners into four groups with distinct two-dimensional learning modes. For Kolb the four stages of the learning cycle are Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualisation (AC), and Active Experimentation (AE). After completing the Learning Style Inventory, learners are placed into learning styles based on their two dominant learning modes. These four modes are Diverging (CE/RO), Assimilating (AC/RO), Converging (AC/AE), and Accommodating (CE/AE). Another popular model based on Kolb's cycle of learning theory combined with a learning inventory is the Honey and Mumford model. (Atherton, 2005). As noted above there are over seventy models in existence used to categorize learning styles. Each one has developed its own spectrum of learning. It must be noted that there is a large amount of scepticism regarding the validity and usefulness of all learning style models. Detractors have pointed out many flaws, such as limited research and testing, testing subjectivity, and lack of any evidence that these models can improve educational results.

## 2.5 Multiple Intelligences

These learning styles/channels in some way can be likened to Howard Gardner's Multiple Intelligences Theory. Gardner described intelligences to be '*a bio psychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture.*' (Gardner, 1999b 33/4) Gardner outlined eight ways of thinking and knowing, thereby naming eight intelligences, as below:

- |                                      |                               |
|--------------------------------------|-------------------------------|
| 1. Linguistic Intelligence           | 5. Musical Intelligence       |
| 2. Logical-Mathematical Intelligence | 6. Intrapersonal Intelligence |
| 3. Spatial Intelligence              | 7. Interpersonal Intelligence |
| 4. Bodily-Kinaesthetic Intelligence  | 8. Naturalist Intelligence    |

Comparing the Multiple Intelligences to the learning styles/channels it can be seen that visual learners are associated with spatial intelligence and kinaesthetic learners to bodily-kinaesthetic intelligence.

## 2.6 Spatial Intelligence

Spatial intelligence makes it possible for people to perceive visual information, transform this information, and to recreate visual images from memory. Well developed spatial capacities are needed for the work of architects, sculptors, and engineers. The students who turn first to graphs, charts, and pictures in their textbooks, who like to

‘web’ their ideas before writing a paper, and who fill the blank space around their notes with intricate patterns are also using their spatial intelligence.

## **2.7 Bodily-Kinaesthetic Intelligence**

Bodily-kinaesthetic intelligence allows individuals to use all or part of the body to create products or solve problems. Athletes, surgeons, dancers, and crafts people all use bodily-kinaesthetic intelligence. The capacity is also evident in students who relish gym class and who prefer to carry out class projects by making models rather than writing reports.

Gardner demonstrates that students learn in identifiably distinctive ways, and shows how necessary it is that subjects should be taught through a variety of means and strategies. He argues for a form of learning that will allow students to demonstrate their understandings in meaningful ways, which are more suited to their learning styles and intelligence profiles. Gardner refers to casualties in learning, that is, the large number of students who are motivated to learn but whose own learning styles or profiles of intelligence are not in tune with prevailing instructional practices. (Gardner, 1991) These learning styles and intelligences must be stimulated for the students to learn best and therefore it is recommended that course material and their delivery should be designed with this in mind. Educational psychologists suggest that, in general the more one engage the senses of the learner, the more they learn. For example, learners will remember more of what is said if visual reinforcement is provide. The sense of sight is particularly important, and this fact should be taken into account in the design of learning material.

## **2.8 Learning Theory**

Learning theory is defined for educational purposes as the theory or study of how people learn. (Wikipedia, 2007) It is subdivided into the two main categories of behaviourism and constructivism.

## **2.9 Behaviourism**

The principal claim of behaviourism states that people learn through conditioning. Conditioning is a change of behaviour realised through action and response type exercises. This can be in formal ways such as the dog obedience school or informal such as how we respond to pain or pleasure. Learning is the development of new behaviour through this conditioning and requires no inner mental processing. The three major proponents of behaviourism were Pavlov, Watson, and Skinner.

Pavlov developed the theory of ‘conditioned reflex’ also known as classical conditioning. This theory was experimentally shown by the linking of two actions to a response. After a certain time when one action is presented the response will occur. This was demonstrated in his well known experiment where he trained a dog to salivate at a certain sound that had earlier been associated with feeding (Braslau-Schneck, 1998). While Pavlov (1920) was interested in conditioned responses in animals, Watson attributed all human behaviour to conditioning and showed how complex emotions like fear could be conditioned in a person. In his famous ‘Little Albert’ experiment he showed how fear, a non-physical reaction, could be linked to an object that was previously viewed as neutral. This was accomplished in the still controversial experiment where he scared a young boy by associating a fear with a neutral object. When later shown the object, the child was seen to be conditioned to be fearful.

Skinner is credited with the development of radical behaviourism, which believes that voluntary human and animal behaviour can be conditioned. This differs from Pavlov and Watson, who were studying involuntary behaviour.

## 2.10 Constructivism

Constructivism is the theory that people construct their own view of the world based on experience and their own understanding. Each person has his/her own mental image of the world they exist in and learn through experience and processing of their experiences. This is clearly differentiated from Behaviourism by its emphasis on the importance of mental processing. Early constructivism can be traced to Giambattista Vico in the 18<sup>th</sup> century, who believed that people could only truly understand what they themselves had constructed. He felt that he was a ‘teacher of himself’ (Costello, 2003). Later constructivists include Piaget and Dewey. Piaget developed the theory of stages of cognitive development. He believed that children went through four stages of learning, each based on the one that came before. As each stage was mastered and internalized, the developing mind would gain greater complexity and move on to next, more complex, stage. (Atherton, 2005). As a psychologist and educational reformer John Dewey promoted experimentation, problem solving and critical thinking as integral components of learning. Dewey’s ideas were also referred to as pragmatism.

## 2.11 Analysis of needs and purpose

There were three primary considerations in the development of the workshop interface. All three considerations were underpinned with reference to expert opinion in the area of Human Computer Interface principles (HMI). The task of HMI as defined by the International Engineering Consortium (2007) *‘is to make the function of the technology self-evident’*.

The first consideration was the need to be useful in the delivery of knowledge and in this case the curriculum as proscribed by Fás. Cook (2001) states that the ‘knowledge content of the system is crucial to successful design’. In order to reach this objective the interface had to contain a circuit diagram, which the user could easily, read. It was also imperative that all support information was easily accessible which included task descriptions, equipment lists, health & safety guidelines, and testing forms.

The second consideration was to develop material that took account of the learning style of the user of the interface. Normally the information contained within the interface is delivered in textual form by the use of a handout at the beginning of a workshop class. However as will be seen from both the data obtained from the VARK questionnaire as well as the collaborating evidence produced by BUA, most apprentices preferred information delivered in a visual/ kinaesthetic mode. In order to complement this preference, information was produced mainly in a visual form with a strong use of photographs, drawings, and diagrams. With the use of animated diagrams which were controlled by the user, as well the full function of the interface being controlled by touch screen, it was hoped to build on the preference of the visual/kinaesthetic form of learning. Electrical diagrams by their very nature consist of information delivered in a visual form, with the diagrams then made interactive it allows to user to interact with them in a kinaesthetic manner. By designing the interface in this manner it satisfies Cooks’ (2001) belief that the *‘user must be central to the design system.’* It is believed

that computer animated diagrams may help students to understand a subject and create a unique learning experiences (Bagnasco *et al.*, 2003).

The third and final consideration was to help re-create the typical engineering environment of a maintenance electrician enrolled in this type of work. In engineering sectors, the need to match the skills or capability of the engineering labour force with the needs of industrial production contexts is not a new requirement (Pascail, 2006). Boyle(1997) also argued that *'learning tasks should be embedded in problem solving contexts that are relevant in the real world'*. In order to achieve this goal, the steps displayed on the interface were typical of how maintenance workflow is controlled within a high volume engineering environment.

As the needs and special considerations for the interface were being considered, the idea of including some form of testing within the interface was suggested. After deliberation it was decided that the existing use of WebCT was enough in the area of testing. Cunningham (1991) agreed with this decision when he argued that; 'when instruction is embedded in situations where students are involved in realistic or actual tasks, assessment arises naturally from those situations.' It was also anticipated that this would keep the focus on the interface as a tool to help apprentices to complete their practical tasks using information most suited to their learning style. It also helped to create an impression of the typical working environment. The need to complete the practical tasks would encourage the full use of the interface, as opposed to simply passing exams. The use of sound built into the interface was also explored but Boyle (1997) advocates restraints in the use of sound. Due to the noisy environment of the workshop it was decided that sound would not be appropriate.

## 2.12 Collection of resources

The next step in the creation of the workshop interface was the difficult process of collecting the necessary resources. Appropriate resources may include comprehensive learning guides with overview of essential topics, schedules and assessments, worked examples and virtual simulations, activities and exercises (Subic and Maconachie, 2004). The process started with collecting all available documentation from Fás on the topic area. Documentation regarding all practical tasks required to be completed during an electrical apprenticeship were also collected so as to create a interface with special thought to adding these seamlessly in the future.

This documentation consisted of the electrical syllabus 'Trade of Electrician Overview Manual', the apprentices On-The-Job Task Book, and several electrical Phase 2 training manuals, produced by Fás. At this stage photographs were taken of all the practical equipment used in order to complete the tasks set out as part of the Motor Control and Installation Module. Freeware from the Internet was employed consisting of videos that showed some key skills that were a helpful addition to the interface. Additional resources such as a CD that the researcher created, consisting of a complete set of notes as well as important information for Phase 4 Electrical, were also gathered.

Information on touch screens was also collected in order to be confident that the Workshop Interface would be compatible with the industry standard touch screens currently available on the market. Though it was never envisioned that touch screens would be purchased for this research due to cost restraints, It was deemed important that touch screens were compatible as it is expectation that this paper will provided a

basis for the discussion of investing in touch screens for the electrical workshops in the near future.

The collection of resources also included the collection of appropriate software for the creation of the workshop interface. After several trials, with several software packages, it was decided to use the following. Due to the very visual nature of the interface, an appropriate graphics software was fundamental to the success of the creation of the interface. Vaughan (2001) believes that graphic tools '*are perhaps the most important items*' and '*the graphic impact of your project will likely have the greatest impact on your end user.*' Fireworks (2002) was selected due to the combined features of being object oriented and bit mapped. *Illuminatus Opus Pro* was selected as the main authoring tool as it allowed material of multiple formats to be collected together. Amazon (2007) reviewed the software and agreed that the '*real strength of Illuminatus Opus is in its flexibility*'. Boyle (1997, pg.139) also stated that an authoring tool must '*combine all the media resources within a structured framework.*'

**Table: 2.1 Table of selected software**

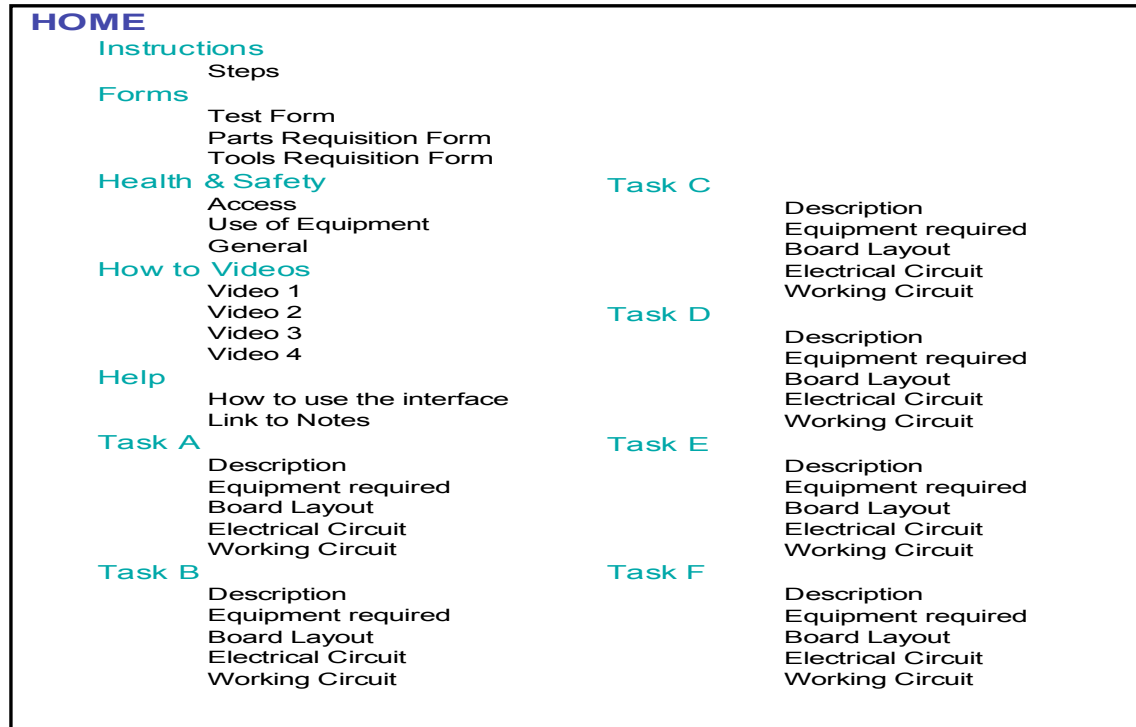
Software Type	Software Title	Specific Use	Reason for selection
Authoring Tools	Illuminatus Opus Pro	Creation of menu driven interface	Ease of use, Flash was trialled but was found too complex for a project of this scale
	Macromedia Flash	Creating animated wiring diagrams	Ability to replicate electrical drawing and then animate them
Graphics	Macromedia fireworks	Editing images	Ease of use, same interface as Macromedia Flash

Flash (2006) was selected for two main reasons, firstly is that it has very few browser issues, it plays well in both Internet Explorer and Mozilla Firefox. Secondly it allows for the creation of animations, Macromedia Flash has a well established reputation as an animation application. (Green, Chilcott, 2006). In all cases ease of use was the main factor in selecting the software. Boyle (1997) believes that the usability of the authoring tool will depend on the experience of the designer.

### 2.13 Design and creation of interface

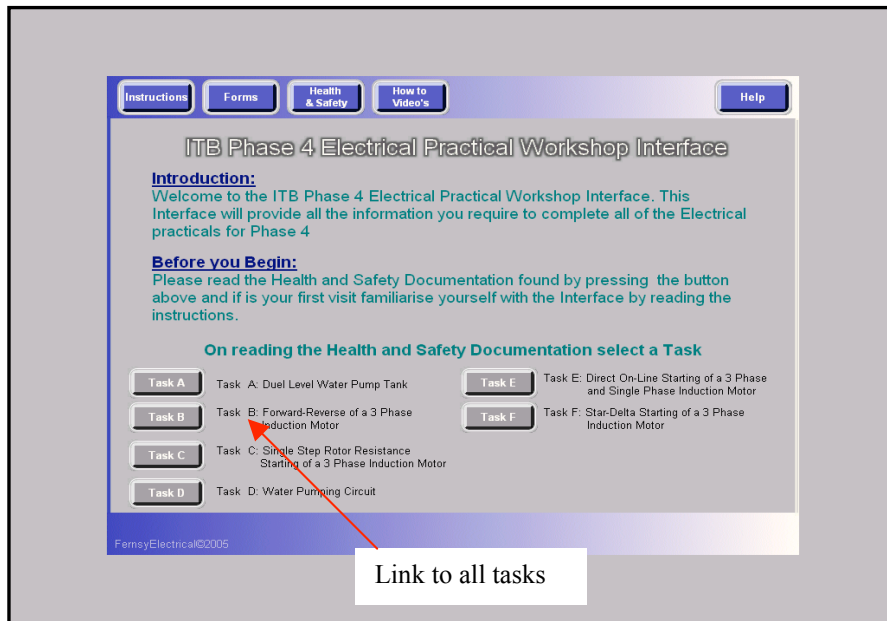
The design of the interface was based on an object-based multimedia flow system. This was accomplished by gathering relevant resources, combining these resources to create objects, and finally by placing these objects, in order, to create a flow system. This system is traditionally thought of as a Behaviourist model, though through the use of this type of system in conjunction with the practical electrical wiring element it would more closely align itself to the Constructivist model. (Cook 2001) In creating the sitemap it was decided early on that the user should be able to access all information with no more than three touches of workshop interface from the home page. A list of information required to complete a typical electrical task was then formulated. This list formed the basis of the sitemap and also helped to inform the decision taken to keep these topics accessible from all pages on the interface. In order to accomplish this, a menu was created for the top of the interface and this position was kept constant throughout the interface. These topics for the menu can be seen in the sitemap coloured light blue. Each topic also required information specific to that topic and the headings for this information formed the sub-menu (top to bottom menu). This list can be seen in the sitemap in black.

Interaction was one of the main ingredients of the design of the interface. Molin and Pettersson (2003) write that interaction ‘is what distinguishes a multimedia system from a mere digitized video film. Flash was used to make the electrical wiring circuit diagrams interactive in order to allow for greater learner interaction with the subject material.



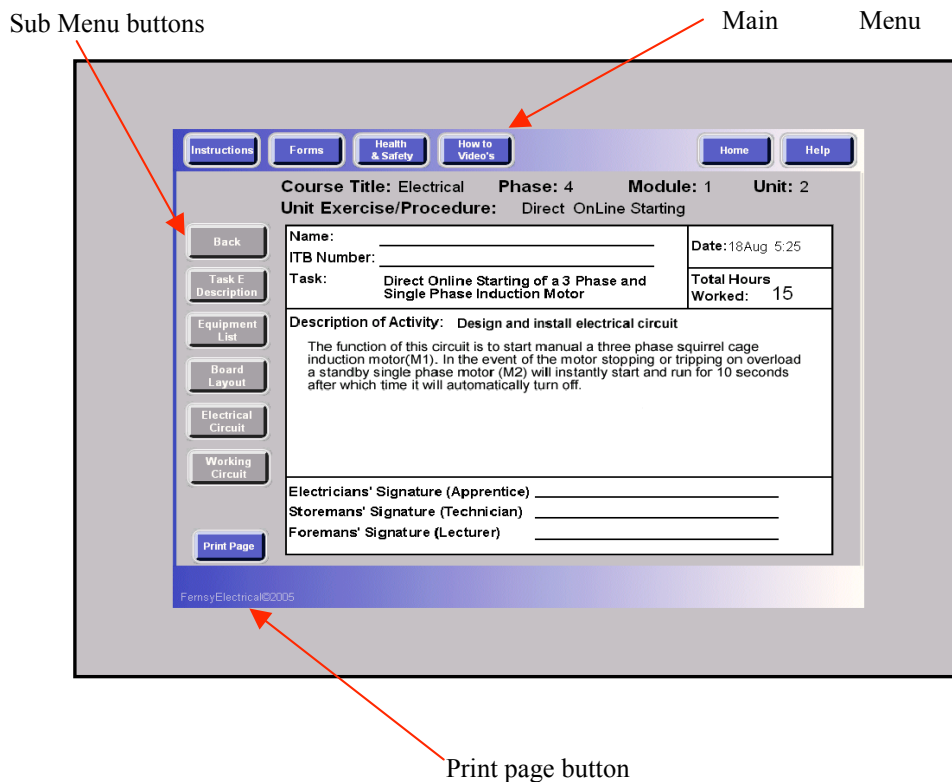
*Figure: 2.1 Navigation image*

There were several considerations taken into account while designing the actual layout of the screen. It is important to provide learners with ease of access and navigation through resources, and appropriate interfaces and capability of interaction (Volery and Lord, 2000). The most significant was to use large easily accessible buttons on all screens. Experience has shown that one of the major frustrations while using touch screens to unintentionally press the wrong button or not being able to press the desired button due to overlapping hotspots. While creating the ‘Working Circuit Screen’ it was found to be impossible to use large buttons while at the same time presenting the appropriate information. It was decided for the trial to use mouse-activated interaction and to undertake to solve this if and when touch screens were actually purchased.



**Figure: 2.2 Home page image**

Text on all printable screens were of a San Serif text so words would be more easily seen, also a mixture of small and capital letters were used in order to be read more easily. 'Studies have shown that words and sentences with mixed upper and lowercase letters are easier to read' (Vaughan 2001).



**Figure: 2.3 Work instruction image**



## 2.14 Evaluation

As part of the assessment and evaluation of the workshop interface, questionnaires and interviews were carried out. Also several meetings with interested colleagues (focus groups) took place before, during, and after the creation of the interface. Many of the improvements suggested have already led to the enhancement of the Workshop Interface.

## 2.15 Conclusion

This review endeavoured to inform the creation of a workshop interface with specific attention to learning styles and the techniques and methodologies used to develop a workshop interface. The first section of the review described the different learning styles and the specific attributes that characterised each style. Gardners' theory of multiple intelligences was then described and how these compare to the learning styles. The first section finished by describing two of the main learning theories Behaviourism and Constructivism. The second section of the literature review provides an overview of the leading research in the development of the interface. It illustrates how this research will contribute to the creation of the interface.

# 3 The Research Methodology

## 3.1 Introduction

This section of the research paper gives an overview of the techniques and methodologies employed to research the dissertation topic. The primary methodologies can be loosely categorized as desk research, qualitative research and quantitative research. The desk research focused primarily on the literature review of learning styles and their place within education to date. The literature review covered central topics such as different learning styles, multiple intelligences, and two main learning theories. Drawing on the literature review, the qualitative research involved carrying out a number of semi-structured interviews with key informants within an Irish Institute of Technology. Focus groups and questionnaires were also utilized to collect information from a diverse group of individuals which included apprentices, lecturing staff, management, and experts in teaching and learning techniques (WebCt users, BUA), as well as interested parties involved in the creation of learning materials. Quantitative findings from questionnaires were also extrapolated though the intention was not intended to generate precise statistical significance, but to indicate important themes relating to learning styles and their significance to apprentice learning.

The section first looks at the fundamental research questions behind this paper that were explored to help clarify specific objectives of the research and more specifically the creation and suitability of the interface. An explanation then follows as to why the predominant research approach taken was qualitative, as opposed to quantitative. In addition, this section looks at how the qualitative data was collected and analyzed, how the research was managed, and how issues such as ethics, credibility and bias were dealt with. Finally, there is a reflection on the learning from the research methodologies used in the thesis, including how the researcher would do things differently for future research projects.

### 3.2 Pre-Software Creation (Support)

Returning to the underlying aims of this paper, the intention was to search for evidence that the use of ICT specifically created to target the typical learning styles of an apprentice, would improve the overall learning experience. This could only take place after a suitable piece of software was created. No evidence was found of a workshop interface that had been created for apprentice training in Ireland; thus it was deemed necessary to draw on the skills and experience of those who have been involved in the use or creation of ICT for education as well as learning style specific experts. To this end several key informants were interviewed before the creation of the software. Therefore, there were a number of questions (Appendix 1), which required investigation before the creation of the workshop interface. These questions formed the basis for the interviews. However, the interviews were deliberately kept semi-structured to encourage a flow of information, both expected and unexpected. By attempting to answer these questions, it became possible to base-line where ITB currently stands in relation to ICT, learning styles and apprentice education.

### 3.3 Pre-Software Creation (Student learning styles)

Prior to the creation of the workshop interface it was necessary to determine if there is a learning style specific to the type of learners who enrol within an apprenticeship system. In order to achieve this, a standard VARK questionnaire was employed. Several meetings were arranged with BUA, to discuss the implications of creating an interface directed by the use of learning styles.

### 3.4 Post-Software Creation

After use of the workshop interface, questionnaires were used to collect information from both apprentices and lecturers. The questionnaires were designed in a manner to collect both qualitative data and quantitative data. Two focus group discussions were also held.

### 3.5 Quantitative Versus Qualitative Research

Mertens (1998) suggested that research is “one of many different ways of knowing or understanding”. There are many different research paradigms available to the prospective researcher. A research paradigm is a set of assumptions about the nature of reality, knowledge, and the goals and aims of the research process combined. Paradigms represent a distillation of what we think about the world, yet often cannot prove. Researchers’ actions are based on the underlying assumptions of each paradigm.

The relative value of qualitative and quantitative inquiry is well debated (Patton, 1990). One of the reasons the qualitative approach appealed was that qualitative research takes the view that the researcher and the data are intertwined and that no dividing line exists between the two.. It made sense, therefore, as the researcher was actively involved in the creation and implementation of the workshop interface both on an emotional and physical basis to follow a research tradition that fit with this reality. According to Dukta (1995:10) *“there is no substitute for an informed, authoritative person who can relate to respondents on their own terms”*. Stokes advises (2000:48) *“If the focus of the research is on gaining a broad understanding of marketplace issues, then a qualitative methodology is an ideal starting point”*. The point is reinforced by Alizadeh, Perry and Riege (1997) who suggest that, since only observable phenomena can be researched by quantitative means, critical realism (qualitative research) rather than positivism is a more appropriate research paradigm for studying external world

phenomena such as inter-organisational links, communicative networks, interpersonal relationships and participation in collaboration activities.

Therefore, a deliberate decision was made that the research methodology would be primarily based on qualitative techniques and it was understood that the outcomes would not claim to be representative in terms of the answers that would be forthcoming. Furthermore, the analysis of the VARK learning style questionnaires and workshop interface questionnaires demonstrated competence in quantitative analysis, as it was felt important to demonstrate an ability to use both techniques.

### **3.6 Managing the Research Process**

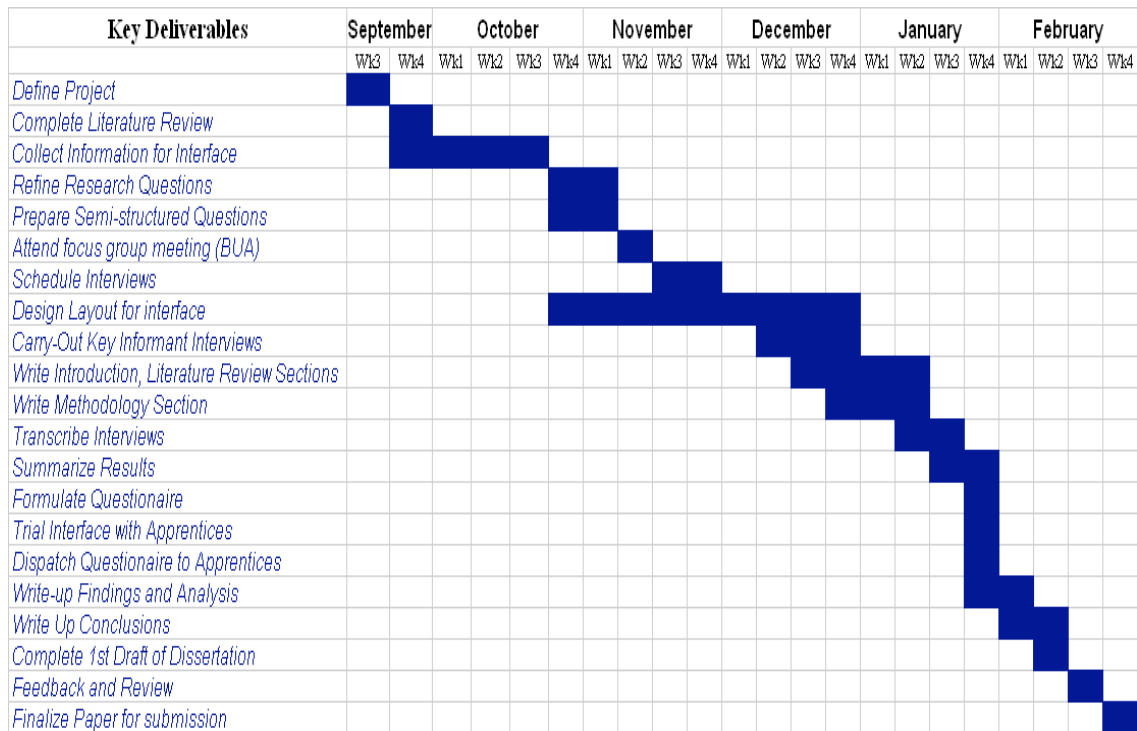
The initial scoping of the project took considerable time, as it involved assessing alternative fields of interest. In selecting the general topic, several important factors were weighed-up. These are:

1. That the timeframe for the research was kept to 20-24 weeks. This had to be balanced with other time-commitments including work, other assignments, family, rest and sport;
2. To select an area that was not entirely new to the researcher, yet would provide significant learning opportunities;
3. To select an area that was relevant to the researcher's current employers.

Having narrowed the research down to the general topics of Learning styles, ICT and Motor Control Installation Phase 4, some time was spent refining the scope of the research, yet encompassing these general areas. A useful tool that helped to clarify the objectives was to write a project objective statement, which in turn became the basis for the title of the project. It was decided to use the following statement:

*'To investigate the feasibility of creating a piece of software for practical electrical classes that engages learners of different learning styles'*

Although research projects by their nature are open-ended, the project objective statement nevertheless provided a mechanism for scoping exactly what was required to do over the defined timeframe. The Institute of Technology Blanchardstown offered their full support, as did BUA; the only proviso was that the results of the findings would be made available to both ITB management and BUA support staff. As part of the planning process, a work-schedule was prepared (Fig. 3.1). Although due to a family bereavement the schedule was not adhered too, it helped to monitor progress and define a suitable order in which to tackle key deliverables.



**Figure: 3.1 Schedule of Key Deliverables**

### 3.7 Data Collection

Denzin and Lincoln (1994) encourage the qualitative researcher to “*use the tools of his or her methodological trade, deploying whatever strategies, methods or empirical materials are to hand*”. In my data collection phase telephone and face-to-face meetings were used to conduct the semi-structured interviews and focus group meetings. A commonly used qualitative technique is the use of one-to-one interviews or group (discussions). Qualitative interviews can be used either as the primary mechanism for data collection, or in conjunction with observation, document analysis, or other techniques (Bogdan and Biklen, 1982). Qualitative interviewing utilizes open-ended questions that allow for individual variations in responses. Jancowitz (2000) writes about a number of methods in qualitative interviewing, including: 1) informal, conversational interviews; 2) semi-structured interviews; and 3) standardized, open-ended interviews. Erlandsen et al (1993:86) advocated that the semi-structured interview is ‘*guided by a set of basic questions and issues to be explored, but neither the exact wording, nor the order of the questions was predetermined*’. The typical style of open ended questions in these interviews provide a greater depth of data than structured interviews in that they attempt ‘to understand the complex behaviour of members of society without imposing any a priori categorisation that may limit the field of inquiry’ (Fontana and Frey, 1994: 362). Semi-structured interviews are, therefore, particularly useful when it is important to understand the construct that the interviewee uses as a basis for their views or beliefs about a particular topic, a factor that is eminently significant in this research.

Interviews were tape recorded and later transcribed for analysis purposes. Dukta (1995:28) stresses the importance of using a recorder: ‘*The use of a tape recorder*

*reduces the almost unavoidable bias created by an interviewer documenting his or her own work'.*

A questionnaire was created to be used by apprentice learners and academic staff post interface creation in order to evaluate its effectiveness. Its purpose was to articulate some form of summary statistics upon reflection of the use of the interface within a workshop situation. Dukta (1995) highlights the importance of the questionnaire design stating: *'It is exceptionally difficult to create a questionnaire that is both accurate and relevant. The skilful preparation of such a questionnaire will contribute significantly to the success of the research'*. It is important to note that although part of the analysis from the questionnaire is quantitative, it merely reinforces some of the common themes that emerged from the qualitative analysis, i.e. the semi-structured interview, questionnaire and focus groups. By combining the qualitative analysis with the quantitative analysis backed-up by the literature survey and the analysis of the views expressed in the pre-workshop interface creation interviews, it was felt that the issues had been tackled from enough different vantage points to achieve sufficient data triangulation, which would help to illuminate important findings and conclusions from multiple standpoints, thereby enhancing the credibility of the findings.

### **3.8 Ethics**

Examining peoples' opinions, attitudes and preferences requires sensitivity, particularly in cases where comments are driven by emotions, as opposed to logic. Although there was never anything inherently confidential in what was set out to investigate, it was set out with the intention of adhering to the principle of informed consent. All key informants were informed of the background and purpose of the study, were given a copy of their interview transcripts, and asked to validate the interview summaries. It was also clarified that they had the option to request confidentiality and anonymity of any information that they provided. To avoid any complications arising directly from quoting an individual interviewee, it was decided not to publish the transcripts of the interviews or questionnaires. By doing this, it not only avoided unnecessary pointing to "who exactly said what" but it also avoided unwarranted clouding of the qualitative analysis that ensued.

### **3.9 Credibility and Bias**

Credibility tends to be more a function of the richness of the information gathered and of the analytical abilities of the researcher than of on sample size (Patton 1990). As pointed out earlier, the researcher can enhance the credibility of his / her findings through triangulation of data. Creswell (1994) argued that triangulation was based on the assumption that any bias inherent in particular sources of data, investigators and methods could be neutralized when used in conjunction with other data sources, investigators and methods. This research involved 'between' methods, drawing on both semi-structured interviews, a survey and relevant literature and a follow-up questionnaire. In qualitative research, the researchers regard bias as unavoidable and they are likely to state their biases openly.

As Brody (1992:179) states:

*Since the naturalistic investigator is him or herself the research instrument, naturalistic inquiry cannot avoid observer bias .... Instead, open disclosure of preconceptions and assumptions that may have influenced data gathering and processing becomes an inherent part of the conduct of the inquiry.*

Greene (1994:539) regards bias as the qualitative researcher's greatest asset: "it is precisely the individual qualities of the human inquirer that are valued as indispensable to meaning construction". The researcher was aware that their own personal perspectives could influence how they viewed the importance of some findings relative to others. It could have been decided to increase the sample size of the interviewees to increase the level of objectivity and statistical significance of the result but at the end of the day regardless of the method of data analysis used researchers see data through '*the lenses we have at our disposal at any given time*' (Ely et. al 1991:143). Apart from having the interviews semi-structured, key informants were deliberately chosen on the basis of their specialized knowledge and experience. Depending on their role, job-title, organisation and their likely perspective on the issue of ICT and learning styles, some questions were more relevant to some interviewees than to others.

### 3.10 Overview of Research

The research for this study was carried out during term 3 of the 2004/2005 academic year. During this term Electrical apprentices had already become familiar to using computers by attending computer classes for a one and half hours a week, they also gained experience by using WebCt in a blended approach to supplement their traditional style classes. The research was carried out in an Irish Institute of Technology. This Institute of Technology currently caters for two groups of 16 for four trade groups which include Brick & Stone, Carpentry and Joinery, Electrical, and Plumbing. The participants for the interface trial were 28 Electrical apprentices and six lecturers, though the learning style questionnaires were completed by all 128 apprentices attending the Institute during term 3. The apprentices ranged in age from nineteen to thirty-six.

### 3.11 Data Analysis

Through the researchers engineering experience in dealing with qualitative research it was considered essential to take a very structured and objective approach to data analysis. However, it is fair to say that researchers tend to notice only those things that they are personally interested in. Again, it is important to reiterate that the small sample size implies that the results probably do not have any statistical significance but merely help to articulate the degree of alignment among key informants on central themes and reinforce the qualitative findings. Qualitative research tends to be inductive in its analysis of data, implying that critical themes emerge from the data (Patton 1990). This implies that the research process requires some degree of creativity, as the challenge is to place the raw data into logical, meaningful categories; to examine them in a holistic fashion; and to find meaningful ways to communicate this interpretation to others. Having had each taped interview transcribed, the interviews were then listened to several times, along with reading the transcripts, to ensure that the transcript material was an accurate interpretation of the interview. Having someone else transcribe the interviews saved considerable time and also instilled some objectivity into the interpretation of the interviews.

### 3.12 Summary

The research methodology used in this paper combines quantitative and qualitative techniques, with the overriding emphasis being on qualitative research. Having said that, the analysis of the literature review represents a major part of the research as it sets the scene for the appropriate research questions. Qualitative analysis was based on key

informant, semi-structured interviews, focus groups and the interface evaluation questionnaire. Quantitative analysis was limited to the results from the Vark learning style questionnaire and the interface evaluation questionnaire.

Having reflected on the research that was carried out, the following are highlighted as critical success factors, which the researcher would try to incorporate into any future research projects in order to improve the quality of the research:

1. balance well-defined goals and objectives with a degree of open-mindedness and flexibility in relation to the questions and answers that the research uncovers.
2. gain a strong mandate and support for the research.
3. prepare a schedule of interviews well in advance and have a careful selection process for key informants (they must provide a balanced set of expertise).

## **4 Results and Findings**

### **4.1 Introduction**

It is important to reiterate that the qualitative research for this thesis has been based on semi-structured interviews with key informants and focus groups. Informants were selected due to their knowledge of educational issues affecting all students and several were selected due to their expertise of the specific difficulties facing apprentice students. At the end of the day, the data generated through the interviews and focus groups is of opinion only. It is also essential to bear in mind that the sample size was very small, 28 Electrical apprentices and six lecturer's trialled the electrical workshop interface. The sample size in relation to the learning style questionnaires was also very small; 128 apprentices. The fact that an interface such as this has never been created before and the informants have little experience of using ICT within a workshop, a certain novelty factor may taint the results. There are two main themes emanating from the research; one being the discussion taking place surrounding Learning styles as well as an evaluation of the students learning style questionnaires; and secondly the relevancy of the workshop interface in meeting the needs of the individual learner.

### **4.2 Brief discussion on interviews**

One issue that emerged from the research work was that individuals involved in education had different perspectives on what was the meaning of "Learning Styles". Some viewed it strictly as a tool to label students regarding their preferred style, others believed that it is a tool that was to be used during the first week of classes and then forgotten about. Still others believed that aligning all educational resources to suit particular students' learning style would revolutionize education. Though there was disagreement on the use and definition, all contributors agreed that through the use of "Learning styles" educators would be better equipped in responding to the individual differences of each learner. It was also agreed that "Learning styles" allows for the broadening of the definition of intelligence.

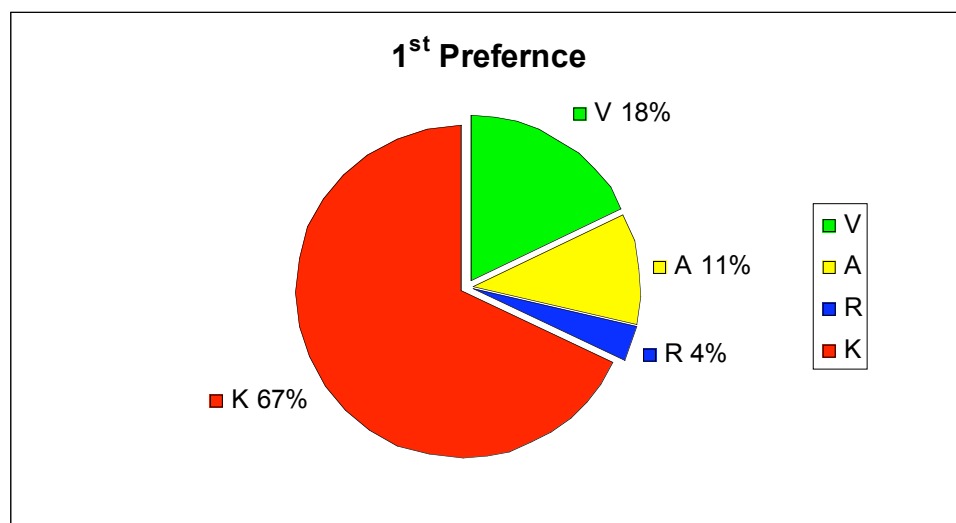
The discussion also entertained the idea of using VLEs in the delivery of courses. A majority agreed that they could have a positive impact on allowing learners to progress at their own pace and also allow them to access resources that better suited their individual learning style. A negative factor that continuously arose in conversation was the issue of resources. A common problem in the area of VLEs, one interviewee stated:

*'I've always argued that they'll give you millions to build buildings but I've never managed to successfully convince them to give us millions to achieve the same end result by using a VLE infrastructure. So ultimately that will be our main constraint.'*

All participants agreed that with this negative attitude towards the use of VLEs and also agreed that it will take individuals at local level to progress the use of ICT in education.

### 4.3 Discussion on learning style questionnaires

An easily available VARK learning style questionnaire was administered to 128 apprentices enrolled at an Irish Institute of Technology in apprenticeship courses ranging from Brick & Stone, Carpentry & Joinery, Electrical, and Plumbing.



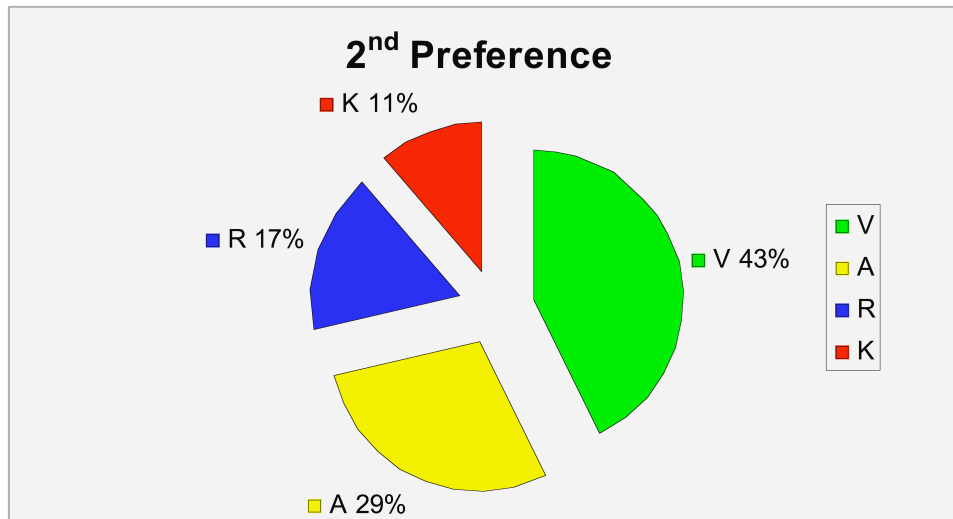
**Figure: 4.1 Learning style 1<sup>st</sup> preference**

As can be seen from the above chart 67% of the apprentice learners categorised themselves as primarily Kinaesthetic learners with a further 18% categorising themselves as Visual learners. It was soon very evident that the overriding preferred style was that of Kinaesthetic and Visual and this would need to be taken into account in the construction of the interface.

The second preferences also showed an inclination towards Visual (43%) and Kinaesthetic (11%) with also a strong second place showing for Audio (29%). This strong showing for Audio was also reflected in many of the discussions and responses from the questionnaires, as will be shown below.

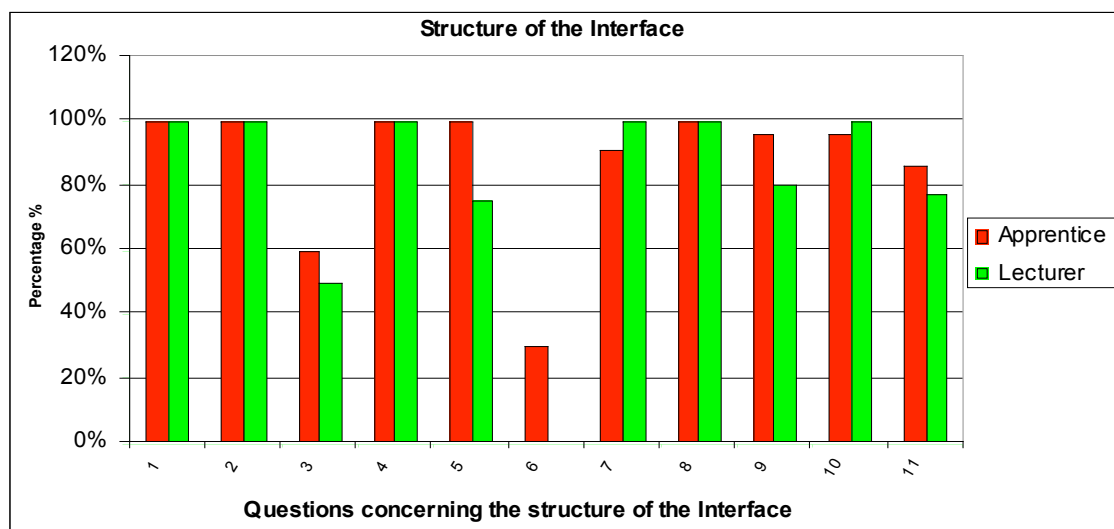
This data interrogated from the VARK questionnaires collaborates with BUA's (2004) work in this area where they found after tests that the majority of apprentice learners they examined had a preference towards learning in a Kinaesthetic or Visual manner. A researcher from BUA stated; 'that the evidence shows that it will require possible innovative teaching / learning methodologies to maximise performance.'





*Figure: 4.2 Learning style 2<sup>nd</sup> preference*

In order to gauge the effectiveness of the workshop interface, electrical apprentice students as well as a selection of lecturers were asked to complete a questionnaire; a total of six lecturers and 24 apprentices completed the questionnaires. The questionnaire was divided into three distinct categories; the structure of the interface, the content of the interface and finally the future use of the interface/ICT in this environment.



*Figure: 4.3 Structure of the interface*

#### 4.3 Findings for structure of the interface

The first question asked regarded the navigation of the interface and both lecturers and apprentices rated it at 100%; this was important as an easy navigated interface was a key objective in the design. A follow on question concerned whether the information was presented in a clear and understandable way, again both lecturers and apprentice

learners 100% agreed that it was with one apprentice learner commenting *'that everything was well identified so could be easily understood'*.

**Table: 4.1 Structure of the interface**

No.	Question	App %Yes	Lect %Yes
1	Was the software program easy to navigate?	100%	100%
2	Is the information presented in a clear and understandable way?	100%	100%
3	Would you like to hear a narration guiding you while using the software?	60%	50%
4	Do you feel the interface is an improvement in the delivery of the material?	100%	100%
5	Is there enough interaction in this system?	100%	75%
6	Did you find it difficult referring to additional resources for information (e.g. the CD of notes, the ETCI rules).	30%	0%
7	Would you say the tasks/exercises were appropriate?	91%	100%
8	Are the on line help and directions clear?	100%	100%
9	Were the colours used helpful to highlight the important parts?	96%	80%
10	Did you find the screen layout interesting?	96%	100%
11	<b>Indicate the overall rating for the structure of the CD.</b>	<b>86%</b>	<b>77%</b>

Question three was a point of much debate that was contained both in the interviews as well as the questionnaire. It simply asked if the user would like to hear a narration while using the interface, many felt this would be useful as would appeal to their audio skills, several though thought that the noise within a workshop would add an extra distraction to an already noisy environment. This difference in opinion is evident with 60% of apprentice students and 50% of lecturers favourable to narration. All participants felt this interface was an improvement in the delivery of the material as is reflected in the 100% result and it was remarked by several of the apprentice learners that the interface tells and shows you (the user) exactly what everything is and how it functions. 100% of the student felt there was enough interaction contained within the interface, but only 75% of lecturers felt the same. They cited the need for more interaction on the working electrical circuits and another lecturer made the excellent suggestion of showing real-life examples and applications of the electrical tasks that are required to be completed.

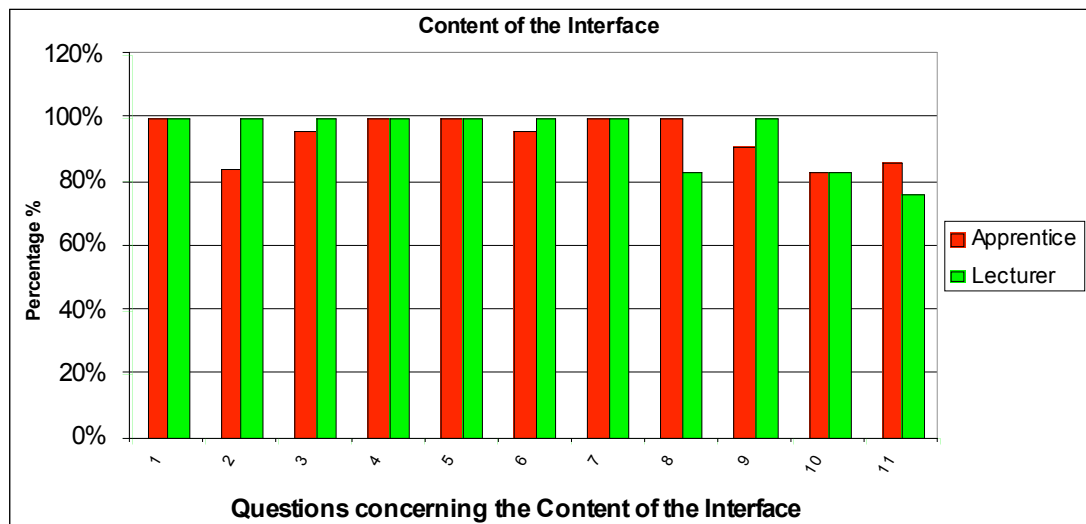
Question six also provoked much discussion; it asked if there was difficulty in referring to additional resources. One suggestion, which was acted upon, was to connect the CD of notes directly to the workshop interface; another suggestion was to obtain a softcopy of the National Rules for Electrical Installations (Irish electrical regulations) and hyperlink relevant material but it was felt this was beyond the scope of this project. A very positive response (91%/100%) was received when questioned about the appropriateness of the tasks/exercises, it was important that all users appreciated the importance and the reason behind the tasks/exercises they were asked to complete. All users agreed that the online help and directions were clear. It has been suggested that a proper help section similar to one found in all popular software packages be created for the interface. Most (96%) apprentices thought that the colours used in the interface were appropriate though only 80% of Lecturers agreed; two of the Lecturers suggested that the colours on the working circuit should be enhanced to highlight a live circuit better.

There was an agreed feeling (96%/100%) that the interface was of a professional design with one Lecturer stating it had a *'good similarity to other commonly available screen formats'*

More than 75% of both apprentices and students felt that the structure of the interface was more than suitable for the purpose it was designed, though as stated above, two areas of concern were the referencing of additional information and the question of whether or not to add narration.

#### 4.4 Content of the interface

The first question in relation to the content of the interface queried whether the topic i.e. electrical workshop practice, was well presented and all users agreed that it was, with an apprentice learner stating that it was *'presented well and easy to work with.'* When asked if the interface motivated the user to learn, all the lecturers (100%) agreed that it did, 16% of apprentice learners disagreed with this opinion stating; *'it could become boring after awhile'* and one also suggesting that there should be an incentive to finish all projects.



**Figure: 4.4 Content of the interface**

The completed questionnaires also illustrated an overwhelming agreement that the material was correct and up-to-date (96%/100%), that the information was well organised (100%/100%), that they were aware of the topic that it was trying to demonstrate (100%/100%), that the material could be used outside the workshop (96%/100%) and the exercises were effective (100%/100%).

When asked if there were sufficient pictures, examples, and animations there was much agreement, though this question solicited the most suggestions for improvement. The Lecturers recommended showing videos or pictures of differing standards of work (excellent, good, poor), as well as repeating the suggestion for videos showing real-life applications for the circuits. The apprentice learners put forward the idea of showing the contacts opening and closing on the working circuits and also advocated an animated walk-through of the final working circuit

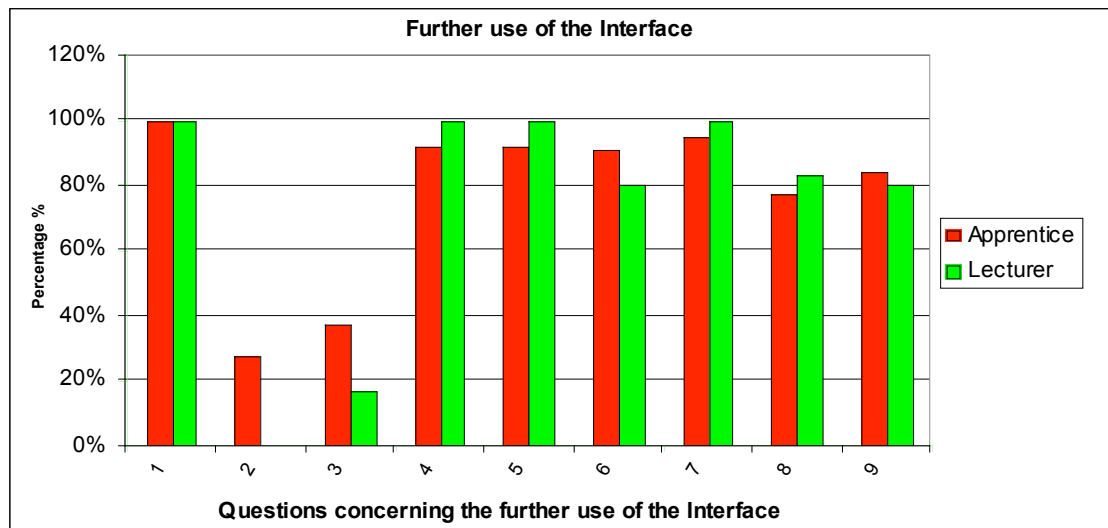
**Table: 4.2 Content of the interface**

No.	Question	App %Yes	Lect %Yes
1	Did you like the way the topic was presented?	100%	100%
2	Did you feel motivated to learn more?	84%	100%
3	Is the material correct and up to date?	96%	100%
4	Is the information well organised?	100%	100%
5	Did you know what topic the software was trying to teach at all times?	100%	100%
6	Could the material be used in areas outside the workshop?	96%	100%
7	Are the exercises effective?	100%	100%
8	Is there sufficient a. pictures? b. examples? c. animations?	100% 91% 83%	83% 100% 83%
9	<b>Indicate the overall rating for electrical content of the Software</b>	87%	77%

Finally, when asked to rate the overall electrical content of the interface the apprentices, as expected from the results of individual questions, rated it highly (86%). The Lecturers only gave it a rating of 77%. As it stands it's a very positive result but if an average of the individual questions was calculated a rating of 97% would have been achieved. This gives the impression that the questionnaire was deficient as lecturers were unable to fully articulate their views on the content of the interface.

#### 4.4 Further use of interface

We can see from the graph all participants unanimously agreed (100%/100%) that the interface could be used successfully to teach other electrical subjects.

**Figure: 4.5 Further use of the interface**

**Table: 4.3 Further use of the interface**

No.	Question	App %Yes	Lect %Yes
1	Do you feel that the interface can be used successfully to teach other electrical subjects?	100%	100%
2	Can you see an interface like this replacing face-to-face teaching?	28%	0%
3	Did you experience any hardware or software problems while using the interface?	38%	17%
4	Did you find the interface enjoyable to use?	92%	100%
5	Do you feel in a more comfortable position to use similar types of software for learning in the future?	92%	100%
6	What features of ICT would you like to see in the future a. pictures b. animations c. narration	91% 95% 77%	80% 100% 83%
7	<b>Indicate the overall rating for the quality of the Interface</b>	<b>84%</b>	<b>80%</b>

When asked if they could see an interface such as this being used to replace face-to-face teaching, only 28% of apprentice learners felt that it could. Lecturers where even more negative, they felt that it could never replace face-to-face teaching. For example one lecturer stated; *'not fully, as confirmation of deeper understanding of a topic needs to be personally communicated to the student as a mix of emotions are available to a teacher as opposed to ICT'*. A different view from lecturers did surface through the interviews, most saw the benefits of using ICT of this style in education with the major difficulties highlighted surrounding the lack of resources:

*'with VLEs' is that, all of the infrastructure needs to be in place and all the resources need to be in place.'* and *'I would imagine that if you're talking about virtual learning and so on, I would imagine that to establish that is very expensive'*

A low number of participants have stated that they had difficulties in using the Interface and this was to be expected in its first trial as the interface was designed to only be an exploration of the feasibility of creating a useful piece of software for practical electrical classes that engaged learners of different learning styles. The majority of the participants agreed the Interface was enjoyable to use (96%/100%) and that they would feel more comfortable using similar types of software for learning in the future (96%/100%). When asked what features they would like to see in the future, all agreed the need for more pictures and animations and a majority asked for narration but as discussed earlier the form that this would take is unclear. Overall the participants rated the Interface quite highly (84%/80%) with one student proposing a further comment that the power and control circuits should be separated on the animations.

#### **4.6 Weaknesses of the research**

It was felt that the cohort of apprentices and lecturers that reviewed the interface were not of an adequate size to gauge an accurate outcome. In reality the study would need to cover all apprentices attending the college at a particular time. Although the Interface did cover one particular aspect of the course it did not cover nearly enough material to allow apprentices to get a full appreciation of using ICT. Much of the enthusiasm that

apprentices showed towards the Interface could be put down to the novelty factor rather than the concept.

## 5 Conclusions

This research paper set out with the goal of investigating the feasibility of creating a piece of software for practical electrical classes that engages learners of different learning styles. Prior to this research a learner would be presented with a majority of the information required for completing the module in a format that matched one learning style. With the introduction of a new workshop at ITB it was hoped to leverage some of the advantage of ICT to allow for the diverse learner by providing materials in a variety of formats. It was through the development of a touch screen operated workshop interface that this was hoped to be achieved. The evidence produced by the research points to a strong potential for the development of this interface that will meet these needs. The workshop interface that was created for electrical practical classes and evaluated by both apprentice learners as well as lecturers was met with a positive response. Apprentice learners more interested in mobile phones and Playstations found it a comfortable and enjoyable way to learn. They appreciated that the material was delivered in a way more suited to their individual needs. Lecturers could also see the advantages of using ICT, they discovered that through the use of ICT learners could take more ownership for their own learning and has also made them more aware of the need to deliver material in a form best suited to the learner.

## 6 Recommendations

The following are recommendations for the further development of this interface. Implemented in conjunction with each other these could allow for the creation of a self-directed learning environment which respects the needs of the diverse learner within a practical workshop.

The recommendations are:

- The installation of touch screens at workstations within the new practical workshops
- Allocation of resources to allow for further development and training
- Integration with the Institute of Technology's VLE
- Continued evaluation of Apprentice learning styles in the hope of creating an apprentice learning profile.
- Researching an appropriate tool for measuring the actual learning taking place.

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