Monitor Setups for IT Helpdesk Workers:

A Comparison Study

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2007

Thesis submitted to the

Auckland University of Technology

in partial fulfilment of the degree of

Master of Business

Table of Contents

List of Tables

List of Figures

Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

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Sarah Marie Whalley

Acknowledgements

I would like to thank my research organisation and participants for volunteering their time and resources. Thanks to Dr Philip Carter for being such a patient and helpful supervisor. Thanks to my family for their love and support, my employers for allowing me the time to complete this and a special thanks to Puredepth for the loan of the MLD™ monitors.

Abstract

In the hectic world of an IT helpdesk with an ever increasing number of applications and tasks on the go, managing the intricacies of how to navigate these is a cause of frustration for helpdesk workers. I had noticed while working on a helpdesk that the workspace area - particularly the monitor setups that IT helpdesk workers have to use - makes doing their job difficult. The number of applications open, the number of tasks on the go at once and the added pressure of customer contact, all call for applications and data to be accessed quickly - but the set up of the users workspace generally does not allow for this.

The main objective of this research is to compare the difference between the use of a single screen, a dual screen and the new Multi-Layer Display (MLD™) and the complications of having multiple applications and multiple monitors operating at one time for IT Helpdesk Workers. This research looked at how the users' monitor setup influenced the performance, efficiency, satisfaction, ergonomics and learning of the participants.

The research showed that there was a clear dislike of the current set up of single screens; all participants felt that the single screen setup limited what they could do at once and it rated the least favourite of all. The dual and MLD™ screens showed positive outcomes for increasing multi-tasking abilities and raising users' perceived performance and satisfaction levels. The added screen real estate of both the dual and MLD™ over the single screen meant that users consistently had more information available to them

which enabled them to complete tasks quicker, monitor other applications for incoming jobs, easily transfer data from one application to another and multi-task more effectively. While there were some minor ergonomic concerns and learning difficulties with the unique features and utilities of the both the dual and MLD™ monitors, participants still preferred to use these setups over the single screen.

1. INTRODUCTION

1.1 Background

Over the last few years I have been working on an IT helpdesk. Over this time I have noticed that the workspace area that we have to use makes doing our job difficult. The number of applications open, the number of tasks on the go at once and the added pressure of customer contact all call for applications and data to be accessed quickly - but the set up of the users workspace generally does not allow for this.

Whilst working on the IT Helpdesk I identified some issues that occurred regularly. During an undergraduate paper in Human Computer Interaction (HCI) at AUT, I carried out a study into these workspace issues for IT Helpdesk users. The outcomes of this previous research I have extended for my Thesis. There were three main themes:

1. Multiple applications open – but users can only see one application at a time.

The first major theme was the number of applications IT Helpdesk workers need to have open at once. The multi-tasking nature of IT helpdesk work requires users to transfer information from one application to another; to be reading/writing in one application while also having a connection to another computer or database all happening at once while on the phone to a customer. IT help desk workers regularly have remote desktop sessions, email, documentation, call logging software and databases all open at once and this increased the need to navigate around the screen and swap between these open applications. In my experience this made tasks take longer because the information you

required was in another application which meant that you swap out, find the information you needed and then swap back in.

2. Limited screen real estate - limits what users can see at one time

With traditional monitor setups workstations are generally only equipped with a single monitor. This monitor must display all the required information and is commonly the cause of complaints that users do not have enough screen real estate to effectively carry out their tasks. With a single screen users must minimize and maximize applications or "alt+tab" to toggle between open applications in order to view the information they need to see. IT Helpdesk users switch applications a number of times a minute which can increase the time it takes to complete tasks.

Most Calls would be logged via the phone and the customer would be on the phone while the helpdesk person was trying to assist them. With customer service being a driving factor in all helpdesk environments the quicker a task can be resolved the better. The lack of screen real estate was recognized as a major concern for IT Helpdesk users and was identified as an area that could be researched further.

3. Paper notes for calls – can cause problems with statistics if calls are not logged

Users have the tendency to write information about an incident down on paper then type it into the call system later to avoid having to swap between screens. The issue with this is that sometimes this data is not transferred or the calls not logged. This was generally because it was quicker to write information onto a pad of paper then toggle into the required application. This was identified as an area of interest because if users had the

applications they required readily available to them on screen, then they may not need to write it down on paper and calls would not be lost.

These themes made me think about what could be done to improve the workspace area of IT Helpdesk workers. I wanted to see if dual monitor setups or new 3D multilayer Screens would eliminate this as call system/online documentation could be open on one monitor and a remote connection session/email etc could be on the other monitor.

The main objective of this research is to compare the difference between the use of a single screen, a dual screen and the new Multi-Layer Display within the actual operating situation for IT Helpdesk Workers. Recommendations and an implementation plan have also been included to assist the intended audience.

1.2   Intended Audience

This thesis will be written for the following communities: IT helpdesk workers, IT helpdesk management, and the HCI field which includes developers of software and hardware.

IT Helpdesk workers

IT helpdesk workers consistently face the increasing workspace issues mentioned previously - having multiple windows open, multiple applications, remote sessions and management tools all on the one monitor. This thesis will examine different workspace setups for these users to investigate optional ways to manage the various tasks more effectively.

IT Helpdesk Management

IT Helpdesk management oversee the overall running of the IT helpdesk environment. They manage IT helpdesk workers and are a point of escalation for any difficulties that may arise.   Helpdesk managers may have predefined Service Level Agreement (SLA) targets for their employees – such as the number of calls solved at tier one or first call resolution. This research aims to see if a change in workspace setup could make the job easier for IT helpdesk workers so that they could run a more efficient and effective helpdesk that provides better support to clients. The research will also offer an implementation plan for IT helpdesk management to implement some of the suggested recommendations if required.

The HCI community & Developers

Workspace is an aspect of research in the field of Human Computer Interaction. Workspace relates to the consequences of technology and how it is applied and adopted in the workplace. This thesis investigates the workspace issues of IT Helpdesk workers and as such will be of benefit to the HCI community by highlighting key areas of concern and identifying further research opportunities.

Designers of both Software and Hardware must increasingly take notice of how people use their monitors and workspace. Software designers should bear in mind that users may not be using a conventional single screen. As LCD monitors and graphics cards become cheaper, users may be adding additional hardware which may alter how software is used. Similarly hardware designers must bear in mind the changes that software will have on their hardware particularly with emergent technology such as the Multi-Layer Display (MLD™) monitors discussed in this thesis.

This Thesis has been written in a mix of both academic and industry report styles so that both worlds would gain some benefits. Recommendations and an implementation plan that are not commonly found in a strictly academic report have been targeted for the industry audience.

1.3 Approach

This research study was designed to compare three workspace scenarios to find the best monitor setup for IT Helpdesk workers. The three setups were:

- Single screen – used as a control measure;

- Dual screen – two LCD displays side by side;

- Multi-Layer Display – new multi layer LCD technology.

The data collection took place over six weeks in mid 2005. The research organisation allowed six workers to participant in the study. The participants represented a varied cross section of the IT helpdesk community including management, helpdesk analysts, technical schedulers and SLA target managers. The participants' workspaces were altered every two weeks which allowed all 6 users to trial all 3 setups.

The methodological approach taken involved participant observation, interviews, document analysis and management feedback. The data was analysed by comparing the interview and observational data for individual participants and then collectively for major trends.

A qualitative approach to the research was applied in order for the factors important to the users to be highlighted in a way that was relaxing and natural for the participants. It was anticipated that this approach would better highlight the pertinent factors that could then be further investigated in greater precision in future research.

1.4 *Structure of Thesis*

The thesis is structured in the following way. Chapter 1 gives a brief introduction and background as to why I did this research; it presents the intended audience and outlines the approach to the research. Chapter 2, Helpdesks workspace and monitors, begins with an introduction to IT helpdesks and then moves into the literature surrounding workspace, particularly the literature in the areas of dual monitors and multi-layer displays.

Methodology is in the third chapter. This begins with an introduction to the research company and the technology used for the research. The user profiles are discussed to give readers an idea of the job roles that the participants' carried out and their effect on the research. The data collection methods of participant observation and interviews are also outlined.

Chapter 4, Findings and Discussion, has been broken down into the main themes identified whilst conducting the research, namely: 1). Performance, efficiency and satisfaction, 2). Learning (which is further broken down into subsections - dual screens, MLD™ screens and utilities); and 3). Ergonomics.

Chapter 5 discusses the overall conclusions based on the three main themes. Recommendations are made on the three different screen types and a basic implementation plan is provided followed by implications and future work.

2. HELPDESKS, WORKSPACE & MONITORS

This chapter introduces the Helpdesk industry. Some literature relating to the HCI area of workspace is discussed and the monitor displays of both the Dual and Multi-Layer display setups are outlined.

2.1 Industry Review – IT Help Desks

The IT Help desk has many names - IT Service Desk, IT Call centre - but they all aim to do the same thing – solve customers' IT issues as quickly and efficiently as possible.

A help desk is a single point of contact for information and assistance to help users trouble shoot technical problems related to computing. Companies can host internal help desks or outsource the support to external vendors. Help desks provide support to their customers via the telephone, website and/or e-mail.

Common functions of a help desk include:

- Receiving calls, first line customer interaction

- Recording and tracking incidents and complaints

- Keeping customers informed on request status and progress

- Making an initial assessment of requests, attempting to resolve them or refer them to someone who can

- Monitoring and escalation procedures relative to the appropriate Service Level Agreements (SLA)

- Identifying problems

- Closing incidents and confirmation with customers

- Coordinating second level and third level support.

A typical day's work can involve:

- Taking support calls via phone and email.

- Logging, escalating, and resolving calls.

- Remote connections to user's computers.

- Logging requests for new users, new hardware, etc.

- Visiting sites/users to fix equipment, for example computers, printers, PDA's

- Installing/uninstalling software.

Help desks can run as call centre's whereby the calls are logged and passed on to the relevant support teams or they can run as expert help desks. An expert help desk analyst provides technical support for any aspect of the information systems department, including computer hardware, operating systems, applications and networks. Calls are generally logged into helpdesk software to track and monitor incoming calls through to completion. This allows call management and Service Level Agreements to be devised between the business and customer it also provides a management tool to ensure that these SLA's are fulfilled. There are a number of frameworks for IT service management including ITIL (Information Technology Infrastructure Library) and COBIT (Control Objectives for Information Technology).

Helpdesks can be run internally or externally. Internal helpdesks are managed in-house by the organisation, whereas companies who cannot, or choose not, to manage an

internal IT Helpdesk can now outsource this aspect of the business to an external service provider.

Helpdesk Environments

Helpdesk users are generally multi-taskers. They have a number of things on the go at once - emails, phone calls, and a number of open applications on their computers. Helpdesk users I have spoken to have all identified similar issues with their environment. The main issue is the limited amount of screen real estate that they have to display their many open applications. The issue I have identified with IT helpdesk users in previous research is with the visibility of applications on the available screen space and the impact of switching between these open applications. The main impact that we identified was that the amount of application switching increased the time it took to complete tasks, ultimately making jobs take longer.

Helpdesk Performance

Companies monitor their IT Helpdesks performance with indicators. They generally tie these into the Service Level Agreements that they have set up with their customers. Some examples of performance indicators are below:

- Call times: a company may decide the average speed to answer a call is important to track as a part of the SLA

- First tier resolution rates: the number of calls that are fixed by the first level of help without escalation to another team.

- Calls fixed within SLA agreed time frames – how many calls were fixed late?

A major factor that has been identified in increasing IT Helpdesk performance and satisfaction levels is the setup of the user's workspace and the amount of screen real-estate they have to effectively complete their jobs.

2.2   *Workspace*

One of the many topics to do with Human Computer Interaction (HCI) is the work area. For a given person, the combination of work equipment comprising of display equipment, which may be provided with a keyboard and/or input device and/or software determining the operator/machine interface, optional accessories, peripherals and the immediate work environment (HCI Glossary, retrieved 29 November 2006).   A persons work area can include their desk, telephone, computer, mouse, keyboard, chair, lighting, shelves and filing, but their workspace is the electronic "desktop" that incorporates the open sessions they have running on their computer and how they negotiate around these.

The issues I have identified with IT helpdesk users in previous research is with the visibility of applications on the available screen space and the impact of switching between these open applications. These electronic systems cause problems for users as they must now learn to negotiate around these sessions while, in many cases, only being able to see one session at a time.

Hutchings and Stasko (2004) state that the desktop of personal computers has dramatically changed since its inception 26 years ago. The number of tasks that are completed has risen considerably, computer speed, memory size and the internet have all changed the way people use and interact with computers.   As more of our activities are being supported digitally and we are using more applications, the amount of accessible information is rapidly overloading displays (Grudin, 2001).

People are capable of multitasking and someone may well be planning work while reading results whilst the computer is processing data (Shneiderman, 1984). Research has shown that people on average spend 3 minutes on one event before switching to another event. People also spend on average two minutes on any use of an electronic tool, application or paper document before they switch to another tool (Gonzalez & Mark, 2004). Bannon, Cypher, Greenspan & Monty (1983) identified that users with multiple interfaces struggle when they try to change tasks and that many users cope with the problem of task switching by keeping a pad of paper handy or having Notepad open in Windows. It has also been suggested that having secondary task information permanently available while completing a task can help improve performance (Morse, 1979; Mills & Weldon, 1987).

With screen space being such a limited resource (Ringel, 2003) and users having multiple applications running simultaneously on the one computer it creates "display space management" issues. There are a number of different methods and technologies that computer users employ to try and combat workspace issues.

A study by Bly and Rosenberg (1986) compared the use of tiled and overlapping window systems. Overlapping windows occlude each other (Baudisch & Gutwin, 2004) and users have to switch back and forth in order to access different tools to complete their task but users can control the window size and location. Tiled window systems don't allow windows to overlap; rather the system controls the layout and size of each window. Thus window size decreases with the number of open windows. Tiled Window systems also limit the number of open windows at one time.

Multiblending (Baudisch & Gutwin, 2004) is another alternative which allows the simultaneous display of overlapping windows by blending the foreground into the background while preserving the visibility of both. This was used primarily for CAD and software development applications. In these environments having palettes on a second monitor is not always functional as you are moving the pallets further away from where they are needed so using them takes more time (Baudisch & Gutwin, 2004).

Virtual Rooms (Henderson and Card, 1987) divide a user's workspace into a suite of virtual workspaces so instead of forcing all the objects (applications such as email, text editors, web browsers etc) to fit onto the one screen the user arranges them in multiple virtual workspaces. The screen then becomes a moveable viewpoint for the space allowing the user to switch between workspaces through "Doors". The use of virtual workspaces allows users to set up each workspace to reflect a set task, so that task switching is easier on users (Henderson and Card, 1987; Kandogan and Shneiderman, 1997)

Focus and context screens allow users to view a detailed area of a large multi-scale document and retain perspective of where they are within the document or surrounding area (Baudisch, Good, Bellotti and Schraedley, 2002). Focus and Context screens project a "context" image onto a wall-size screen, an LCD monitor is located in the middle to provide the "focus" (Baudisch et. al, 2002). The context image is projected at a very low resolution which results in a blurry image. The focus image is displayed at a very high resolution which shows a detailed crisp display of the focus area. Focus and Context tries to combat issues surrounding large multi-scale documents whereby a

documents complexity exceeds a screen displays capability. This forces users to manually navigate through the document (Baudisch et. al, 2002). This technology is useful to view maps, architecture blueprints, and information technology designs (Baudisch et. al, 2002).

 Baudisch et. al, (2002) compared the use of focus and context with that of overview plus detail. Overview plus detail uses dual screen technology to display the overview or context on one screen and the detail or focus on the second screen. The research compared two tasks. Task one was a static multi-scale document task (map task asking users to find the closet hotel to a location). Task two involved an interactive dynamic view (in this case users had to play a game where they were navigating a car along a road trying to avoid nails on the road (focus) and rocks falling on the car (context)). The results from this study showed that in task one, while no improvement in performance, the user's completion time improved and subjective satisfaction rates increased when using the focus and context screen. Task two showed that performance increased with the use of focus and context as the users were using their peripheral vision to monitor both focus and context data at once.

An important and interesting aspect of the focus and context research was its inclusion of multi screen environments. This can be compared with the studies on tiled and overlapping widows, multiblending and virtual rooms which all focused on managing the workspace within an existing screen display.

Two types of multi screen environments - Dual Displays and Multi Layer Displays – will now be outlined.

2.2.1   Dual Monitors

In previous research I conducted into how members of an IT Customer Support team captured, stored and processed data from incoming support calls, I identified several issues with how they manage their workspace. The main issue was with the lack of screen space due to the amount of applications and open sessions they had running simultaneously. Some users preferred to print out electronic information from intranets and knowledgebase's so that they did not have to swap between open windows while others were using pen and paper to note down information to avoid navigating to other screens. Further research was identified into how the use of

Figure 2.1: Dual Display setup

http://www.dell.com

different screen layouts could influence a call centre, particularly the use of Dual Monitors so that a user can utilize two screens at once. An illustration of a Dual screen setup is shown in Figure 2.1.

Dual Displays are created by installing either dual graphics cards (the board that links the computer to the monitor) or dual head video cards (one card that has two DVI or VGA ports) in a computer. The dual cards allow two monitors to be connected to the computer. Microsoft, Apple and Linux have functionally for the desktop to be extended

across two or more display screens. This allows users to move applications to either screen with a sweep of the mouse. Dual setups are not hard to configure and offer an economic alternative to upgrading to a larger monitor.

Recent displays have taken this a step further and made this set up more aesthetically pleasing by joining the monitors together with a shared base thus eliminating some of the bulk from having two monitors side by side; this is illustrated in Figure 2.2.

Figure 2.2: Dual Display With shared base

http://www.digitaltigers.com/dualmonitors.shtml

There has also been a lot of hype regarding two or more monitors, for the purpose of my research I focused on dual screens.

Adding a second monitor is one way to help manage the ever increasing quantity of digital information (Grudin, 2004). Hutching, Smith and Meyers (2004) deployed a tool to a group of single and multiple monitor users to log window management activity. Their findings show that multiple monitors increase a users multitasking ability. Czerwinski, M., Smith, G., Regan, T., Meyers, B., Robertson, G. & Starkweather, G. (2003) indicate that multiple monitor systems can help users be more productive. Grudin (2004) also noted anecdotal evidence for productivity gains. Multiple Monitors limited

the need for <alt>+<tab> keystrokes and use of the taskbar to navigate around open windows.

The first real research into productivity gains from multi screen displays was conducted by Colvin, Tobler and Anderson at the University of Utah (2004). This research compared single monitors, multi-monitors and multi-monitors with Hydravision. Hydravision is a screen management technology developed by ATI that allows users to manage where applications are placed in multi-screen environments. In Colvin et. al, research respondents were given 3 set tasks for each of the 3 display types; this was conducted in a lab environment and involved 108 participants. The research involved a combination of performance testing – what the users actually did and how long it took them to do it; and usability testing - the users subjectively rate the ease of use of the software or hardware. The researchers wanted to get a sense of the "optimal" number of monitors and so for the multi-screen and multi-screen with Hydravision component, half of the respondents had two screens and half had three. This was to determine if an increase in the number of monitors affected the levels of performance/usability. The results from this study were conclusive.

> "Respondents were able to get on task quicker, do the work faster, and get more of the work done with fewer errors in multi-screen configurations than with a single screen The gains are solid: 6 percent quicker to task, 7 percent faster on task, 10 percent more production, 16 percent faster in production 33 percent fewer errors and 18 percent faster in errorless production." (Colvin et al, pg 48, 2004)

The screen management tool, Hydravision, did not show any significant improvements over the multi-screen without screen management software. Nor did having the third monitor show any significant improvement over the dual screen setup. According to

Colvin et al (50, 2004) the three monitor condition consistently showed no advantage over the two monitor condition.

Usability results were consistent with the researcher's hypothesis

> *"Multi-screens either with or without management software are reported as significantly more usable then single screens on measures of effectiveness, comfort, learning ease, time to productivity, mistake recovery, task tracking, task focus and ease of source movement"* *(Colvin et al, 51, 2004)*

The work is judged as being easier to do with a multi-screen and thus was considered more positive then single screen setups (Colvin et al, 2004).

> *"Multi screens were seen as 29 percent more effective for task, 24 percent more comfortable to use in tasks, 17 percent easier to learn, 32 percent faster to productive work, 19 percent easier for recovery from mistakes, 45 percent easier for task tracking, 28 percent easier in task focus and 38 percent easier to more around sources of information". (Colvin et al, 51, 2004)*

Colvin et al (2004) concluded that given the consistency of both the performance and usability measures that multiple monitor configurations should be recommended for use in any situation where multiple screens of information are an ordinary part of the work. While multiple monitors help to manage the problems of having a small amount of screen space they can also create new problems in having to manage large amounts of space (Hutching et al 2004). Grudin (2001) found that instead of using the extra monitors as additional space users tended to manage the windows within monitors – i.e. not extending a single window over multiple screens. The tendency was for users to use one monitor as a working surface and the other monitor as a "Miscellaneous" screen for email, ICQ, CD player, and desktop icons (Grudin, 2001).

Applications are also not developed for multiple monitors and this causes display issues such as pop-up windows opening in unexpected places, while toolbars and menus are dragged by users to more convenient locations – a task which must be repeated as the interface elements have no memory for where they were placed when reopened (Grudin, 2001). We must understand how users interact with and manage windows and how multiple monitor use differs from single monitor use in order to develop applications that support multiple monitor use (Hutching et al 2004).

While dual screens extend a users existing workspace by adding a second or third monitor, a new technology for multiple monitor environments, the Multi Layer display adds a third dimension of depth into screen displays.

2.2.2   Multi Layer Displays

The distinctive contribution of the research will be it's consideration of Multiple Layer Display monitors. MLD™ screens offer a new way to utilize screen real-estate. Instead of spreading work across multiple displays or stacking windows which causes users to shift their attention back and forth they can now view all their information simultaneously

Figure 2.3: The PureDepth MLD™ 3000™

http://www.puredepth.com/partners/index.html

on the one monitor.   PureDepth™ Multi Layer Display (MLD™) monitors are a new

technology which incorporates a third dimension of "depth" into video display devices

(www.puredepth.com; Kooi, 2001).

Multi Layer Displays (MLD™) are a

patented technology that layers two

transparent Liquid Crystal Displays (LCD)

approximately 7mm apart. Behind the back

LCD panel is an illuminated white surface

or backlight like a normal LCD screen, this

is illustrated in Figure 2.4 (Kooi, 2001;

**Figure 2.4: PureDepth MLD™
Design**
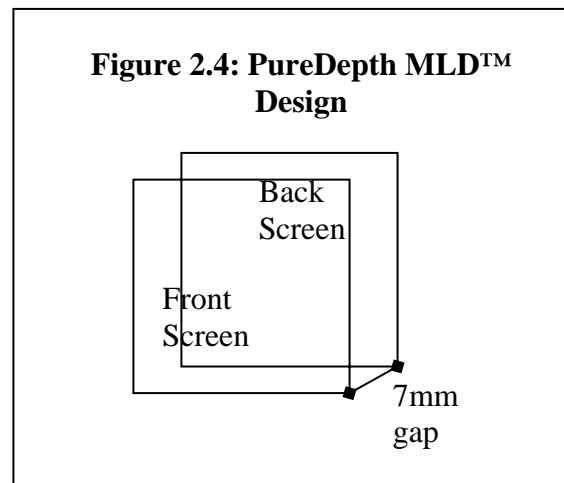
Masoodian, 2004; Bishop, 2005). When the front panel colour is set to "white" it

becomes transparent and the back panel is visible, coloured information and writing in

the front panel appears to float over the back panel thus creating a multilayer 3d effect

(Masoodian, 2004). The LCD's are encased in a single Display unit which is a few

centimetres thicker than an average LCD.

The technology behind the screens were designed and developed by Puredepth.

Puredepth license the technology as opposed to building or selling displays using their

40+ covering patents worldwide. The MLD 3000 used for the study is an evaluation unit

to display the technology.

Similar in theory to the focus and context studies of Baudisch et. al, (2002) the MLD™

allows users to see through the transparent front layer to the back layer which allows

users to view both the focus and context of a task. Unlike focus and context where the context fills the display and the focus is a small section of the display, the MLD™ allows the focus to spread over the whole display too, although now there is the added complication of visual interference between the layers (Cox et. al, 1998). Cox et. al, (1998) conducted a study into the usability of transparent overview layers and found that people were able to shift their focus rapidly between the two views, to the point of initiating an action in the foreground layer and continuing it in the background layer.

Bishop (2005) conducted an investigation into the usability effects of the MLD™ in relation to map reading tasks. Bishop found that the participants using the MLD™ could easily determine the layer that the image was displayed on. For routine or non demanding situations performance was no better on the MLD™ then on a single screen display; however for complex tasks that involved using layers to discriminate related information performance on the MLD™ improved by 4.5 seconds (Wong, 2005).

While previous research into MLD™ displays (Masoodian, 2004; Harrison et. al, 1995; Bishop, 2005; Cox et. al,1998) focuses on the level of transparency and the development of applications to utilize the 3d effect that MLD™'s produce, there is no current literature comparing the use of Single, Dual and Multi Layer Displays in a helpdesk/call centre environment. The proposed thesis will compare and contrast how users manage the Single, Dual and Multiple Layer Display setups and monitor user performance in each situation. I will perform an inquiry into workspace utilisation and examine the outcomes in relation to user performance, efficiency, learning, satisfaction and ergonomics.

3.   METHODOLOGY

This research was conducted at the Auckland office of ComputerLand over a six week period from 10th of June to the 22nd of July 2005. The main objective was to compare the difference between the use of Single, Dual and MultiLayer Display monitors for Helpdesk workers. It focused on the HCI aspects and how users adjusted to the different setups. The research was carried out in a continuous work period (rather than separate episodes) to determine the effects of the setup on a sustained real world work environment. The research consisted of interviews and observation and as such was subjective with participants reflecting on their performance, efficiency, ergonomics and satisfaction in using each of the display setups.

3.1   Research Company

ComputerLand agreed to be the research organisation. ComputerLand were an outsource solution for companies that do not want to or could not host an internal IT Helpdesk. ComputerLand had IT Customer Support teams in Auckland and Wellington and had over 50 trained support staff. In preliminary discussions with ComputerLand management, they had confirmed that their staff were facing similar issues already discussed on a daily basis. This research was conducted at the Auckland office over a six week period from 10th June to the 22 July 2005.

Before the research was conducted Computerland was brought by Telecom in late 2004. Just after this research completed in mid 2005 ComputerLand was merged into Gen-i, another telecom acquisition. Since this research finished they have been through some

major organisational changes. However at the time of this research the company was still branded ComputerLand and for the purpose of this research I will continue to refer to them as such.

ComputerLand provided managed infrastructure services, information solutions, enterprise systems and services, consulting, procurement, project and account management all backed by a 24x7 national help desk. They had been in operation for over 20 years and had 13 offices with over 500 professional and technical staff. ComputerLand served many of New Zealand's top corporate businesses, central and local government agencies as well as many Health Boards, supplying infrastructure services and support throughout the country.

ComputerLand Help Desk services provided first tier reception and resolution for user requests. It provided a range of services including desktop support, LAN problem diagnosis, LAN administration, remote desktop takeover and analytical reporting along with the standard features of job logging, tracking, escalation and standard reporting facilities. It was an "expert" Help Desk that was committed to high levels of 1st tier resolution.

They offered three levels of Help Desk services:

- **Service Desk** - an expert helpdesk providing full event and call management and live resolution of service requests.

- **ASSIST** - a 24-hour IT helpdesk providing remote access support including desktop support, LAN problem diagnosis, LAN administration, remote desktop takeover and analytical reporting, along with the standard features of job logging, tracking, escalation and standard reporting facilities. Assist also provided how-to" and "how-do-I" support on the full suite of Microsoft productivity applications.

- **Call Management** - a low-cost management of service requests to internal support teams and external service providers

3.2   Technology

The research setting was equipped with the appropriate computer technology. The following was set up at the participant's usual workstation to minimize the disruption that they would get from being positioned in a new environment. There were three groups – Single, Dual and MultiLayer Display.

- **Single Monitor environment:** this group was used as a control group. The environment did not change.

- **Dual Monitor environment**:   The workspace was set up with two LCD monitors. A second graphics card was installed in each computer.

- **Multiple Layer Display environment**:   The workstation was set up with a PureDepth™ MLD™ monitor and a second graphics card was installed. MLD™ mouse™ and MLD™ Window™ utility software were installed.

All of the participants trialled each setup for two weeks at a time.

3.3 User profiles

The research involved seven participants from the Auckland helpdesk. Seven participants were chosen as this was approximately half of the Auckland staff. It was decided by ComputerLand management that it would be best not to involve all staff to minimise possible side effects and disruption to both participants and customers. Four of the Auckland staff were not able to participate in the research as they were the IT Helpdesk for a national financial institution, as such I was not able to observe their on screen data due to privacy issues. The seven participants were made of five helpdesk workers and two managers.

NOTE: Participant 1 was also Manager 1. He was an active participant that trailed the different screen setups whereas manager 2 did not trial the setups but participated in interviews about how she thought the staff were reacting to the different setups. The participants were chosen by Manager 2. She said that some people would be more receptive to the changes than others and she would try and get a mix of people.

The different job roles influenced how the screens were utilised by the participants: Below is a table showing the participants and their job roles.

Table 3.1: Participants job role

Participant #	Job Role
Participant 1 (P1)	Manager 1
Participant 2 (P2)	Scheduler
Participant 3 (P3)	SLA Target Manager
Participant 4 (P4)	Scheduler
Participant 5 (P5)	Analyst
Participant 6 (P6)	Analyst

Job Roles

Table 3.1 lists the four different job roles: Managers, Schedulers, SLA Target Managers and Analysts. Managers and support analysts are also typical roles in other organisations. However smaller companies may not have dedicated SLA Target Managers and internal Helpdesks or smaller organisations may not have dedicated schedulers to organise their technicians.

The work the participants were doing and the number of applications they were using had an effect on how they viewed the technology. In table 3.2, below, I will list the main applications used for each role and then discuss what the role involved.

Table 3.2: Job Role Descriptions

Manager	
Main applications	MS Outlook, Phone software.
Role	To manage staff and liaise with clients; monitors the phone queues and workload to see if there are any queues building up.
Scheduler	
Main applications	Helpdesk Software, Internet Explorer, MS Outlook, Phone software.
Role	Takes incoming calls and manages technician's schedules as to when they will be able to go onsite and complete jobs. Checks warranty status of hardware from internet sites as calls come in. Schedulers do NOT fix the calls themselves they are the point of contact between the customer and the technician's.
SLA Target Manager	
Main applications	Helpdesk Software, MS Excel and MS Outlook
Role	Monitors that logged calls are resolved within the Service Level Agreements (SLA) as defined with the customer. Reports are run from Helpdesk Software regarding SLA targets. These reports are outputted into an Excel spreadsheet, this information is then analysed and if necessary emailed to technicians or managers for follow up/escalation.
Analyst	
Main applications	Helpdesk Software, Internet Explorer, MS Outlook, Remote connection, phone software.
Role	Customers call/email the Analysts for IT assistance. They have specific customers that they are responsible for (managed service desk). Companies contract the service desk for all their computer support needs. The analysts have access to the companies' servers, Active Directory domains and can have remote access capabilities to manage caller's computers

3.4   The Methodology

The methodology consisted of a triangulation of ethnographic techniques, including; participant observation, interviews, documents and management feedback.

The data was analysed by comparing the interview and observational data for individual participants and then collectively for major trends. The data was collected over a 6 week period. Table 3.3 shows the schedule for screen setups per participant; each participant trialled each screen setup for two weeks.

Table 3.3: Participant Screen Setups for Weeks 1-6

	Wk 1-2	Wk 3-4	Wk 5-6
Participant 1 (P1)	Single	Dual	MLD™
Participant 2 (P2)	Single	MLD™	Dual
Participant 3 (P3)	Dual	Single	MLD™
Participant 4 (P4)	Dual	MLD™	Single
Participant 5 (P5)	MLD™	Single	Dual
Participant 6 (P6)	MLD™	Dual	Single

Over each two week period I went into the research organisation for 5 days. Table 3.4 shows the data collection timetable for each two week period. On the final day of week 6 a final interview was also conducted.

Table 3.4: Data Collection Weekly Timetable

Week 1, 3, 5	
Day 1 – Monday	Set up and initial observation
Day 2 – Tuesday	Observation and interview
Day 3 – Wednesday	-
Day 4 – Thursday	-
Day 5 – Friday	Observation
Week 2, 4, 6	
Day 6 – Monday	Observation
Day 7 – Tuesday	-
Day 8 – Wednesday	-
Day 9 – Thursday	-
Day 10 - Friday	Observation and interview *Week 6 = final interview*

Originally I had devised a set of hypothesis to investigate:

H1: Dual Monitor displays will increase user performance when compared with Single Monitor displays

> *1a Dual Monitor displays will increase user efficiency when compared with Single Monitor displays*

> *1b Dual Monitor displays will increase user satisfaction when compared with Single Monitor displays*

1c Dual Monitor displays will increase a user's ergonomics when compared with Single Monitor displays

H2: Multiple Layer displays will increase user performance when compared with Dual Monitor displays.

2a Multiple Layer displays will increase user efficiency when compared with Dual Monitor displays.

2b Multiple Layer displays will increase user satisfaction when compared with Dual Monitor displays.

2c Multiple Layer displays will increase a user's ergonomics when compared with Dual Monitor displays.

However, very early in the research collection phase it was found that the above hypothesis had occurred. So it was instead decided to focus on the outcomes of the following research areas: performance, efficiency, satisfaction, and ergonomics.

- **Performance**: was performance compromised or increased?

  It was very hard to asses any increase or decrease in performance as the research company did not monitor performance in those terms. Alternatively performance was measured more in terms of personal satisfaction and whether users thought their performance had improved. I had wanted to look at call times, number of calls and resolution rates but found this did not correspond to what all the users were doing and was not comparable across all job roles.

- **Efficiency**: did the setup enable users to be more efficient? Did participants notice any improvements to the way they worked? Was it easier/harder to complete tasks?

- **Satisfaction**: were the users happy with the set up?

   This measure is very subjective as it is based on the users and managers opinions of their own and others satisfaction levels, however it is important to compare the differing levels of participant satisfaction on the various monitor setups.

- **Ergonomics**: were there any ergonomic issues with the setups?

   Did it cause participants any adverse affects such as sore wrists or necks, headaches or eyestrain?

An area that was not included in the hypotheses but proved to be very influential in the research was learning. I have included learning in the findings:

- **Learning**: how easy was it to learn? Did participants pick it up easily? Was there any required teaching in order for the participants to understand how to use the setup? During the early stages of the research it was apparent that the participants all had varied learning styles ranging from "Players" to "leave it as it is". I decided to focus on how easy it was to "pick up" the technology rather than the intricacies of how and why people learn. This was mainly to make it easier to focus on the main outcomes of comparing the screen types for helpdesk environments but I could not ignore the impact that learning would play on the adoption of the technology.

Data Analysis phase

- Interviews were transcribed into a word document.

- Observation data was transferred from the observation check sheets (Appendix 3) into a word document (Appendix 7).

- Observation and interview data was analysed by inputting the results into an Excel spreadsheet. These spreadsheets contained both positive and negative comments and observations for single, dual and MLD™ setups for all participants and managers (appendix 8).

- The Matrix was then scanned for major trends and recurring themes.

- These trends were then compared to the literature.

3.5   Data Collection Methods

Data was collected in two major ways – through participant observation and interviews. Typical ethnographic research employs three kinds of data collection: interviews, observation, and documents. (Genzuk, 1999)

3.5.1   Participant Observation

Participant observation "involves social interaction between the researcher and informants… the idea being to enable the observer to study firsthand the day-to-day experience of subjects in a particular situation, and, if necessary, to talk to them about their feelings and interpretations" (Waddington, 1994, pg 108). In this research I undertook the role of *participant-as-observer* – "observer who forms relationships and participates in activities but makes no secret of an intention to observe events" (Waddington, 1994, pg 108). This means that the researcher not only sees what is happening but "feels" what it is like to be part of the group (Genzuk, 1999). In order to enter an existing environment Genzuk (1999) advises to build trust and rapport at the

entry stage. This allows participants to open up to the researcher and allows them to say a few things they may not have otherwise. This was noticeable during the research when participants would ask me if they were "doing it right" or tell me honestly when they did not like a setup.

During observation I sat beside the participant and noted down on the Observation Check Sheet (Appendix 3) what they had on their screen and how they were navigating around it. Taking particular notice of when they answered the phone, wrote notes on paper, opened and closed applications, how they moved from one application to another and where applications were positioned on screen. I asked questions where suitable (some had phone-based roles and there were times when interrupting was not an option). I also asked for screenshots at the end or beginning of the observation period. I had a list of frequently used software that I abbreviated (Appendix 4). This enabled faster note taking. For example instead of writing Outlook it was OL, instead of Jobtrack (the helpdesk software) it was JT.

3.5.2   Interviews

An interview is "a method whereby information is collected from the respondent and transferred to the researcher via a communication between the interviewer and respondent" (van der Zouwen, 2001). All interviews were recorded to Dictaphone and transcribed by Sarah Whalley.

I had a semi-structured set of questions (Appendix 5) to help guide the interview but let the participants tell me what they wanted to. This allowed me to get more information than just sticking to a predefined set of questions. Examples of questions include: "How many applications do you have open at one time?" "Did you notice any change in the way you do your job?" "Do you get any physical discomfort from your current set up?" "What do you like about your current monitor setup?" These were roughly framed around the main themes I was trying to investigate: performance, satisfaction, ergonomics, learning and efficiency.

In Week 6, the final interview (Appendix 6) began with the standard interview questions from the previous weeks and then had an extra component that asked users to look back at the entire 6 week period and compare and contrast their overall feelings, issues and comments. Participants were asked to evaluate their opinions on the display setups.

I also had a set of questions for management. The management interview was conducted in week 6 on the final day and focused on the full 6 week period

3.6   Issues with Methodology

The main problem with this research method was that because the research was conducted in a real work environment it was sometimes inconvenient to take participants away from their work. The availability of participants for observations and interviews was sometimes affected particularly as some of the research participants had time off

sick or were at other branches on interview/observation days. The main concerns were logistical and included:

- Participants away on interview day.

- Participants on Sick leave or at another branch.

- Participants busy on phones with no time available for interviews.

- Fitting in around lunches and breaks

This meant that I had to adjust the timetable and scheduling to go in on extra days or miss an observation or interview for that participant. This hasn't affected the research as such; it just made it a bit harder to collect the data.

4. FINDINGS & DISCUSSION

In this chapter the key findings are presented and discussed within three sections: performance, efficiency & satisfaction; learning; and ergonomics.

4.1 Performance, Efficiency & Satisfaction

Performance was evaluated through users' personal satisfaction and whether they thought their performance had improved rather than any predefined performance measures, such as call times or resolution rates. This was because Computerland did not monitor the user's performance in this way.

Participants were asked if they noticed any difference in the way they did their job with the monitor setups; if they liked or disliked any particular aspect of the setups; if they felt more productive, or if they felt the setup had adversely affected their performance, efficiency or satisfaction levels. Participants were also observed as to how they used their monitors for example – how many applications they had on screen at one time, how they navigated around these (either using the mouse or alt+tab), how they transferred information from one application to another, and how they logged calls from the phone – either onto a pad of paper or directly into software.

The overall results showed that participants preferred the Dual and MLD™ monitors over the traditional single screen. Table 4.1 below shows the overall results from the

final interview where participants were asked to rate their first choice of monitor setup that they would choose to use on a daily basis. The table also shows the results from when Participants were asked to choose one of either the Single vs. Dual, Dual vs. MLD™ or MLD™ vs. Single.

Table 4.1: Participant Choices of Screen Displays					
Participant	**First Choice everyday use**	**Single v Dual**	**Dual v MLD™**	**MLD™ v Single**	**Screen After Research [1]**
P1	Dual	Dual	Dual	MLD™	Single
P2	MLD™	Dual	MLD™	MLD™	MLD™
P3	Dual	Dual	Dual	MLD™	Single
P4	Dual	Dual	MLD™	MLD™	MLD™
P5	Dual/MLD™[2]	Dual	Dual	MLD™	MLD™
P6	Dual	Dual	Dual	MLD™	Single
Totals	Dual 5 MLD™ 1	Single 0 Dual 6	Dual 4 MLD™ 2	MLD™ 6 Single 0	MLD™ 3 Single 3
[1] users were not offered dual screen setups after the research completed					
[2] found it too hard to choose between the two					

The dual screen was the overall first choice for nearly all participants. The Dual and MLD™ were both preferred over the single setup 6-0. The harder choice was when participants were asked to choose between the Dual or MLD™ screens. Participant 5 found this a particularly hard choice and had to say "both" when asked what screen was

his first choice, but then when asked again to choose between the MLD™ and Dual, chose the dual screen for its ease of use. All users could see the benefits of the dual and MLD™ setups. What was surprising was that P2 and P4 both chose the MLD™ over the dual screen and P2 choose the MLD™ as the screen she would like to work with everyday.

This was surprising because in initial meetings with ComputerLand management they had expected dual screens to be the overall clear-cut first choice as they perceived them to be easier to use and less of a learning curve then the MLD™ monitor – which management were unsure of at first. Managers choose the dual screen as their final choice for all users. The reasoning behind this was that the dual screen setup would be the most suitable for the widest range of people as it was the most adaptable and accepted solution.

4.1.1 Personal satisfaction

All users agreed that their personal satisfaction levels increased when using the MLD™ or Dual screen when compared with the single display - for all 6 users the Single Display was the least favourite setup.

P3 was asked about user satisfaction when using the Dual screen setup and replied "I am happier now then I was last week with one monitor (P3)". After reverting back to the single screen, P3 remarked how difficult it now felt to work on a single display. He said: "it's really cumbersome… that it has become very difficult to look at two sets of information at once having gotten used to having both screens. So it's *very* difficult".

In contrast P3 found that the MLD™ hampered his satisfaction and performance to the point where he turned the back screen off and used the MLD™ as a single screen. P1 and P6 also turned the back screen off on the MLD™ at some stage in the two weeks that they trialled it. The reasoning behind this was when they had a lot of applications open at once (during one observation P6 had 21 applications open) they found it hard to try and navigate around them on the MLD™'s dual layers and decided it would be easier to just turn the back screen off and revert to a single screen.

P2 really liked using the MLD™ and made numerous comments such as "I like your screens" and "I don't know how I did it on the normal screen now!" P2 liked the MLD™ the best overall and choose it as her first choice of screen setup.

Participant 4 liked the added screen real-estate that the dual and MLD™ setups provided. In the first two weeks he trialled the dual screen. In the second phase he trialled the MLD™ and then he reverted back to the single screen for the final two week period. P4 had a varied approach as to how he used his monitor with all 3 setups. When he was first observed on a single screen pre-trial he used all applications in full screen mode, when using the dual he had full screens on both displays (Figure 4.1 below), and when he had an MLD™ he used a four corner method (Figure 4.2 below). Then when he reverted back to a single screen after the research period he used a tiled window approach where he would have four programs open and all visible on the one screen (Figure 4.3 below).

Figure 4.1: Participant 4 – Dual screen
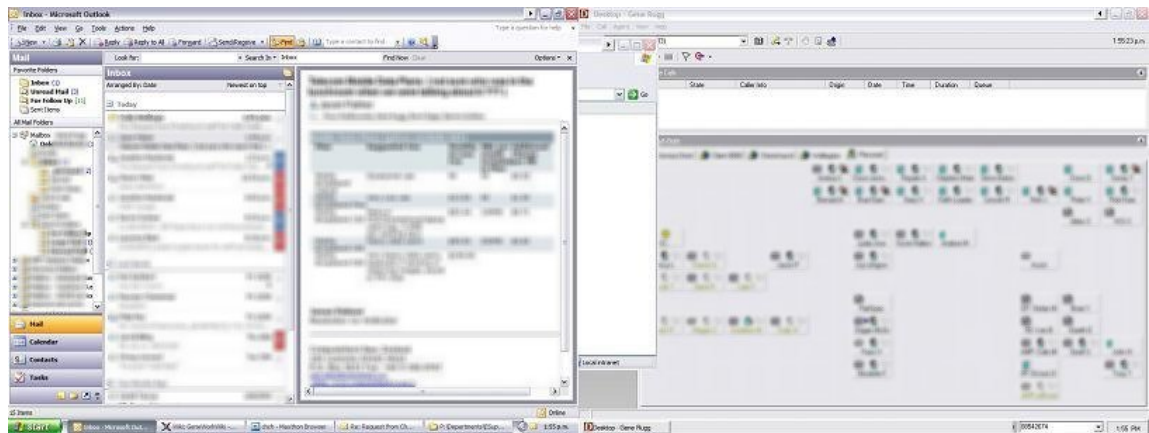
With the Dual screen P4 gradually extended his workspace to spread the applications across to the second screen, as illustrated in Figure 4.1 above. He continued to use it in relatively the same way he had with the single screen by either using the mouse to open or alt+tab to move between open applications. All applications were in full screen mode.

Figure 4.2: Participant 4 – MLD™ – Four corner method
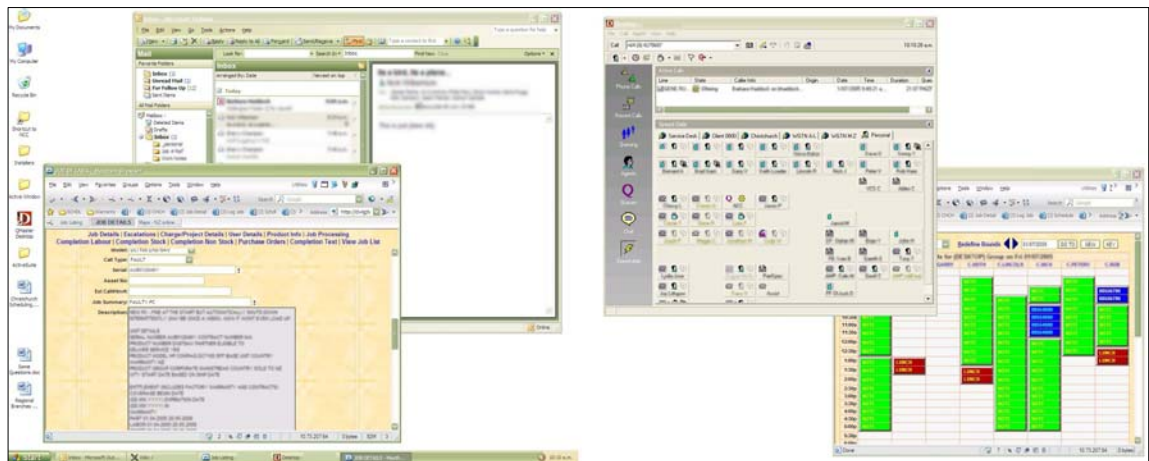
Figure 4.2 shows how P4 used his MLD™ monitor. As opposed to his use of the dual screen setup where he extended what he had done with the single screen, with the

MLD™ monitor P4 radically changed how he managed his open applications. As you can see he ran applications as tiled windows which were layered to overlap with the MLD™'s front and back layers. The transparency of the MLD™'s layers also allowed him to see *through* the applications on front screen to the applications on the back screen. When P4 reverted back to a single screen he continued using the tilled window approach, as can be seen in Figure 4.3 below.

Figure 4.3: Participant 4 – Single screen after trial
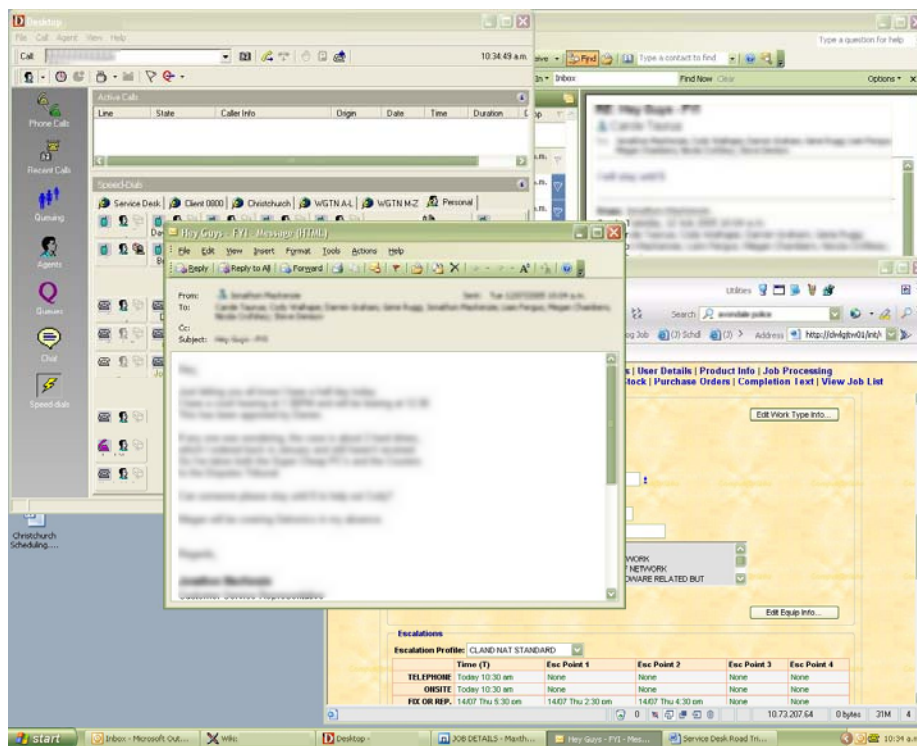
Participant 4 was the only user to radically change the way he manipulated the windows within the various display setups. Before he began the research trial he used his single screen with all windows maximised but after experiencing the added screen real estate of both the Dual and MLD™ he said he had to manipulate the way he used the single screen.

All Participants agreed that their subjective personal satisfaction increased when using the dual and for some users the MLD™ when compared with a single screen. Results also showed that participants' perceived performance and efficiency also increased when using the MLD™ and Dual screen when compared to a single screen.

4.1.2 Performance and Efficiency

All users thought the extra workspace of both the MLD™ and Dual screens made it easier to do their job. The added screen real estate of both the dual and MLD™ over the single screen, meant that users consistently had more information available to them which enabled them to complete tasks quicker, monitor other applications for incoming jobs (i.e. outlook for new email messages and phone management software for incoming calls and queue build ups), easily transfer data from one application to another and ultimately multi-task more effectively.

Multi-tasking

While some participants preferred one screen type over the other and a few had issues with some of the peculiarities of the setups all participants thought the dual and MLD™ screens increased their workable area or "screen real estate". Participant 2 was very impressed with the way she could effectively multi-task with the MLD™.

> *"I guess it's just very helpful and useful. I mean the normal screen; I guess it takes you a bit longer to do one thing at a time. Whereas with the multi screen you can actually do it all at once, like even when you're sending emails you don't just have to have the Outlook screen open you can have other screens underneath. So it's quite good (P2 in reference to her MLD™)"*

Having the secondary task information readily available made it easier for P2 to carry out her job; this is consistent with previous research by Morse (1979) which also found that readily available secondary information helped improve performance when completing a task. P4 also found his dual and MLD™ screens saved time because he no longer needed to alt+tab around his open windows to find things to cross reference because they were already visible on his second or back screen. This enabled the participants to quickly make decisions as they had all the relevant information that they needed in front of them at one time

Participant 6 found the "Multi tasking ability awesome" with the MLD™. I observed P6 on a call to a customer where he had Outlook open on the back screen and was talking the user through the problem using his outlook client as a guide. The call logging software was on the front screen and P6 was entering the call details into the job while helping the user on the phone. When observed in a similar situation on a single screen the calls were not logged into the call logging software until after the phone call had ended. Out of all the participants P6 consistently had the most applications open ranging from 7 to 21 open applications at any one time. Other users averaged around 8 open applications.

When asked whether the Dual screen had changed the way he did his job participant 6 replied that it had made it easier to manage calls:

> *"Yeah it's probably easier to manage calls, and easier to work on a call. Because you've got more, well you've just got more area and more possibilities of windows you could use at once especially if you're using it in tiles as opposed to full screen." [P6]*

Participant 6 found that when he reverted back to a single screen that it was very limited "I just don't have as much screen area as I used to". There was not as much screen area as he had become accustomed to with both the MLD™ and Dual and he could no longer just "flick and leave stuff open on the other screen". Everyday tasks where he could drag and drop changed. He was missing his dual screen when he reverted back to a single screen setup and if given the option would choose to use a dual monitor setup everyday.

Both the MLD™ and the dual screen setups increased the participant's multi-tasking ability and ultimately their perceived performance. This supports previous research (Hutchings et al, 2004; Czerwinski et al, 2003; Colvin et al, 2004) and is in line with Colvin et. al's, (2004) recommendation that multiple monitor configurations be used in any situation where multiple screens of information are an ordinary part of the work

Text on Text

The MLD™ screen received a very mixed response; some users loved the concept whereas other users were very negative towards it and could not comprehend how it would benefit them. The main objections were that it was confusing to read the screen when text was overlapped with text. Participant 3 used the MLD™ as a single screen for most of the 2 weeks by turning the back screen off. Three of the participants P1, P3 and P6 all turned the back screen off at some stage of the two weeks that they were using it. P3's job role was different to all the other participants in that he was primarily transferring data between Excel and Outlook.

Issues arose over "text on text" where both the front and back screen of the MLD™ had lots of text. This caused words to be mixed up or obscured by the overlapping text. The main person who had this problem was participant 3. Participant 3 was SLA Target Manager and his job consisted of monitoring the reports exported from JobTrack into Microsoft Excel and then transferring the data into Microsoft Outlook by "cutting and pasting". This was ok on the dual screen where he could drag the text from one screen to the other but on the MLD™ he could not clearly read the text and so turned the back screen off effectively working on a single screen. Participant 5 also had issues with this and also turned off his back screen – this could also have been attributed to the fact that he had not made his desktop white and was getting distortion from the colour on the desktop – this was not picked up until late in the two weeks that he was using the MLD™.

Other participants liked the fact that you could read through the front screen to the back but their jobs were not so "text" focused there was a lot more "white space" on their applications which made it easier for them to see through. Participant 2 commented that the MLD™ made it easier to do her job as she could monitor the phones and read emails all whilst logging a job.

Monitoring Applications

The Dual and MLD™ monitors assisted the participants in monitoring applications. For example, when there is a queue on the phones the phone queue flashes red or alternatively emits a sound to alert managers/helpdesk workers to the fact that there is a queue building. P1 previously had the audio alert on as he was not able to monitor the

phone queue while working on other things; however, with both the Dual and MLD™

setup he was able to turn the audio alerts off. During the MLD™ trial, P1 was observed

writing emails in Outlook on the front screen and monitoring the phone queues on the

back screen.   When the phone queue went red it was noticeably flashing in the

background – he was able to view the queue and continue with his work without having

to flick applications open and closed.   While P1 preferred the Dual screen setup, he

noted that this feature of the MLD™ was very useful.

P2 also mentioned how useful the MLD™ was to assist with monitoring the email

inbox, phone software and Job queue:

> *"I guess I don't open up as many windows and its very helpful when
> you are scheduling because with the desktop [phone software] screen
> open while scheduling a job and if there's hardly anyone on the
> phone then you don't really need to go on a break whereas with the
> normal screen you just automatically go onto a cup [break] every
> time. So that way it's helpful. And I don't get a lot of chance to check
> emails so I've had the desktop [phone software] screen behind or the
> Outlook one. And the JobTrack [job logging] one in front. So it's
> very helpful to have the 3D screens. Better then the normal screen!!
> <Laughs> it's so much easier, it's a lot easier "(P2 in reference to
> her MLD™)*

Participant 5 was surprised to find that he missed his MLD™ when it was taken away

and he was given his a standard 17 inch monitor back. "I'm not happy you've taken

away my toy!" he said.

Transferring data from one application to another

While P3 did not like the text on text issue that the MLD™ created for him. He was very impressed with how the Dual screen setup made it easier for him to complete his work:

> *"I was able to pull information a lot easier from one program to another. From Excel to JobTrack. I was able to read multiple screens of JobTrack. I was able to compare things a lot more easily"(P3 in reference to his MLD™)*

Data was easily transferred from one application to another by dragging and dropping or cutting and pasting. This was easy to complete as it did not involve any minimisation of applications as they were already both visible. All participants were observed transferring information from one application to another at some stage of their observation period. All users said it was easier to do this on dual screens. It was not as easy with the MLD™ as the participants still needed to bounce the mouse into the right location, unlike the dual screen where this was easy.

The two managers were both of the opinion that it was very hard to monitor the performance of the participants as this would involve constant supervision and effort. Manager 1 said that "it's very hard to monitor the performance of our staff because you would have to sit and time them and we don't do that sort of thing". As there were three different job roles being monitored it would also have been difficult to compare the results of one participant to another as their job roles were not comparable. What occurred was more personal satisfaction, comfort and "happiness" rather than a performance improvement that could be monitored. Manager 2 stated that she had noted a personal satisfaction with how the participants were using the monitors.

"I think they have, once they've got used to it, they've actually, most of them, have enjoyed having the added advantage of seeing more on their screen at once (Manager 2)"

Perceived performance and efficiency clearly increased when using the dual screens. The added screen real estate of both the dual and MLD™ over the single screen meant that users consistently had more information available to them which enabled them to complete tasks quicker, monitor other applications for incoming jobs, easily transfer data from one application to another and ultimately multi-task more effectively. While the extra workspace of both the MLD™ and Dual screens made it easier to do their job some participants did have some difficulty with learning some of the utilities and quirks of each setup type.

4.2 Learning

While learning was not originally a focus in the research it proved to be a very important aspect. Learning is a large and varied field so I tried to focus on the user's ability to "pick up" and learn the different technologies and utilities rather then the intricacies of how and why people learn. The findings are structured under the headings of MLD™ and Dual Screens. A considerable portion of the learning to do with the MLD™ and Dual screen setups was to do with the utilities that were required for them to run effectively. The section also discusses the Dual screen utility MultiMon and the MLD™ utilities, MLD™ Mouse and MLD™ window.

4.2.1 MLD™

The concept and use of the MLD™ was new to all participants. Some picked it up easily (P2, P4, P5, P6), whereas others (P1, P3) struggled with it. The jobs of both P1 and P3 are centred on text-based applications and the layering effect of the MLD™ caused difficulties with reading text placed over text. However, it is unclear the influence of this on learning.

P4 described the difference between learning how to use the MLD™ and the Dual screen:

> *"There is a learning curve and it is annoying for the MLD™ one. Though with the dual you just sort of adapt… you just slowly overflow and just slowly progressively get better at it. While with the MLD™ you have to very quickly be able to hide things so you can show other people what's going on, on your screen." (P4)*

P4's comment above was in reference to the fact that if you are not directly in front of the MLD™ screen the objects on the front layer may block objects on the back. P6 also referred to this as being similar to "steering with a play station remote" whereby you move your head to look around objects.

MLD™ Utilities

With the MLD™ there were two utilities provided by Pure Depth for participants to use; the MLD™ Mouse and the MLD™ Window. The first utility was the MLD™ Mouse – this was to enable the middle click or scroll button to push the mouse between the two layers and thereby save time from having to move the mouse across the screen as you

would have to do on a dual screen setup. The second utility was the MLD™ window which allowed users to change the transparency and opacity levels of the open application windows. This let the user's control how much they could "see through" the MLD™.

The MLD™'s dependency on utilities may have caused issues with how quickly participants picked up the technology. The Utilities that were required to get the added functionality out of the MLD™ were not fully developed and prevented some users from learning the MLD™ fully. Participants found the utilities hard to learn and said they were not user friendly.

MLD™ Mouse™

MLD™ mouse was a utility that allowed the mouse to be "bounced" back and forth between the front and back screen. It also allows applications to be moved back and forth between the monitors if the mouse's scroll button was clicked while on an un-maximised windows title bar. P3 found this utility particularly hard to use:

> *"Being able to bounce, yes. But I mean the flicking of the applications, was a problem... but I can quite easily... understand how to go between the two screens. It's just changing the screens backwards and forwards and reading them" (P3)*

This resulted in P3 turning the back screen off and using the MLD™ as a single screen for most of the two week period that he had the MLD™.

The middle scroll button on a "wheel" mouse is used for scrolling in windows and when combined with the MLD™ Mouse utility which used the scroll button for moving

between screens some of the participants found that they were trying to scroll down or up in a window and would bounce to the front or back screen.

> *"I made a phone call yesterday when I was trying to type something in an email cause I had the wrong screen highlighted and I just hit enter cause I thought I was going down to a new line and I hit enter and I was actually on the back screen so it dialled the last number I dialled. (P1)"*

Interestingly I observed P2 continuing to use the MLD™ mouse on her dual screen setup, so instead of moving the mouse from one screen to the other she would click on the scroll button and bounce to the second display screen. When I asked her why she was using it this way she said it saved having to flick the mouse to the other screen but that she hadn't realised she was still using the MLD™ utility. She had just naturally adapted it to the dual screen environment for both bouncing the mouse and applications between screens.

The main comment from both P4 and P5 on the MLD™ Mouse was that they would have found keyboard shortcuts useful. P5 has had issues in the past with using the mouse too much and tries where possible to use the keyboard shortcut keys, he noticed while using the MLD™ that he was "feeling" his wrist more.

MLD™ Window™

The MLD™ window utility allowed users to control the level of transparency in the open windows. This would allow them to be able to see through open windows to what was on the back screen or on the other hand, to not be able to see through them. Similar in theory to Multi-blending (Baudisch & Gutwin, 2004) MLD™ Window "blends" the

front screen into the back screen by altering the opacity and transparency of the front display.

P1, P2, P3 and P6 all tried and disliked the MLD™ Window utility – with various comments ranging from "I wasn't fussed on it (P1)", "tried it but didn't really use it (p2)" to "I tried that but found it wasn't really me (P3)" and "I didn't like it so didn't use it day to day (p6)" These participants who are all in IT technical support roles found the MLD™ window difficult to use.

Participants 4 and 5 both tried and found the MLD™ window a useful tool, but a tool that needed some major improvements before it would be of any real benefit. P4 was in the second group to trial the MLD™ screen and was given an "updated" version of the MLD™ window by the Puredepth team. The second version allowed the user to set the opacity/transparency level by holding down the Control (Ctrl) button on the keyboard and moving the mouse to the left to decrease, or right to increase the opacity levels of the windows.

> *"I preferred the first version of it where it just cut everything out*
> *because the second version where it sort of made everything go white*
> *rather then just making the things less opaque in behind. That was just*
> *frustrating. Oh and with that one you hold down ctrl and you move the*
> *mouse and all of a sudden everything just disappears! Cause your*
> *always like copy paste and like shifting around. Oh it was amusing!*
> *(P4)"*

The use of the mouse and ctrl keys were also confusing factors for participants. In Windows the ctrl button is a key function tool and is used as a shortcut key for cutting text (Ctrl + C) and pasting text (Ctrl + V) and for moving around in documents; so when participants tried to do a ctrl function and move the mouse they found that the

transparency of the windows would change and they would then need to reconfigure the MLD™ widow to the right transparency level. I witnessed this on a number of occasions and this caused a number of disgruntled noises from participants.

For example on an occasion when P5 was using the MLD™ window tool, he was trying to cut and paste and then accidentally made the opaqueness level of the window grey, he made a frustrated noise and yelled "I don't know how I did that or how to change it!". While P5 had some issues with both utilities, he still considered both of them to be essential in order to run the MLD™ properly.

The MLD™ is an "impressive" technology. It generated a lot of interest in the research organisation and the participants had "visitors" who came to have a look the "cool screen" in the service centre. General impressions were that the MLD™ was cool and on a number of occasions the participants, particularly P2, would say how much they liked the "cool screens" or P5 made the comment that I had taken away his "cool toy". Bishop (2005) also noted the novelty factor of the MLD™ in her research, saying that it had the "ability to impress anyone that experiences it".

4.2.2 Dual Screens

The dual screen setup was easier to learn then the MLD™ because it was just an extension of what the users were already used to doing. There were no new utilities for the mouse or opaqueness levels and the learning curve was not as steep. Two of the

participants (P1 and P6) had used dual screens in the past and the other 4 participants all said that they picked it up easily.

As discussed in the MLD™ section above P4 described the difference between learning how to use the MLD™ and the dual screen. With the MLD™ it was a new concept to learn where as with the Dual screen set up it was adapting what you already did to spread over two screens.

Dual Screen Utilities

While the concept of dual screens was easy to learn some of the irregularities of the dual screen setup had to be learnt by users.   The taskbar along the bottom of the screen is only active on the primary monitor. For the dual screen setup participants were not offered or told about utilities. However in the first morning of using the Dual screen setup P4 had searched on the internet and found a free utility called MultiMon that would enable the taskbar to extend across both displays in a dual screen environment.

In Microsoft Windows operating systems when dual screens are enabled the taskbar along the bottom of the screen is only active on the primary monitor. See Figure 4.4 for an illustration. In Microsoft Windows when using dual screens you only have one taskbar on the primary screen, (in this case the left screen). If you have applications open on the second/right screen they will show up on the primary screen taskbar.

Figure 4.4: Example of Dual screen inconsistencies
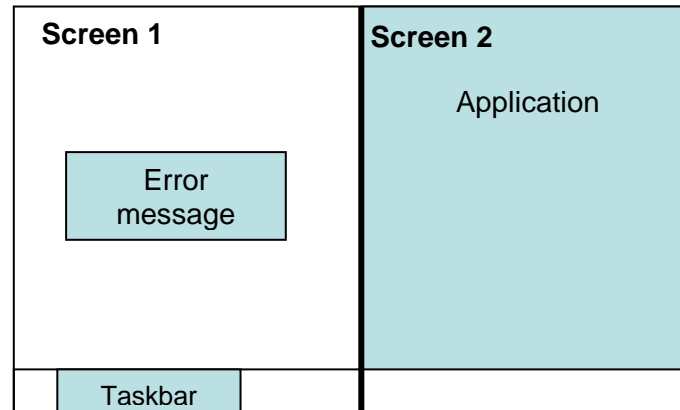
So when you maximize an application from the primary monitor (screen 1) it may appear on the second screen. Error messages from the application on screen 2 can also pop up on screen 1 and can be missed or confusing for users.

This was the cause of frustration for P4. P4 downloaded a free screen management utility to manage the taskbar on dual screens. His reasoning for this was that when learning how to use the dual screen he had to "think" about where applications were. He also said it was confusing when a pop up error message from an application on screen 1 would appear on screen 2. The application P4 downloaded was called MultiMon. MultiMon is a utility application that puts a taskbar on the second screen and allows you to assign applications to each screen. What MultiMon does:

- It adds a second taskbar to the extended desktop on Monitor 2 (either right or left)

- It shows only applications from that Monitor

- It hides the applications on Monitor 2 from the normal Windows Taskbar

- Adds a "Move to Monitor" button to all windows applications.

- Adds a Text Clipboard Extender

(http://www.mediachance.com/free/multimon.htm)
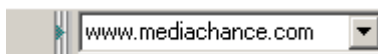
P3, P4 and P5 all installed MultiMon. The main reason these three participants installed the utility was to know what screen an application was on when maximizing a screen from the taskbar. Participant 5 stated that he installed MultiMon "just to know what application is on what side. Cause it's really confusing if you don't. I found that too hard." This is a known issue with Multi-screen environments. Grudin (2001) emphasises that applications are not developed for multi-screens and as such pop up windows can open in unexpected places; which was witnessed on a number of occasion's over the six week period of observation (as diagrammed in Figure 4.4 on page 64 above).

Another issue with the dual screen setup was moving applications between the two monitors. The Move to monitor button on each application window was the MultiMon solution for this.

> *"That's one reason why I got MultiMon. I mean the whole un-maximise move it over maximise was just I, I personally just find that Grrrr (P4)"*

When asked why he felt he needed MultiMon, P3 responded:

> *"Just because I found that I wanted to know where programs were. I found that with the original toolbar I was unsure when clicking on the minimised icon where the program was, on which screen it was and I believed at the time that MultiMon would show me which [programmes] were on the second screen (P3)"*

Screen management tools like Multimon are becoming more common as users try to battle their display space management issues. In Bishops' (2005) research users had either dual screens or dual screens with "Hydravision" which was a display space management tool. Research into multi-screen environments with and without management software like MultiMon, have shown that they are significantly easier to use then single screens (Colvin et al, 51, 2004).

P3 found the dual screens easier with MultiMon. MultiMon also had a cut and paste tool incorporated into it which allows users to see the last 100 cut and paste tasks that he had performed. When P3 reverted back to the single screen he found a cut and paste clipboard tool that sits on the taskbar

> *"I found that once it wasn't there I needed something to compensate for it so yeah I then had a search around I don't know if the one I got is the best but it's certainly a help (P3)"*

P2 said the dual screen setup was easier to learn then the MLD™. Again this came down to the utilities that had to be learnt with the MLD™ in order for it to be easily picked up and learnt.

4.3 Ergonomics

The participants were all asked if the setups caused them any ergonomic discomfort such as sore wrists or necks, headaches, or eyestrain. The MLD™ caused some ergonomic issues such as extra usage of the mouse, and two users thought it was hard on their eyes. The dual screen caused one participant to develop a sore neck, and one user thought the screens were too bright.

MLD™

Before the research was underway the main concern that all participants and managers shared was whether the MLD™ would cause users to experience any ergonomic issues. It was decided that if a participant felt that they were developing any ergonomic problems that they could stop using the monitor setup and revert back to a single screen. The main concern with the MLD™ was the effect the monitor would have on participant's eyes and whether it would cause eyestrain.

Of the six participants, two users complained of eyestrain. P4 initially commented in his first interview that he was starting to suffer from "very minor " eyestrain from using the MLD™ but in the following observations and final interview admitted that he had gotten used to using the MLD™ and that eyestrain was now no longer a problem. P1 also commented that the MLD™ monitor was very hard on the eyes.

The MLD™ monitor also caused ergonomic issues for some participants as there was extra usage of the mouse. The MLD™ Mouse utility allowed users to move or "bounce" the mouse between the front and back screen by clicking on the middle scroll wheel. This utility was invented so that users of the MLD™ screen would not have to flick the mouse to the left side of the screen so that it would move onto the back screen – which is a function of windows to allow for dual screen usage. While this did prevent users from flicking the mouse from side to side P5 complained of a sore wrist whilst using the MLD™.

"I think I noticed with the 3D one that I was using the mouse a lot more. Dual screen didn't seem to be increasing my amount of clicks by using the mouse a little more. But the MLD™ I did notice. Well it was the clicking all the time, clicking when you switch between screens or things like that" (P5)

P6 also noted that extra mouse movements were necessary in order to use the MLD™ to its full potential and suggested that keyboard shortcuts would perhaps be a better option – a suggestion shared by P5. Whilst observing P6, I noticed that when he had multiple applications and windows open on the back layer he found it hard to bring them to the front. He suggested that there may be a "Keyboard shortcut" that could bring a window to the front and minimise all others. Both P5 and P6 agreed that they prefer to use keyboard shortcuts such as <Alt> +<Tab> to move around in Microsoft Windows.

"I'm using the mouse a lot more, which I do have to be careful of, if there were keyboard commands it would cool. Because I'm a keyboard person so I do prefer [the] keyboard then [the] mouse because it's quicker" (P5).

Grudin (2004) found that multiple monitors limited the need for <Alt+<Tab> keystrokes, interestingly the MLD™ increased this need. P4 noticed that the back layer of the MLD™ appeared fuzzy. This has also been documented on www.xyz.com when they did a review of the MLD™ screen.

"A Side effect of the Puredepth design is the blurring / darkening effect on the background display. The foreground LCD—even if set to a blank, white (transparent) image—slightly blurs and shadows the image of the background LCD."
(http://www.xyzcomputing.com/index.php?option=content&task=view&id=283&Itemid=2&limit=1&limitstart=3).

A large number of participants in Bishop's (2005) research also noted that the MLD™ was "sometimes unclear or out of focus". Bishop (2005) attributed this to the fact that

the light has to travel through the rear layer to reach the front layer. Bishop (2005) suggested that the rear layer may not be suitable for fine detail such as text.

The other participants had minor ergonomic concerns:

- That the MLD™ had to be straight on to your eyes because otherwise you were looking around the front screen icons to the back screen. Both P1 and P6 commented on this. P6 said "I've been looking over the top and going around the side, which is a little like steering with a PlayStation remote"

- Surprisingly while P3 had major issues with viewing Text-on-Text he admitted that the MLD™ caused him no ergonomic issues.

- P6 admitted that it was "more hassle then discomfort" with the MLD™

As a side note, P2 found the MLD™ screen improved her ergonomic setup. She commented that with a single screen she was getting eyestrain but that with the MLD™ there were no ergonomic or OSH factors. P2 could not explain why this happened just that she felt the MLD was easier to read and caused less eyestrain.

Dual Screens

P3 loved his dual screen setup but on the first 3-4 days it caused him to get headaches from the brightness of having two LCD monitors side by side. This was rectified by turning the brightness levels down on both monitors. After this he had no concerns with the dual screens.

P4 had ergonomic concerns with the dual screen, mainly because of the shape of his desk. The desk was in the shape of a "jelly bean" and had a small monitor stand at the back of it.   Both LCD screens would not fit on the monitor stand and so one was set up on a shelf to the right of the other one. This caused him to be moving his head to the right constantly and he gradually developed a sore neck as a result. Over the weeks he rearranged the set up of the monitors so that they were more centred.

> *"During that week it became very vivid that its all right, everything's right and I was getting a bit of a sore neck... it was just more that your comfort, you know how you sit naturally, there was natural [Head to front] there was slightly odd [moves head to right].(P4)"*

Participant 4 also noted that he was used to 17" monitors and two 15" LCD's side by side seemed small even though he had double the space. He also interestingly taped the two screens together as there was a gap between the top of the two screens. He didn't like the look of the screens angling away from each other.

Other users had no ergonomic concerns with the dual LCD screens.

The monitor setups were monitored for ergonomic discomfort. The main concerns regarding ergonomics were increased mouse usage with the MLD™ utilities, minor eye strain with the MLD™ and a sore neck from the dual screen setup.

5. CONCLUSIONS

This chapter will conclude the research based on the above findings and make recommendations for the best screen setup for helpdesk workers. An implementation plan will also be offered for helpdesk management. The implications of this research on the intended audience will be discussed as will further research possibilities.

5.1 Overall Conclusions

This section will be structured under the following three headings: Performance, Efficiency & Satisfaction; Learning; and Ergonomics.

5.1.1 Performance, Efficiency & Satisfaction

The extra workspace increased user's perceived performance, efficiency and satisfaction. This is comparable to previous research into productivity (Colvin et al, 2004; Czerwinski et al, 2003) which showed a marked increase in productivity and task completion time when users were equipped with two screen displays.

The added screen real estate of both the dual and MLD™ over the single screen meant that users consistently had more information available to them which enabled them to:

- complete tasks quicker,
- monitor other applications for incoming jobs
- easily transfer data from one application to another; and
- multi-task more effectively.

There was a noticeable increase in user's satisfaction levels when using the multiple monitors. Users were happy with the MLD™ or Dual screen setup and when they had to revert back to the single screen noted that it felt cumbersome and hard to use. Managers also noticed an increase in personal satisfaction when the participants had more screen real estate.

With the Dual and MLD™ users had secondary information readily available, they were able to view multiple screens and applications and readily transfer information between them. They found that the multitasking ability was increased which allowed them to complete work quicker and more effectively.

5.1.2   Learning

Dual screens were easier to learn than the MLD™ monitor. The Dual screens were easier to learn as it was just a matter of overflowing applications from one desktop to another. The participants gradually spread their work over onto the second screen.

An aspect of the dual screen environment that some users found hard to learn was where applications were situated within the dual screens. Three of the participants who used the MultiMon utility to extend the taskbar across both screens found that it helped them to adjust to using the dual screens and eliminated some of the guess work as to which screen applications were on.

MLD™ utility applications were required to effectively use the MLD™ screen. The dependency on the MLD™ utilities hindered some user's performance to the point

where they did not want to use the MLD™ and turned off the back panel. There were some big issues with the MLD™ when it came to users learning and using the MLD™ utilities. Most users came to grips with the MLD™ mouse but the MLD™ window was harder for them to pick up. The combination of the ctrl button and mouse movement to the left or right to change the opacity of the windows conflicted with some already predefined keyboard shortcuts which caused some abnormalities to occur. In the end the users stopped using this utility because it was too hard for them to learn and adapt into their workflow.

Overall the learning involved with the Dual screen was minimal and allowed participants to use the technology quickly. In contrast the MLD™ was a totally new concept for users and required greater thinking as to how to use it. It also had the added complication of having to adjust to the layering and transparency effect.

5.1.3   Ergonomics

The ergonomic setup of the Single, Dual and MLD™ monitors was important to compare as this is a vital factor when deciding on an ideal setup.

The MLD™ caused some ergonomic issues:

- **Extra usage of the mouse -** which caused two users to develop sore wrists. The main usage of the mouse came from the MLD™ Mouse utility which allowed users of the MLD™ to bounce the mouse and applications between the layers. Without this tool it was possible to move applications to the other screen but it was time consuming and troublesome for users. It was suggested that instead of

the mouse utility that keyboard shortcuts be devised to eliminate the need for so much usage of the mouse – thus limiting some of the ergonomic impacts of the MLD™ monitor.

- **Text on Text** - The layering of the MLD™ screens which put text behind and on top of other text was hard on some of the participant's eyes. It caused the text to overlap and become unreadable. The MLD™ is not suitable at this stage for heavily text focused work.

The ergonomics of the dual screen monitor setup did cause minor considerations for some users because they had to keep moving their head from left to right continuously. This shows the importance of workstation design and screen placement when setting up a new monitor.

Overall the ergonomics of the Dual and MLD™ displays were good. There were a few participant specific issues that occurred but they were generally isolated and not generalisable to all participants.

Based on the above conclusions I have made recommendations for the best monitor setup for helpdesk environments.

5.2   Recommendations

At the conclusion of this research I recommend the following display set-ups for IT helpdesk workers:

First choice: Dual Screens

Second choice: Multi-Layer Display

Third choice: Single Screen

5.2.1   Dual Screens

Dual screens proved to be the best screen setup choice for IT helpdesk workers. The main reasons are listed below:

- **Cost effective -** Second or dual head graphics cards are relatively cheap to buy and LCD's are getting cheaper too. This means that it now relatively inexpensive to install an extra monitor on someone's desk and you can have them up and running in 20 minutes.   Buying an extra LCD display (you can buy a Dell 17 inch monitor for NZ$329 online as at 30/10/2006) is cost effective when compared with the price of the MLD™ (was around US$1900 when it was available to the market).

- **Most preferred option by the widest range of people** (both users and management).

- **Users were satisfied using this setup and felt they could complete their jobs quicker as they could see more of the information they required to complete their tasks**. The increased screen area allowed users to see more information at one

time and made it easier to cut and paste or transfer information from one application to another.

- **Managing multiple applications and remote sessions was easier.** Users could simultaneously log calls whilst running a remote connection to a client's computer or server without having to minimise all open applications to find the correct one.

5.2.2   Multi-Layer Display

The MLD™ was not as favoured by users or management as the Dual screen and could not be deployed to all users as a complete solution. As such the MLD™ would be the second choice of screen setup after the dual screen. The reasons are listed below:

- **Text on Text difficulties.**   Text intensive work such as word processing or numerical spreadsheet documents are not suited to the overlay approach of the MLD™. The Text becomes unreadable when there is too much text on the front and back layers.

- **Utilities.** The MLD™ utilities need further development. The MLD™ mouse and MLD™ Window needed to be redefined to make them easier to learn and use.

- **Expensive.** The MLD™ is still a new technology and the cost is still relatively high when compared to standard LCD's, as discussed above.   This will deter organisations from implementing MLD™'s at this stage.

With adjustments to utilities, applications development and more research this display could become a valuable work tool for helpdesk environments in the future.

5.2.3 Single Screens

The single screen was the least desired because:

- **Not enough screen "Real Estate"** for Helpdesk workers to effectively complete their tasks. The jobs can be completed quicker and easier on a dual monitor.

- **Users do not like using a single display after experiencing Dual or MLD™ environments**. Users' satisfaction levels were low when they reverted back to a single screens after experiencing the Dual and MLD™ setups.

5.3 *Implementation plan*

The following is an initial guide for helping create an implementation plan if help desk management want to implement a dual display environment for their organisations.

Equipment. Depending on your hardware specifications you may need to install a second graphics card or a dual head graphics card. If installing the second graphics card, don't forget to enable it in the computers BIOS. The display will then need to be extended to the second display in the display properties settings. This tells the computer that you have attached a second screen and allows you to configure which monitor you want to be the primary or secondary screen. The primary screen will contain the taskbar at the bottom.

Choose the right LCD. Do you want two 17 inch monitors side by side or a dual screen with a shared base to save desk space? Since this research was completed 24 inch wide screens have also become more common. This could also be an alternative to two LCD screens as two application windows can sit side by side comfortably on these monitors.

Staff Training.   Some training will be required at the set up stage.   This will be dependent on the individual user and their ability to learn the new setup. Training is important to ensure that all users are happy with their setup.

Change Management. It is important to note that not all users will react favourably to a change of their workspace. It will be worth the effort noting user's grievances with the intended setup. In my research I have found that most help desk workers are more than happy to be given a second or larger monitor.

Minimise Ergonomic Impacts. Workspace ergonomics should be considered when implementing dual screens. Do the desks have enough room for two screens side by side? Will the screens cause users to have to move their heads from the left to right continuously or will they be looking straight on? It would be beneficial to conduct workspace assessments for all users once a new setup has been implemented.

5.4   Implications & Future Work

This section will discuss the implications of this research and any future research for IT helpdesk workers, IT helpdesk managers, the HCI community and developers of software and hardware.

5.4.1   IT Helpdesk Workers

The reasons for helpdesk workers to change to dual screens is compelling. The advantages of a dual screen setup for IT Helpdesk workers are:

- More information on screen;

- Easier to transfer information between applications;

- Easier to multi-task;

- Quicker to complete tasks.

Schedulers: Schedulers will be able to see schedules of the technicians and the list of jobs that they have to assign at once. This will enable them to quickly make decisions as they will have all the relevant information they need in front of them at one time. Dual screens or Multi-Layer displays would be advantageous for this type of work.

SLA Target Managers: This role is the most text focused out of all of the roles observed. As such this role had major difficulties with the Multi-Layer Display where text on the front screen was obscuring text on the back screen and making it unreadable. The Dual screens are the ideal set up for the SLA Target Managers as it enables them to be able to cut and paste information easily from one screen to the other without having to minimise and maximise open applications. This allows the work to be completed quickly and more efficiently.

Analysts: The Analyst role is the easiest to compare to other IT helpdesk roles in other organisations. They deal directly with customers on the phone fixing their IT queries. The analysts generally have the most applications on screen at once and are more often then not dealing with multiple things at once. As such the Dual and Multi-layer screens allow the analysts to multi-task more effectively and see more of the information they need at once.

Future Work: Faster work completion time - comparison testing.

This work would compare the task completion time of specific IT Helpdesk jobs comparing time taken against the screen type used – single, MLD™ or Dual. The participants in this study said that the Dual and in some cases the MLD™ screen setups allowed them to complete their tasks quicker. It would be beneficial to compare the time taken to complete standard IT Helpdesk tasks on the different screen types. This research would be quantitative to give more statistical research findings.

5.4.2 IT Help Desk Management

IT helpdesk managers ultimately want their staff to perform to the best of their ability. With dual screens user satisfaction increased, subjective performance levels increased, participants were happier and felt they were more effective in their jobs. When using the screen setups themselves, management said the dual screen setup would allow managers to monitor the phone queues easily whilst continuing on with their own work.

This research along with previous research (Hutchings et al, 2004; Czerwinski et al, 2003; Colvin et al, 2004) into screen setups and productivity begins to show that dual screens make users more productive.

This research highlights that management needs to be very aware of the impact of the physical environment on their staff's performance. It also indicates attention needs to be given to different ways to monitor performance in an IT Helpdesk environment.

Future Work: How to monitor performance?

In order to really measure the performance of IT Helpdesk workers we first need to determine the best way to measure performance. What is the best way to measure performance? Some companies use statistics to measure success such as, number of calls logged and fixed at first tier. Some companies use client satisfaction, call throughput, calls logged, calls fixed. Different companies have different ways of measuring performance. This will of course be dependent on the company and their own SLA agreements with customers. Should there be a standardised performance monitoring for IT helpdesks so that companies can comparatively compare their success? Effort can be made to get finer grain, more precise measurements, such as the ability for a Helpdesk worker to multi-task by logging calls directly into software while on a call.

5.4.3   The HCI community & Developers

The designers of both hardware and software need to be aware when designing applications and new technology that their product could be used with multiple screens or multiple layer technology. Furthermore, this type of usage is likely to increase. There were a few abnormalities when using both the dual and MLD™ monitors.

The concept of the MLD™'s dual layers was new to everyone. First time users had to understand the theory behind it and then adapt how they used their mouse and keyboard to the new technology. Not only did they have to learn to read through screens, but they had to learn new utilities for the mouse and transparency functionality to work.

The MLD™ also caused some ergonomics issues, mainly overuse of the wrist due to the increased mouse clicks from using the MLD™ mouse utility. Careful consideration of ergonomic impacts should also be considered when designing new hardware and software.

Dual screen technology in Microsoft windows while supporting multiple displays did not support multiple toolbars – users had to download additional utilities for this functionality.

Future Work: MLD™ in real life environments

The MLD™ was not initially developed for office-based work. It was very interesting to see how the IT Helpdesk staff adapted the technology to their situation. It would be beneficial to conduct more extensive research into how and/or if an MLD™ screen could be used everyday within an office environment. The issues surrounding the MLD™, such as text on text and its effect on learning, could be looked at to see how and if this could be overcome. Future research in this area could include a larger scale project involving general office workers rather then specifically IT helpdesk workers. This would allow the research to be made more generalisable for all users rather then specifically IT related.

Future Work: Mouse Click Comparisons:

Some participants felt that the MLD™ Mouse utility increased the amount of "clicks" they made on their mouse and caused them to develop sore wrists. During my research

it was hard trying to analyze if participants were using the mouse more with one set up then another.

 It would be interesting to compare the "clicks" used in an MLD™ vs. a Dual screen setup. Technology such as keystroke/mouse click software, or video analysis could be used to gather data to analyse the difference in the amount of clicks for each screen type. It would also be interesting to analyse if there was more head movement with a particular set up and does this contribute to any ergonomic factors?

This research would help to identify any ergonomic impact of the MLD™ or Dual screen setups on Helpdesk workers and allow developers to develop ergonomically friendly software and hardware.

Future Work: MLD™ Blurring Effect

It would be beneficial to investigate the blurring effect that the MLD™ layers have on the image quality. Bishop (2005) attributed this to the fact that the light has to travel through the rear layer to reach the front layer. This blurring effect was noted by not only by participants in this study but also participants in Bishop's (2005) research and also on a technical website that reviewed the MLD™ technology (www.xyz.com). In order for this technology to be used for detailed text or graphic work this should be investigated further by the MLD™ designers to see if they can minimise this effect.

5.5 *Wrap Up*

The main objective of this research was to compare the difference between the use of a single screen, a dual screen and the new Multi-Layer Display (MLD™) and the complications of having multiple applications and multiple monitors operating at one time for IT Helpdesk Workers. This research looked at how the users monitor setup influenced the performance, efficiency, satisfaction, ergonomics and learning of the participants.

The research showed that there was a clear dislike of the current set up of single screens; all participants felt that the single screen setup limited what they could do at once and it rated the least favourite of all. The dual and MLD™ screens showed positive outcomes for increasing multitasking abilities and raising user's perceived performance and satisfaction levels. The added screen real estate of both the dual and MLD™ over the single screen, meant that users consistently had more information available to them which enabled them to complete tasks quicker, monitor other applications for incoming jobs, easily transfer data from one application to another and ultimately multi-task more effectively. While there were some minor ergonomic concerns and learning difficulties surrounding the unique features and utilities of the both the dual and MLD™ monitors, participants still preferred to use these setups over the single screen. While the MLD™ is an impressive technology I do not think it is quite at the stage where it could be offered as a complete solution for everyday use by all IT Helpdesk workers. This research has shown IT helpdesk workers and management the importance and impact of monitor setups on their work performance and satisfaction levels.

It is therefore envisaged that the above research will assist the IT helpdesk community to create more efficient work practices and help IT Helpdesk workers to be more satisfied and productive in their work. Also, the HCI community and designers of hardware and software in these areas will get some additional feedback on the effects of their work and research on the way people work in real life environments.

In doing this research I personally have learnt some valuable skills regarding research design, data collection and most importantly data analysis. Having never undertaken a project of this size before it has shown me the importance that good planning plays in the success of your research. This research has also shown me that something that most people would consider a minor detail – the monitor you use - can in fact have a major effect on your performance and satisfaction levels.

6. Appendices

Appendix 1: Consent to Participation in Research

Title of Project:	**Monitor setups for helpdesk workers: A comparison study**
Project Supervisor:	**Dr Philip Carter**
Researcher:	**Sarah Whalley**

- I have read and understood the information provided about this research project (Information Sheet dated 26/04/2005.)

- I have had an opportunity to ask questions and to have them answered.

- I understand that the interview will be audio-taped and transcribed.

- I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.

- If I withdraw, I understand that all relevant tapes and transcripts, or parts thereof, will be destroyed.

- I agree to take part in this research.

- I wish to receive a copy of the report from the research: tick one: Yes   O   No   O

Participant signature: ....………………….

Participant name: …………………………………………………………

Participant Contact Details (if appropriate):

…………………………………………………………………………………..

…………………………………………………………………………………..

…………………………………………………………………………………..

…………………………………………………………………………………..

Date:

**Approved by the Auckland University of Technology Ethics Committee on 03/05/2005
AUTEC Reference number 05/72**

Note: The Participant should retain a copy of this form.

Appendix 2: Participant Information Sheet & Research Design Information

Participant Information Sheet

Date Information Sheet Produced: 26/04/2005

Project Title: **Monitor setups for helpdesk workers: A comparison study**

What is the purpose of the study?
The purpose of the study is to investigate different workstation setups for helpdesk environments. The research will compare how different monitor setups - single, dual and Multi Layer Displays - affect user performance, user efficiency, user satisfaction and ergonomics. The Study will be the basis of a Master's Thesis.

What happens in the study?
Your Workstation may be modified to include a Dual monitor or a Multi Layer Display. At various times over a six week period, there will be an observer taking notes while you work. You may be asked questions during the process (where appropriate) and possibly again after the session. These will be recorded on audiotape. You may decide to stop at any time without adverse consequences.

What are the discomforts and risks?

It is expected that the new monitor setup will be less of a physical strain then the current setup, although there may be a chance that some users may not find the setup ergonomically suitable for them. If strain (for example eye or neck strain) is excessive, monitors will be reverted to normal working conditions.

How will my privacy be protected?
You will not be personally identifiable in the final report. All information collected, notes, questionnaires and audiotapes will be securely stored at AUT. The material will be destroyed when no longer of use for its original purpose.

What are the costs of participating in the project? (Including time)
It is expected that you will have 4-6 weeks full time use of the monitor setup with observation and interviews taking approximately one to two hours each week.

Participant Concerns

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor.

Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC, Madeline Banda, madeline.banda@aut.ac.nz , 917 9999 ext 8044.

Researcher Contact Details: Sarah Whalley, sarah.whalley@watsonwyatt.com , 021 444 906

Project Supervisor Contact Details: Dr Philip Carter, phil.carter@aut.ac.nz, 917 9999 ext 5300

Research Design

Every participant tests each setup

	Wk1-2	Wk3-4	Wk5-6
Participant 1	Single	Dual	MLD
Participant 2	Single	MLD	Dual
Participant 3	Dual	Single	MLD
Participant 4	Dual	MLD	Single
Participant 5	MLD	Single	Dual
Participant 6	MLD	Dual	Single

Each two week schedule will follow this format:

Week 1, 3, 5	
Day 1 - Monday	Observation
Day 2 - Tuesday	Observation and interview
Day 3 - Wednesday	-
Day 4 - Thursday	-
Day 5 - Friday	Observation
Week 2, 4, 6	
Day 6 - Monday	Observation
Day 7 - Tuesday	-
Day 8 - Wednesday	-
Day 9 - Thursday	-
Day 10 -Friday	Observation and interview remove/install setup

Observation
During observation I will sit beside you and note how you utilize your monitor layouts.
I may ask you to take a screen shot of the layout (all identifiable data will be edited out) .
Observation will take less then one hour per session.

Interviews
Interviews will take approximately 15 minutes and will be digitally recorded.

If you have any questions or problems please give me a call – Sarah – 021 444 906.

Appendix 3: Observation Check Sheet

Participant Observation
Participant #
Monitor   Single ❑   Dual ❑   MLD ❑
Observation   1 ❑   2 ❑   3 ❑   4 ❑   5 ❑

Time	screen	code	Description

Appendix 4: Frequently Used Software – codes for observation

Observation Codes

Software	Description	code
Jobtrak	job logging software	JT
Outlook	Email system	OL
Notepad	Microsoft notepad - electronic	NP
Zeacom Queue master	Phone System	QM
Remote Sessions	remote link to external computer	RS
Knowledge Base	Web based knowledge database	KB
Citrix	Citrix session	CT
Windows Explorer	Windows folder management	WE
Internet Explorer	Internet	IE
Word	Microsoft Word	WD
Excel	Microsoft Excel	XL

Physical	Description	code
Pen and Paper	Physical notebook	PP
Phone	using the phone	TP

Monitor	Description	code
Monitor 1	Left Montior	M1
Monitor 2	Right Monitor	M2
Front screen	Front layer of MLD	FS
Back screen	Back layer of MLD	BS

Appendix 5   Interview Questions

Participant #:
Monitor   Single ❑   Dual ❑   MLD ❑
Interview   1 ❑   2 ❑

Recording # _____

What applications do you have on your second monitor
have you been using any utility software?
        MLD – mouse
        MLD – window
        Dual - MultiMon

Efficiency

Did you notice any change in the way you do your job?

Was it harder or easier to complete?

Are you more productive?

Learning

Was it easy to learn?

Ease of Use – is it easy to use? User friendly?

Have there been any inconsistencies where you thought it would do one thing and it did
something else.

Satisfaction

What do you like about your current monitor setup?

Would you recommend it to others?

Do you have any issues with your current monitor set up?

Ergonomics

Do you get any physical discomfort from your current set up?
- Headache
- Eyestrain
- Neck ache
- Shoulder ache

What would you change about the set up?

Performance

Comments??
If you had to choose now between MLD, Single or dual??

Appendix 6:   Final Interview Questions

Friday 22ⁿᵈ July 2005

Participant #:
Monitor   Single ❑   Dual ❑   MLD ❑
Interview   1 ❑   2 ❑

Recording # _____

What applications do you have on your second monitor
have you been using any utility software?
     MLD – mouse
     MLD – window
     Dual - MultiMon

Efficiency

Did you notice any change in the way you do your job?

Was it harder or easier to complete?

Are you more productive?

Learning

Was it easy to learn?

Ease of Use – is it easy to use? User friendly?

Have there been any inconsistencies where you thought it would do one thing and it did something else.

Satisfaction

What do you like about your current monitor setup?

Would you recommend it to others?

Do you have any issues with your current monitor set up?

Ergonomics

Do you get any physical discomfort from your current set up?
- Headache
- Eyestrain
- Neck ache
- Shoulder ache

What would you change about the set up?
Final Questions

Over the last 6 weeks you have had the chance to trial 2 new setups

If you had to choose now between MLD, Single or dual??
Main reasons why:
-

-

-

Single – Dual
Dual – MLD
MLD – Single

Performance:

How do you think this setup increased your performance compared with the other setups?

Efficency
How were you more efficent?
Some examples

Satisfaction

Was learning a factor in how satisfied you were with the setup

Utilities
- MultiMon   Y/N

- MLD Mouse   Y/N

- MLD Window   Y/N

Ergonomics
Did one set up have more of a detrimental effect on you then the others and what were the effects?

What set up suited you best and why?

Interview Questions - Manager's
Friday 22nd July 2005

Did you notice any difference in the way the participants were working?

Have they made any comments to you about any of the setups?

Have there been any noticeable improvements in performance?

If you were to choose a set up for your teams which one would you choose?

- Single
- Dual
- MLD

Reasons:

Comments from the last 6 weeks:

Appendix 7: Observation Data

Round 1 – Observation Data

Round 1 - Day 1 Observations 13/06/05
1 hour observations

Main findings

- **Single** P1– lots of swapping between screens. Mainly between OL and JT. Noted that he would like dual screens so that he could keep and eye on the call queues in Desktop queue master.

- **Single** P2 - lots of swapping between screens. Mainly between OL and JT.

- **Dual** P3– really likes it. Has an open SS which contains info on jobs that have been open for a long time on monitor 1. On monitor 2 has Job track and Queue Master open. This allows him to copy and paste text from the .xls report into an email to follow up the call. Also used a physical note pad to jot down notes as he was using the phone. Says that it will be good because you don't have to keep minimising all the time. –installed MultiMon in the afternoon.

- **Dual** P4 - Has installed SW called MultiMon. This puts a tool bar on the second screen and allows you to assign applications to screens. M1 has job track and email. M2 has the phone system. Noticed that he put some windows over both screens so that half of each window was on each screen.

- **MLD** P5– finding it quite difficult to control the windows. Came and asked me why the windows were going grey? He had clicked on something by accident and it had caused the windows to have a grey background and made the screen look really dark. He was not running the active window utility. Once he ran this it allowed him to set the windows with a level of opaqueness. He can turn the opaqueness off and on as he wants. Figured out that he has been double clicking instead of single clicking. Also need to have the window active and the mouse on the header but on the opposite layer. He doesn't think that text on text is too much of an issue it is just trying to control the windows and deciding what window is on the back or the front that is causing him problems at the moment.

- **MLD** P6 – AWAY
-

Round 1 - Day 2 Observations 14/06/05
30 minutes observations

Main findings

- **Single** P1– Mainly using OL. No as only using one application.

- **Single** P2– using as she did yesterday. Mainly between JT and OL QM opens up all the time when new calls come in. 9 open windows. Cuts and pastes by flicking between screens.

- **Dual** P3– Installed MultiMon yesterday afternoon. Uses arrows on toolbar to swap application to other monitor. Copy and paste data from S1 to S2. 5 open windows. S1 = 3 S2 = 2

- **Dual** P4– dragging and dropping. Sometimes has two sessions of job track open – job on one and scheduling on the other. Using the MultiMon toolbar. Cutting and pasting using one screen as a reference screen.

- **MLD** P5– able to log into a RS and unlock passwords by reading through the front screen to the back screen. Eg password file is on the back and the RS in on the front. "really cool". JT Is set to opaque – when using the long lists he says it looks "icky". 7 Apps (screens) open. Uses Alt + Tab to move to another application. Writes lots of notes on paper. Says he hasn't logged some of those jobs. JT open in FS OL in BS – reading through logging job and copy and pastes into JT. Accidentally made the opaqueness Grey – frustrated noise. "don't know how I did that or how to change it!! Text on text not really and issue. "This is Handy" reading through JT at OL and typing in to JT. Minimised all windows – only has OL open. Found a couple of cool uses – but not many.

- **MLD** P6– AWAY

Interviews completed.

P6 Observation 1 16-6-05
1 hour observation

Main findings

- **MLD** P6– "multi taking ability awesome". Using the mouse but prefer keystrokes for moving between layers. Has his windows start bar on the top of the screen like a Mac – using the restore and minimise all when having issues with viewing. Transparency is 100%. Using copy and paste function between layers. Moves QM on the back window to a different spot to see it better. Has trouble with the mouse when trying to pick up a call. Doesn't have active mouse utility working. Starts active mouse and says its heaps easier. screens are not maximised – i.e. they are at different sizes and can be seen through and around. Minimises applications that are not In use.

Round 1 - Day 3 Observations 17/06/05
30 minute observations

Main findings

- **Single** P1 – AWAY

- **Single** P2 - . Mainly JT and OL QM opens up all the time when new calls come in. 5 open windows. Cuts and pastes by flicking between screens.

- **Dual** P3 – S1 = QM, OL, IE, WE, XL S2= IE. Mainly cutting and pasting between XL and OL or JT. OI is on S1 but when he opens a new msg it opens up on S2. mentioned that he has been getting a headache. Has made the desktop black and minimises S2 when not in use. Thinks it might be the extra glare from the second monitor.

- **Dual** P4- S1 = JT OL S2= QM, WIKI, JT. Has Job Track on both screens. Using cut and paste between screens. Drags and drops from JT on S1 to JT on S2. uses alt tab to move between applications.

- **MLD** P5 – FS = clear. BS = OL. Apps open = OL IE QM CT. copies and pastes between layers. Tires to go into a Citrix session but loses where the mouse is. Has a RS open on BS and is reading through the RS into JT. Notes that the mouse utility would actually be better as keyboard shortcuts. Mostly uses apps in full screen. is using the mouse utility to move between layers. Does some frantic clicking to move screen to front, says he just randomly clicks until it does what he wants. Is getting a sore wrist from using the mouse more used to alt tab. Noticed he has changed the primary desktop to the BS to stop the icons on the Desktop being in the way all the time when they were on the FS - which was "a pain in the ass"

- **MLD** P6 – OBSERVATION #2 1 hour. – FS clear. BS QM JT. Using mouse utility to move between layers. When typing in NP mouse accidentally moves to FS moves it back. Has to move his head to see around a desktop icon to the text on the layer behind it. Minimises all screens to get clear screen. moving apps between layers and copying and pasting between them.   On call to user - Has OL open on BS and is talking user through an OL problem by using his OL as a guide JT is on FS and is logging call at the same time. Uses alt tab to move to another application.

Interviewed P6

Round 1 - Day 4 Observations 20/06/05
30 minute observations

Main findings

- **Single** P1 – AWAY

- **Single** P2 - Mainly JT and OL QM. 6 open windows. Cuts and pastes by flicking between screens. Has print outs of jobs that she uses as reference.

- **Dual** P3 - has 4 applications open S1= OL XL JT QM. S2= JT. New email msgs open on S2. mostly copy and paste from s1 to s2. important to note that P3 does not log calls. His job is to monitor open calls and follow up on call resolutions. He does this by exporting call data per client from JT into excel. From here he sorts the information and either emails or calls the tech/customer.

- **Dual** P4 – has 6 applications open. S1= OL JT PDF   S2= Wiki JT QM. Swaps between OL JT & QM. Cutting and pasting between applications and monitors.
  - Issues: moved the screens on the desk so that they are more centered, they had been positioned to the left.
  - Is used to having a 17" monitor – so the two 15" that he is using he finds small. Even though he has double the space. Said he would like to have more then one window on each screen ie OL have a msg open as well as

the inbox so that he could read both but finds it too hard with the 15" monitors.

- o Graphics on both monitors appear to look different. S1 is really clear and good colour, S2 looks a bit pixilated Has brightness set to different for each screen because they seem different. Both monitors are the same make and model.

- o When trying to close an application on S1 the mouse moves over the and goes onto the next screen. this can be a pain.

- **MLD** P5 – 8 applications open. FS= clear BS= OL. Open = OL, IEx2 QM RS Ctx2 XL. Screens are open in full screen on the BS. does not bring any layers forward for make them different sizes. Goes home sick.

- **MLD** P6 – 11 applications open. OL QM NP JTx2 XL IEx2 MSg CMD Reporting. using full screen on FS. Only has one thing open at a time.
  - o Is using as a single monitor because he had too much open and it was a pain. Was considering turning the back layer off.
  - o When he has multiple things open on the back layer finds it hard to bring to the front, may be a "Key" that could bring a window to the front and minimise all others.

Round 1 - Day 5 Observations 24/06/05
30 minute observations

Main findings

- **Single** P1 – AWAY

- **Single** P2 – same as above

- **Dual** P3 – same as above.   Using the MultiMon arrow function to move applications between screens.

- **Dual** P4 – same as above.

- **MLD** P5 – apps open =8. using predominately as single monitor. But does utilise the layers occasionally when the situation is called for. E.g. typing into JT from OL (OL on BS, JT on FS) Noticed that when he moves the mouse to the side it goes too far and slides onto the back or front screen.

- **MLD** P6 –   Using only as single layer. Uses layers when remotely connected.

Final Interviews conducted (P2-P6)
Swap Over around 3.30

- **P1** Single →Dual
- **P2** Single →MLD
- **P3** Dual →Single
- **P4** Dual →MLD
- **P5** MLD →Single
- **P6** MLD →Dual

Round 2 – Observation Data

Round 2 Day 1 Observations 27/06/05
1 hour observations

Main findings

- **Dual** P1– S2 only has QM. This enables him to monitor the call queues. Using as a single screen – eg open apps = 8, 7 on S1 and only 1 on S2. Wont put anything else there as he wants to constantly monitor the calls. This has allowed him to turn the audio alerts off. Will not install MultiMon.

- **MLD** P2 – had to adjust her settings so that the effect was right:
  - made the desktop white
  - showed her how to enable MLD Mouse utility – had to ask P6 how to use it.
  - P6 also helped her first thing in the morning when she arrived at work at 7.30am so that she knew the basics.

  Was beginning to understand the concept. Really liked it – though not sure if it was just the novelty factor.

- **Single** P3 – AWAY

- **MLD** P4 – Asked if I thought the back screen was fuzzy? Using the Mouse utility well, flicking between front and back screen, cut and pasting between. Has 4 open apps they are split between the FS and BS. All windows are transparent.

- **Single** P5 – DID NOT OBSERVE

- **Dual** P6 – hasn't installed MultiMon. 10 applications open. S2 primarily for OL.
  - Clicks on OL icon on S1 taskbar but it is already open on S2
  - Moves Citrix session over to the next screen but it splits in a strange way. I.e.: green is open window:
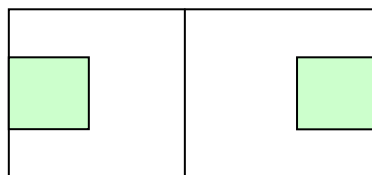
  - opens Ol new msg – OI is on S2 new msg opens on S1 "grr get over there" as he moves it back to S2.
  - Mouse looks a little crasy like above diagram when he moves his mouse from S2 over the edge it moves to S1??

Round 2 Day 2 Observations 28/06/05
30 minute observations
5-10 minute interview

Main findings

- **Dual** P1– S2 only has QM. Same as above. Has used dual screens before and prefers them. Would like to work with one all the time.

- **MLD** P2 – mouse utility was not started – couldn't figure out why she couldn't move the mouse to the BS. she is getting the concept very well. Is experimenting with how to layer the screens. Tried lots of options. Installed new mouse and window utility.

- **Single** P3 – AWAY

- **MLD** P4 – Asked him not to install SW. had tried to download a transparency utility!! Told him that there is a PureDepth one already and that I can install it today.. Not using as full screen applications, can see the desktop icons down the side and has OI and JT open on the FS and QM on the BS. Is using the mouse utility to move between layers. Installed new mouse and window utility

- **Single** P5 – Missing MLD. "you've taken away my toy I'm not happy!" lots of flicking between screens has all windows maximised so can only see one application at a time. Cut and pasting between applications requires alt + tab to move between applications. Has 7 applications open.

- **Dual** P6 – OL & NP on s2. kind of using S1 as a single screen with the second monitor for OL.


Interviews conducted.

PureDepth

- New features if MLD Mouse- need to right click on the mouse button and click on the scroll button to push the window back. Must have the mouse cursor on the title bar.
- New active window functions: press ctrl and move the mouse cursor to the left or right to adjust the window opaqueness or transparency. This will now set the transparency level for all open windows on the front screen layer.
- Left me the CD to install at the next swap over.

Round 2 Day 3 Observations 1/07/05
30 minute observations

Main findings

- **Dual** P1– Using the same as last time. S1 for apps, S2 for QM. When there are calls queuing the queue group turns red. Only wants to use it like this.

- **MLD** P2 – using the new mouse utility to flick between windows. Not using active window. 7 apps open. BS = QM   FS= JT. When in JT screen with lots of writing minimises OL in the BS so she can read it. Still printing out jobs to read them.   Asked her about the text on text issue and she said its not a problem.

- **Single** P3 – Is missing his dual screen panels. Lots of flicking between by clicking on the icon on the taskbar. All in full screen. 4 apps open.

- **MLD** P4 – Applications are laid out in a special way as below. Screenshot emailed to me. Transparency is set to 100%. Using the mouse utility well. Active window is not activated – sent me an email of issues with the utilities.
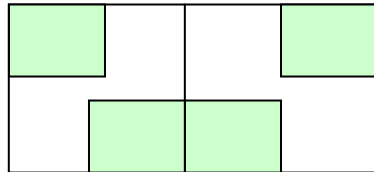
- **Single** P5 – AWAY

- **Dual** P6 – NOT OBSERVED – was not working on anything.

-

Round 2 Day 4 Observations 4/07/05
30 minute observations

Main findings

- **Dual** P1– AWAY – not at his desk all morning

- **MLD** P2 – 6 apps open. JT on Full screen. opens QM on BS. Sometimes forgets that QM is on the BS and tries to open it again by clicking on the taskbar.   Using both layers. OL is on BS. When trying to read msg minimises JT on the front.

- **Single** P3 – SINGLE SCREEN

- **MLD** P4 – 6 apps open. Swapping between layers and applications using mouse utility. Cut and paste between apps.   Using layout as he was the other day in the titled crossover effect.

- **Single** P5 – SINGLE SCREEN

- **Dual** P6 – 7 apps open. Rearranging his desk, moved his phone from the left to right side of his desk. Opens i.e. on s2 and has a RDT session on S1. reading from website and on s1 and working on S2. opens another website and then copies info from to JT.

Round 2 Day 5 Observations 8/07/05
30 minute observations

Main findings

- **Dual** P1– AWAY

- **MLD** P2 – 6 apps open. BS = QM, FS = JT. Opens OL on BS closed JT to see better. When opens a MSG in OL it opens on the FS. Using mouse utility really well. "I like your screens". Using both layers well and moving around between with mouse. Every now and then she closes all apps and then opens what she wants.

- **Single** P3 – 4 apps open. Using in Full screen. has to switch between by using the task bar. Lots of copying and pasting – has installed a clipboard tool that remembers things that you have copied. Found after having used MultiMon.

- **MLD** P4 – 6 apps open. BS = QM, JT FS=OL, JT. Still using tiled format. All transparent 100%. Copying and pasting between screens.

- **Single** P5 – is really missing his MLD. Made several comments about it. Has 13 applications open. Lots of swapping between screens.

- **Dual** P6 – 21 APPLICATIONS OPEN!!

Final Interviews conducted (P2, P3, P4, P6)

Swap Over around 4.30

- **P1** Dual → MLD
- **P2** MLD → Dual
- **P3** Single→ MLD
- **P4** MLD → Single
- **P5** Single → Dual
- **P6** Dual → Single

NOTE: need to interview P1 on Monday11th.

Round 3 – Observation Data

Round 3 Day 1 Observations 11/07/05
1 hour observations

Main findings

- **MLD** P1– AWAY

- **Dual** P2 – 8 applications open. Still using the MLD mouse to move between S1 and S2.

- **MLD** P3 –   still trying to grasp the concept. Showed him how to use the mouse utility. Needs to understand that they are like two screens and that if you have all the applications on the FS then you wont be able to see through them unless some of them are on the BS. 5 applications open.

- **Single** P4 – 4 apps open. Cutting then opening email, back to Jt pasting, back to email cutting back to JT pasting.

- **Dual** P5 – 7 applications open. Alt tabbing around. MultiMon is installed- said it was driving him crazy not knowing which screen the applications were on. JT is on S2 a JT popup window opens on S1 moves this to S2 using the MultiMon arrow utility.

- **Single** P6 – Missing his dual screen. all screens maximised. 11 applications open. Using the taskbar to navigate.

JobTrack was down most of the morning so not much work could actually got done as they were unable to log or update any calls.

Round 3 Day 2 Observations 12/07/05
30 minute observations
5-10 minute interview

Main findings

- **MLD** P1– AWAY

- **Dual** P2 – 6 apps open. Showed how to move apps to the other screen, they need to be in minimise mode. "its actually quite good when you get an email to log a job. You don't have to keep going back and forth". Copies and pastes from email into JT. Mentions again how good the screens are.

- **MLD** P3 – TRAINING – will observe and interview on Thursday

- **Single** P4 – apps open 6. applications set up in a strange way – screenshot emailed to me.

- **Dual** P5 – S1 = QM CT OL APPSERV. S2= JT 6 applications open
Citrix remote session opens over both screens "raises hands" "huh". Using Ol on S1 and JT on S2 still using paper to write notes. Remote desktop session on S1, using JT and email on S2 to log and update job during the remote

session. Using alt tab to move around – eg. Moves MSG to screen 1 using MultiMon utility. types into JT copies A+T to msg pastes A+T back into JT. Primarily using JT on S2.

- **Single** P6 – 11 applications open. Lots of flicking between screens. Mainly the two XL spreadsheets and JT. Cutting and pasting between these. Using keyboard shortcuts.

Interviews NOT conducted. Was too busy to take people off the phones interview everyone on Friday

Round 3 Day 3 Observations 15/07/05
30 minute observations
5-10 minute interview

Main findings

- **MLD** P1– OBSERVATION 1: Has been turning off the BS when wanting to concentrate. Using mouse utility to flick between the BS & FS. Using opaqueness' tool but doesn't like how it doesn't keep the setting when you login the next time. Only putting QM in the BS. Didn't have a problem setting up because he had see how the other users had set up. Likes reply text because it is blue and he can see it better. Text on Text is not really an issue – getting used to it.

- **Dual** P2 –5 apps open. S1= JT S2= QM – half screen OL – full screen. using the MLD mouse to flick between dual screens. S2 is for QM and OI – new MSG's open on S1.

- **MLD** P3 – Only using as a single monitor.

- **Single** P4 – SINGLE

- **Dual** P5 – 13 applications open. Trying to solve a mail merge issue so has Word open on S1 and Excel on S2.

- **Single** P6 – AWAY

Interview – (p1,p2,p3)

Round 3 Day 4 Observations 18/07/05
30 minute observations

Main findings

- **MLD** P1– FS = OL BS = QM. Always has QM on BS. In OL sorting emails, the queue went red in the background and it was very noticeable. Checks the red call queue while writing his email. All apps are in full screen so when he clicks on an app in the FS it takes over the full screen.

- **Dual** P2 – As above.

- **MLD** P3 – Using as a Single Monitor. Flicks between apps by clicking on the taskbar. Using copy and paste utility.

- **Single** P4 – 6 apps open. Browser is split into frames – 1 open ie session on the taskbar may have 4-6 windows open. Marathon browser. Can see parts of all 3 open apps at once. As above.

- **Dual** P5 – All apps full screen. S1 = OL S2 =JT. Citrix remote session on S1 email on S2. working from email on S2 fixing issue on S1.

- **Single** P6 –AWAY

Round 3 Day 5 Observations 22/07/05
20 minute observations
10 minute interview

Main findings

- **MLD** P1– Using as single screen.

- **Dual** P2 – 5 apps open. When she clicks on a new MSG or to open a MSG it opens in full screen on S1. Opens a website to view warranty info on S1

- **MLD** P3 – using as a SINGLE screen, back screen is turned off. Gets reports downloads exports to Xl. Uses pen and paper to take notes.

- **Single** P4 –5 apps open. Set in grid again. Flicks between apps by clicking on the corner of the grid. Can see 3 apps at once.

- **Dual** P5 – 9 apps open. Used MultiMon to move OL to S2 opens a RDT session on S1 working off email on S2. Opens KB on S2 reading from KB working on S1. Moved OL back to S1 logging job from OL on S1 into JT on S2.

- **Single** P6 – 16 apps open. All apps full screen. uses taskbar at top to flick between apps. Uses keyboard shortcuts all the time. Flicking between OL and JT

Final Interviews conducted – P2's interview corrupted. Will email her a copy of the questions and she will email them back to me on Monday.

Managers Interview

Remove Setups
- take out dual cards – Leaving in 3 graphics cards – three MLD screens will be left down there.

Appendix 8: Observation and Interview Data Analysis Spreadsheets

**Observation and Interview Data Analysis Spreadsheets -
Single Screen**

	Single	
	+	**-**
P1	ERGONOMICS: No	just the number of windows … the number of applications I have running um constantly having to check phones … check phone queues because of also the role of being a team leader I have to keep an eye on what calls are coming in and the availability of staff to answer them. … And that's probably that and emails cause we have a constant flow of both, as you've probably seen.
P2	ERGONOMICS: No	I gather when its really busy your constantly looking at it all the time… like 8 hours a day you know… um… I do have a few things open which … and … <pause>… you only have a specific time before you refresh the screen and then as soon as you go into it you have to refresh it and open up a new window…
		I know there's another tool you can use instead of doing that um. < pause> I guess I probably have a lot more open then other people. Um because I prefer to have the screens there then not there. So <pause>… I gather there shouldn't really be a lot I mean really you should only about 4 screens open. Where sometimes have about 8 … < laughs>… or 6 so I gather um <pause> cause sometimes when the phone rings and I've got two… if I'm logging a job I prefer not to use that job or you start from scratch again
		Happy with setup?: well I cant really change it
P3	ERGONOMICS: No	That its really cumbersome, that its very difficult to, that it has become very difficult to look at two sets of information at once having gotten used to having both screens. So its very difficult.
		dual or single?: DUAL
		Would you say in the last two weeks you've noticed more flicking and clicking between the applications and: yes, definitely.
		And with your cutting and pasting cause I noticed you have a tool to do that now which you had found because of the MultiMon function? P3: I found that once it wasn't there I needed something to compensate for it so yeah I then had a search around I don't know if the one I got is the best but its certainly a help.
		change in the way you do your job?: ah, yeah I'm defiantly doing that four corner type thing a lot more (Didn't do that before?) Not as much no I tended to have a couple of things maximised and
P4	ERGONOMICS: No	Yeah cause I just tend to need the three applications all the job logging stuff and that website and I just tab between them
		SATISFIED?: it's a thing of shuffling things round. So its OK but you have to shuffle things round. You end up like having that four corners I tend to have what I'm doing and what I'm looking at pushed to the far corners so its not overlapping so I can actually see what I'm doing. As opposed to the say with the two monitors where I would put it there [gestures to right] and I could have everything showing rather then just three quarters
		I just I actually do need to have four or five things on screen – not all at once – but within thirty seconds wanting to look at each of those five things
P5		Um, I miss the 3D one, surprisingly enough
		yeah no I do miss a few of the things I could do with the 3D which I cant do on the {single}
		MISSING MOST: probably the stuff where I've got JobTrack open in the front and I've got things behind it that I'm working on and I can just switch between the two very easily.
		…alt tabbing all the time and flicking screens all the time which is not as efficient because you forget what was on the first screen and go back and remember what the nest bit is whereas if its stuck behind you can simply look behind and keep typing. So that's what I've found probably the most annoying thing
		I would say I would have to choose the 3D ml whatever its called
P6		Yeah it's been very limited of course. Just don't have as much screen area as I used to. Cant sort of flick and leave stuff open on the other screen and what have you.
		yeah just the practise of everyday like dragging stuff around and things that you used to sort of yeah changed a little bit

	Dual	
	+	**-**
P1	Its good. Its good I like it. I like being able to leave something up that I need to monitor all the time	
	yeah monitoring the phone system because of , probably because of the situation I've got to sit in I've got to me able to see what staff are available and what calls are coming in.	
	EXTRA SOFTWARE INSTALLED?: NO No. I see more cause I get the full expansion of the window	
	would you say its changed the way you do your job?its just allowed me to actually have something going where I don't have to have a sound to alert me I can actually be visually alerted	
	SATISFIED?: : I actually like the dual screens and would prefer to have them all the time	
	ERGONOMICS: No. just have to move the mouse a bit further across.	
P2	It is very Handy. <pause> because for example on the right screen I've only had Desktop or Outlook and when you get a queued email on outlook if it hasn't got an attachment you can actually just click once and the details will show up on that screen and then on the left screen you can then go into jobtrack and log the job. You can just cut and paste and its a lot quicker. Whereas one screen is just backwards and forwards, it takes a lot longer to log the job. So yeah its very handy	LEARNING: Probably only on the first day how to move the , I think when I first started on the Monday, no the next day actually, I couldn't get the desktop screen to go over to that second screen behind [Outlook] but I know how to do it now.
	I'm still using the mouse software from the MLD screen	
	CHANGE IN THE WAY YOU DO YOUR JOB: yeah. A lot more efficiently, quickly	
	LEARNING: yeah, so I didn't really need much training.	
	USER FRIENDLY: Oh yeah. Definitely	
	EASIER TO LEARN THEN MLD: Yeah it probably is easier to learn	
	RECOMMEND?: I think everyone wants one! <laughs> Even people from outside the helpdesk have come in and said you know we all need two screens. So…	
	ERGONOMICS: No. [shaking head] not like the normal screen! (with the normal sceen - sometimes get eyestrain towards the end of the day)	
	MLD OR DUAL: um, I would probably choose the 3d screen cause the dual screen you have two screens. The 3d screen you can actually see through. Yeah you can open up as many screens as you like with the dual but you cant really see through.	
P3	P3 I find its a lot easier in the work that I do with excel spreadsheet on one side and JobTrack on the other. Its a lot easier just to both move information between the two and to um view the information side by side as opposed to having to role through applications	Just because I found that I wanted to know where programs were. Ahh I found that with the original toolbar um I was unsure when clicking on the minimised icon where the program was. On which screen it was and I believed at the time that MultiMon would show me which icons were on the second screen.. sorry which programs were on the second screen
	user satisfaction : yes I would say more then, I am more happy now then I was last week with one monitor	Most annoying: the most annoying thing was the eye strain I was having, however I have reduced the monitors the brightness down and that's sorted things out. And a tech told me and I didn't know this was that the factory settings on those are usually set to the maximum that they can set them. Yeah so it was advisable for me to just turn them down. And I've turned them a bit below the standard. And that's fine
	Best thing: Its been able to have the main application and the spreadsheet sit side by side	
	will you miss it? - Oh Yeah. God yes. Having to pop between Job Track and yes it will be very difficult	
	Um its just a lot easier to do the particular job I do	
	easy of use - easier to use? - It was never a problem in the first place, It was just instantly better	
P4	Yeah. Um I tend to have… I tend to be able to have well, obviously, things for reference and what ever I'm working on at the time in front of me at the same time rather then flicking between them. Just that ability to have that second monitor to put anything just for reference	Yes. But with a proviso. Because you need to have, you need to have it set up for the way that you work. There is a little bit of time that you need to sit down and go how do I use the applications cause you know like I said I have split Job Track into multiple windows. Someone else doesn't do that or they might have two windows open with Job Track and I don't know how that would work with two monitors. But if nothing else just to have that second monitor to have reference stuff is good.

		Dual	
		+	**-**
	No its actually been good, its actually like the time that I would spend alt tabbing between things and cross referencing and you know talking to someone and then id have to you know flick to you know this and then I got to flick back to the desktop and id flick back to this you know it is actually saving time		there are a couple of issues with having dual monitors like if you've got like two scrolly panes and your on this screen and you come over here and just scroll your still focused over here um and if your clicking on and all the task things here and things are popping this way it gets quite annoying
	Learning: I had to think about it a bit. That's one reason why I got that MultiMon. Is I mean the whole un-maximise move it over maximise was just I , I personally just find that Grrrr		Most annoying?: just the fact that windows isn't designed for two monitors. The fact that, I mean the taskbar we have to get a particular utility to do that. If you go minimise all the entire thing goes down rather then just one screen, which would be nice. Just small things really but they do get irritating. Um, that utility if your in outlook and you shift one email over it will take the whole lot
	Best thing? :Of using it, Um again being able to have multiple things on the go. Being able to, even just from the fact of while your writing emails, I've gotten to doing what the other guys were doing by having what your responding to on one side because when your forwarding you lose the email address which we kind of need and because we deal with so many clients we need to have their name up and when we forward we lose the whole email cause it gets put into the attachment. And having jobs open having the digital screens means that you can have something as a reference and swap between the two		
P5	CHANGE: Ah <long Pause>. I suppose a little bit. I've probably got more screens open at once that's probably been the biggest change.		INCONSISTINCIES: a little bit some of the screens I know it's a sort of catch 22 because sometimes screens appear on different sides and in JobTrack when you open some of the sub screens of it will pop up on the other side where it should actually be on that side cause you cant actually do anything on that bit anyway but so its not really an issue or anything like that. It's just that sometimes it really good when that happens as well so its sort of a ... what your trying to achieve yeah sometimes it's a good thing sometimes it bad so…
	PRODUCTIVE: yeah I reckon a bit more efficient		
	LEARNING: yeah had to look at two places, compared to the 3D yeah!!		UTILITIES: multimon flicking applications - yeah. And also just to know what application is on what side. Cause it's really confusing if you don't. I found that too hard
	Once again being able to see two separate screens is quite handy with JobTrack in one and shadowing a client or looking up stuff or whatever. It's just that handy ability to have two things open at once and be able to see both of them.		
	RECOMMEND: yeah		
	ISSUES: NO		
	ERGONOMICS: NO		
P6	yeah, much the same, its just obviously a different. Its quite cool as far as the features are concerned for copying between screens again once again as the old MLD3000. Quite good being able to see something there [points to left] and move it over to what you are looking at on the main screen.		The only thing as far as the bad things are concerned is it's a little bit of a pain not being able to switch you mouse between the two monitors. With that utility I don't know if it does that or not but it would be quite cool. You have to drag it around a lot, back and forth.
	SECOND SCREEN USED FOR: mostly Outlook and maybe browser windows. Sometimes Citrix windows		
	CHANGED THE WAY YOU WORK: yeah definitely yeah. speeds it up. Copy and pasting is easier. Better visibility. That's all		
	LEARNING: Yeah no worries		
	User Friendly: yeah no problems at all.		
	LIKES: yeah just increased desktop area is always good. Um copy and pasting is good, same again.		
	RECOMMEND?: yeah definitely yeah		
	ERGONOMICS: No, none at all		
	MLD OR DUAL: they've both got pros and cons. <pause> probably a dual screen I think to be honest		

	MLD	
	+	**-**
P1		Its very hard to use. It takes a bit of getting used to, but I'm slowly getting used to it
	I like being able to see the phones behind what your working with and not having to have two physical monitors. Its really nice having the phones in the background	Initially when I first started was working out which things to have on the back and the front screen. Getting used to the contrasting colours of it, getting used to reading things when you've got something behind it. Actually isolating because your used to having a white background. Just getting used to the fact that you've got something written there on top of something else and actually trying to follow the one your reading and not look at the one behind it as well
	where one catches your eye and you've got to look where as this one its all focusing in front of you and your doing something in an email or a spreadsheet and suddenly there's a, you see the red behind it and you just seem to change your focal point from the front to what's behind it. You seem to look further into it, I don't – it sounds weird but that's what I think you seem to be doing.	when you've got one in front of the other it can be a bit confusing on your trying to figure out whether its actually in the foreground or background.
	MLD MOUSE: No that was good	LEARNING?: well I've only been using it for two days so probably it's a new technology that's I'm not used to and its probably just the old scenario of your not used to it so you don't use it…
	LIKES?: I liked, once I figured out the opaqueness, just having the phones sitting in the background. Probably that's the main application I liked in the background and if anything happened on it I could see it and it made it noticeable to me.	CHANGE IN WAY YOU WORK?: a little bit. Not too much. Probably still working on the old double screen principle.
		I made a phone call yesterday when I was trying to type something in an email cause I had the wrong screen highlighted and I just hit enter cause I thought I was going down to a new line and I hit enter and I was actually on the back screen so it dialled the last number I dialled. Yeah so I've done that once
		It would be nice if I could take the background down probably need to play around with the brightness or something to actually dim it down so it only highlights more when its red.
		ERGONOMICS?: I had to lift it up a lot. I lifted the screen right up I've actually got up just about as far as it will go to get the height in it. Because I find if your straight on to the screen you tend to see the dual screens a lot better, then if you were standing up and you look down at it cause your on an angle you cant
		OPAQUENESS TOOL: if it was an inbuilt function it would be good. If it was something that was hot key or something like that that you could switch it on or something that remember on your profile
		: I've been using it off and on with both screens sometimes I've just been turning the back screen off when I've been quite heavily into my emails and not really too focused on the other things that are going on. Other times I've had it on when I've had the phones in the background. But yeah I've found it pretty good, it's hard on the eyes but now that ive just learnt today how to alter things properly and set the white background and I can see that there's a good use of it.
		yeah no one told me I had to change the background, which is probably good it was too colourful, it doesn't work well with colours.
		Obviously the software to make it opaque or not opaque is not as good as it could be, and it chews up a lot of memory too that piece of software. because it just makes it lag a lot
		MLD MOUSE: disappearing off to the right to try and close the window was a bit unusual. the window size of the screen was probably too much it was past the edge of the screen. If you could turn it off so you didn't go past the edge of the screen it would be good and you could just use the mouse to go backwards and forwards
		CHANGE IN WAY YOU WORK?: No probably not so much that screen. Probably the dual screens did but not the MLD. I found I probably used it too much as a single screen…. Because it was easier.
		LEARNING?: takes a wee bit of time to adjust to it yeah
		USER FRIENDLY?: no
		RECCOMNED TO OTHERS?: <long pause> ummm NO
		ERGONOMICS?: probably a bit of eye strain
P2	I guess I don't open up as many windows and its very helpful when you are scheduling because of with desktop screen open while scheduling a job and if there's hardly anyone of the phone then you don't really need to go on a break whereas the normal screen you just automatically go a cup every time. So that way its helpful. And I don't get a lot of chance to check emails so I've had the desktop screen behind or the Outlook one. And the JobTrack one in front. So its very helpful to have the three screens. Better then the normal screen!! <laughs> Its so much easier, it's a lot easier. I know it doesn't suit all people.	well at first I couldn't move the mouse. I didn't know what to do that was yesterday when I first started at 8. but yeah quite thing with it now. Its all about playing around and seeing what you can actually do with the screen

	MLD	
	+	**-**
	I don't know how I did it on the normal screen now!	Inconsistencies: yesterday I was on a phone call and I didn't know where the screen went! <laughs> I think I was logging a job or updating a job and cause the customer was on the phone and I didn't know where the screen went
	I think because in this industry you need to, well with a screen like that were you can have multi screens open is very helpful and you can do your job a lot quicker.	
	I guess its just very helpful and useful. I mean the normal screen, I guess it takes you a bit longer to do one thing at a time. Where as with the multi screen you can actually do it all at once. Like even when your sending emails you don't just have to have the Outlook screen open you can have other screens underneath. So its quite good	
	With a normal screen you only have one screen that you can actually physically see whereas with this screen you can bring up multiple screens that you can see while your working. Which is quite handy	
	if you had to chose now between MLD or dual - The Multi. Definitely. I mean the normal screen I do get eyestrain on it but this particular screen and model there's no ergonomics or OSH things with it at all. Its just really good.	
P3	the clarity of the screen is actually better I think then an actual then the LCD panel I was using previously. I don't know why that is – but I just seems to be clearer to read, and nicer to read but its just a shame that yeah. really sharp. Its really nice	I think its just me in as much as I'm not used to using it and I have a couple of problems. The first is that I do find it difficult to read the two lots of information when there up together.
		text on text. And the other thing is that I'm actually having problems using the mouse application with it. I know how to go between the two screens but I don't know how to push the screens forward and backward. And I have tried it and it don't if I'm just doing something wrong but I cant do it.
		And I can go between two screens or I appear to be able to but I just don't know how to get two applications. Its by fluke that I get two applications one in front of the other.
		well in itself its fine you know and I know for instance I can turn off the back screen if I need to. I know how to as I say move between the front screen and the back screen with the mouse. But I'm just having problems reading text and using both applications together. But its not a difficult thing to use its just getting used to it. I don't think its yeah – it don't think its necessarily right for me.
		At times its useful – I mean yeah at times I have been able to copy information from one screen to another but its all a fluke, but it hasn't been like completely negative but I would say my preference would be to have either a single screen or dual screen.
		PRODUCTIVITY?: hampered? Yes. <Laughs>. Unfortunately.
		MAIN ISSUES?: text on text and my ability to fully grasp how to use it.
		learning was a big thing for you? Which surprises me because I usually am quite good at these things but yeah
		SATISFACTION?: NO
		RECOMMEND TO OTHERS?: based on different things yeah I mean if they were doing more graphical work perhaps yeah but not for the role that I do
P4	the positives are that everything's right there in front of you. You don't have to move your head or anything and its you can always see everything	I would find quite a heavy reliance on the utilities and things like the, I'm not using any utilities except for that mouse – pushing the mouse backwards and forwards. But even then that needs tweaking or someway of changing the options of it. It would be much. it would be useful to be able to make things a little bit more opaque but not without losing what's actually happening
	ergonomics, no not particularly. I was actually expecting to have a bit like eyes or something but that didn't happen in the end. So in that respect it was quite a bit better.	Its got a reliance on the utilities. You have to basically sit down and go "how am I going to use it". More so then the LCD's [dual] the LCD's you just have that you know its just like a normal screen except that you have things over on that side. That one you actually have to arrange things, especially if you don't have the utilities set up you have to arrange things so that you can see things that are going on.
		opaqness utitlity?: Yeah but if you move it around the thing in the front goes white and disappears. So its quite annoying in that respect so I just turn it off
		user had set up 4 key tiles: The main reason behind that is again the utilities. If you push the mouse forward using the scroll wheel the scroll wheel function activates. So like if you in the emails it will come up with a little circle of the up and down. And it will activate that window but you've jumped. So its just a thing of – free spaces in the corners so that I can actually have somewhere safe to jump or to put something extra. Like I do have occasionally when you are replying to an email I'll put it into a different corner. That way I can just jump around the 8 corners I suppose it is, quite quickly.

	MLD	
	+	**-**
		If you don't have these utilities or if you don't have them set up right you have problems.
		And that's the learning curve is actually learning how to use the utilities. Yeah and again the fact that your getting up to the top right corner and your not expecting it to suddenly pop onto the back left hand side. Which It would be nice to have a little utility to make it you know so that it is a screen and that it is a forward and a back rather then a pseudo left and right that's been arranged differently.
		would you reccoment MLD?: I wouldn't I'd probably recommend as such the power user type yeah they'd probably find more benefit then anyone else. But if I was to say to like the boss hey we should do 1 2 or 3 – probably LCD's [dual] at the moment is what I'm thinking
		Other people looking in at the screen. quite often you have to minimise everything and just have that one application going. Otherwise they just cant see – they cant look at it.
		So far, again learning curve, a bit more difficult then the dual screen because its not something you haven't encountered before. Frustrating quite a lot of the time because cause its you know anything white just becomes transparent so most emails and browser pages and everything else you know its quite hard
		opaqueness: I find that confusing because I'm looking at something's which are opaque and some that are transparent and then there not transparent to themselves or to the other windows. So I'm actually finding that quite confusing
		egonomics: I'm just finding my eyes are, eyestrain would probably be the closest one. Just very minor but I can see it becoming an issue if you know what I mean
		Easy to learn: no oh god no. god no! I mean with dual screens you could just go with what you had before and then just start using it, with this no you actually have to think right learn how to use it. Because the foreground is the primary one isn't it? Cause its so much sharper – especially when your at that sweet spot resolution, but that background influences it so much. And the background seems to be a bit fuzzy
P5	Um some of them is um being able to have certain screens open behind others so I can copy data across with out having to cut and paste or if I cant cut and paste in certain applications I don't have to I can the double screen that way so in that way its quite handy but I don't do it a huge amount	Just getting the windows in the right levels, at the right levels at the right time when you need them was probably been the most challenging things after what, 1 ½ days of using it. Um…. But yeah that's probably been the most challenging thing to get that working properly.
	text on Text: after I got used to it you can focus on where you want to focus. Um its just when you have text on text on text. It can be a little bit confusing.B ut most of the time yeah not to bad actually. I was surprised at that cause I thought it would be a problem but you actually learn to focus on what you need to see…	its been easier when I get the windows in the right place I've found it *sometimes* helpful. But sometimes its been a bit hard when I've lost control of my windows and I cant see what one I want to see and everything's flicking and going all over the place… Um so yeah which is more of a user error shall we say. <laughs>
		it is a learning curve to get your head around the windows
		ergonomics: I'm using the mouse a lot more which I do have be careful of , … If there were keyboard commands it would cool. Cause I'm a keyboard person so I do prefer keyboard then mouse cause its quicker
P6	real handy with especially remote control desktop cause you can, I can be logging a call and getting a server name or recording some details off the remote session and having JobTrack open there so I don't have to sort of flick across screens which is kind of a bit annoying.	generally speaking its quite good. The graphics is really good but sometimes you'll get an overlay with the text, also the, with my computer setup with windows 2000 windows XP, I noticed this morning the blue bars at the top of the windows you cant see it cause it sort of overlapping my start menu, just with the way ive got my computer set up. I think also it would block off even if my start menu wasn't there.
	change in job? - Yeah its probably easier to manage calls, and easier to work on a call. Cause you've got more, well you've just got more area and more possibilities of windows you could use at once especially if your using it in tiles as opposed to full screen. That was one of the things I noticed as well	Easy to use: it was like learning to use a mouse again all over again
	that feature with the remote control desktop is really handy and being able to have three windows open and once and flick between them is quite cool	Inconsistencies: of course also the mouse thingy is a little bit of a dog because - I don't know whether you've used this feature - but you can click and drag with your middle button if your scrolling down a screen.
		text on text is just a little bit of a pain yeah…..
		Focus through?: yeah I've been looking over the top and going around the side yeah, which is a little bit like steering with a PlayStation remote

**Observation and Interview Data Analysis Spreadsheets -
Final Comments**

P1	CHOICE: Dual
	MAIN REASON: Ease of use. Easy to see. Functional for what I would describe as what I was doing. The fact that it is an extension of your desktop but its easy to move between the two you know where your mouse is because you can actually physically see it and maximising a window in a screen only takes it to the outside edge of that screen
	SINGLE OR DUAL: dual
	DUAL OR MLD: dual
	MLD OR SINGLE: mld
	REASON: yeah the extra functionality of having a back screen that I can put the phones on because that primarily is what my task is is monitoring the team performance
	LEARNING A FACTOR: Um propably because I could already function with the dual screen type situation propably the only learning factor was the physical usage of the MLD
	MLD UTILTIES: yeah the utilities yeah. Because I'd already working in an environment with dual screens and used them at home and so yeah got really used to them
	MULTIMON: NO
	MLD MOUSE: YES -
	MLD WINDOW: yeah, no I wasn't fussed on it
	ERGONOMICS (which of the three was worse): MLD - Yeah just very hard on the eyes

P2	CHOICE:
	MAIN REASON:
	SINGLE OR DUAL:
	DUAL OR MLD:
	MLD OR SINGLE:
	REASON:
	LEARNING A FACTOR:
	MULTIMON:
	MLD MOUSE:
	MLD WINDOW:
	ERGONOMICS (which of the three was worse):

P3	CHOICE: dual
	MAIN REASON: Ease of use. The ability to pull information from one screen to the other. Yeah it was just very easy to use within minutes of plugging it in I knew what to do
	SINGLE OR DUAL: Dual
	DUAL OR MLD: Dual
	MLD OR SINGLE: : Now… I'd probably choose the MLD. Because there have been times where I have used it, it's just that I haven't used it that often. But at times it has been helpful
	REASON: In time I would probably understand it more yes. I don't know whether because of the text on text how often it would be used but as I say there have been occasions where I have used it.
	LEARNING A FACTOR: yes. With the MLD yes. In fact in all cases because with the dual screen there was virtually no learning it was just very easy.
	MULTIMON: Yes - I found it easier. I was looking for a tool bar scenario for the other side and whether it had been somehow extending the tool across or whether it had been MultiMon I don't know. But I was just told MultiMon by someone so I used that
	MLD MOUSE: yes - being able to bounce, yes. But I mean the flicking of the applications yes was a problem but I can quite easily, I understand how to go between the two screens. It's just changing the screens backwards and forwards and reading them
	MLD WINDOW: : I tried that, but I found it wasn't really me either
	ERGONOMICS (which of the three was worse): To begin with the dual screen. And that was the brightness and we turned that down and that was no longer a problem. No, I mean the MLD is fantastic in that it's range of movement is much better, you get a much better feel for it and a lot of what I do is discussion with "NAME" as you know and that screen is fantastic for just being able to move and show "NAME" the information and swing it back. I don't have that kind of range with a standard monitor. That's a terrible thing to say because the standard was very good!
	PERFORMANCE: how OK. I was able to pull information a lot easier from one program to another. From excel to JobTrack. I was able to read multiple screens of JobTrack. I was able to compare things a lot more easily.

| P4	CHOICE: Dual
	MAIN REASON: The MLD is very good but the utilities aren't there. Its just frustrating yeah its frustrating otherwise the only utility I used with the dual screen was just to supplement what was already there : the task bar. Just so it was more clear on where the tasks were. I mean that's a flaw in windows I mean if you have two screens your supposed to have two taskbars! But with the MLD you have a utility that you know it's actually left and right but ones in front of the other so you have… I would prefer to have a utility that would stop you from going around. And of course pushing through and pushing applications you have to have that. I'm fine with them but they need to be a little more user friendly and little bit more cleaner, yeah cause things like that middle click, especially when your hovering over something else the middle click triggers something else
	SINGLE OR DUAL: Dual
	DUAL OR MLD: MLD
	MLD OR SINGLE: MLD

	REASON:(so you've chosen the MLD twice but you'd prefer to use the dual on a day to day working basis until the utilities are up to scratch with the MLD screen) oh god yes. Yes.
	LEARNING A FACTOR: : Yes. There is a learning curve and it is annoying for the MLD one. Though with the dual you just sort of adapt… yeah, you just slowly overflow and just slowly progressively get better at it. While with the MLD you have to very quickly be able to hide things so you can show other people what's going on on your screen. You have to be able to move things round things like that
	MULTIMON: YES - (and the main reason was because you wanted to know which screen the application was on) - yep and that was on dual only.
	MLD MOUSE: YES - (apart from the flicking off to the side) ahh that was just mouse stuff wasn't it. I think it was just middle click. And if you could customise what button it was or something I don't know.
	MLD WINDOW: did try. I preferred the first version of it where it just cut everything out because the second version where it sort of made everything go white rather then just making the things less opaque in behind. That was just frustrating. Oh and with that one you hold down ctrl and you move the mouse and all of a sudden everything just disappears! Cause your always like copy paste and like shifting around Oh it was amusing
	ERGONOMICS (which of the three was worse): Dual screen surprisingly, because I had, I mean the set up of my desk is all on the right hand side rather then just the phone and I ended up with the dual screens being pretty much centre and right which slowly did progress across as left and centre that was a bit of shuffling and juggling with that but. During that week it became very vivid that yeah it's all right, everything's right and I was getting a bit of a sore neck – but that was easily enough like dealt too, I could deal with that but. (but that was an issue?) Yeah, it was just more that your comfort you know how you sit natural, there was natural [front] there was slightly [right] odd.
	PERFORMANCE: (INCREASED?) YES. How? Um going back to the, what I have open as my applications I'll have a job open and I'll have the schedules in two windows and I'll look at the job, I'll have several jobs open and I'll have the two scheduling pages open and I'll just go OK I've got five jobs I need to shuffle through I've got these five I need to organise a tech for this, what are they doing, whats that one doing and you know flick backwards and forwards left to right. If nothing else just that.
P5	CHOICE: : I would – it's a hard question to be honest. Umm I would defiantly use the 3d or the two screens over a single screen no question. Out of the two of those that's a bit of a harder choice. <long pause> I couldn't really make a call on that I think I'd need a bit more time. To be honest.
	MAIN REASON:
	SINGLE OR DUAL: Dual
	DUAL OR MLD: yeah its um <pause> its quite hard to pick between the two actually cause of cool things. yeah slightly different cause I think the two screens are certainly a lot easier to get used to but once you get used to the 3D its quite cool that way. Yeah I suppose I would probably head towards the double screen rather then the 3D, sort of just.
	MLD OR SINGLE: MLD
	REASON:
	LEARNING A FACTOR:um. No not really. No (so if it was harder to learn it didn't mean that you didn't like it) God no, if your in IT your learning all the time you've got to get used to learning.
	MULTIMON: yes - No its brilliant. Its quite cool actually
	MLD MOUSE: Yes – you have to, um. No not with the actual mouse it was only the, no keyboard shortcuts was the only thing I had with the MLD mouse
	MLD WINDOW: yes - yep. Both of those utilities you needed really to run that 3D properly
	ERGONOMICS (which of the three was worse): : I think I noticed with the 3D one that I was using the mouse a lot more. Double screen didn't seem to be increasing my amount of clicks by using the mouse a lit more. But the MLD I did notice. yeah well it was the clicking all the time, clicking when you switch between screens or things like that
P6	CHOICE: Dual
	MAIN REASON: ease of use. Yeah the fact that I've always got something there [left] and something there [right] that I can look at.
	SINGLE OR DUAL: Dual
	DUAL OR MLD: Dual
	MLD OR SINGLE: MLD
	REASON: I think I just found it difficult to focus on where I was with the dual layer one. As I said before I prefer to have it open and visible on both screens. It just seems to work well for me
	LEARNING A FACTOR: No I picked it up reasonably quickly I think. The MLD was probably the biggest learning curve. And the ah ive worked with multi ah twin displays before anyway so I knew how they worked.
	MULTIMON: NO
	MLD MOUSE: yes
	MLD WINDOW: no. oh actually I sort of did but I didn't like it so I didn't use it day to day
	ERGONOMICS (which of the three was worse): yeah it was more hassle then discomfort with the MLD I'd say but yeah that would probably be the one. Yeah.

## Observation and Interview Data Analysis Spreadsheets - Managers Comments

Manager 1

I think P2 has picked up the other one [mld] pretty quickly. I haven't actually talked to her to see what she thinks of it and I haven't talked to P4 to see what he thinks of it but they don't seem to be screaming out having problems. so

Interviewer: No, I was quite surprised. They've picked it up quite well.

P6: yeah.

Interviewer: and especially P2 because she hadn't used the dual screen in the week before to understand the concept of the two screens.

P6: so it will be interesting to see what she thinks of when she gets the dual screens. To see how she functions with dual screens.

Interviewer: Yeah cause P5 said before that he really misses his 3d screen.

P6: yeah. Well he would be changing windows so often.

Interviewer: its interesting!

P6: yeah, are you getting good feedback?

Interviewer: yeah I think it also depends on what job your doing. Cause everyone's got slightly different job descriptions and how they work…

P6: …analysts, schedulers. But your getting a whole cross section of them which is probably good.

… Not really apart from what I've seen just observing them.. yeah… just the way their using applications a bit differently

A couple of them have just said that they quite like … well the dual monitors they like. P5 has said its taken quite a bit of work to get used to the… the single monitor with the dual sort of behind it. Buts he says he's coming to grips with it. He said it would have been helpful to know probably a bit more about it before he started using it as quickly as he did

And he said it was confusing for a while but he's now starting to … his comment this morning was he's starting to see things a lot clearer like you can have things in the background but your focusing on a certain part not what's in the background…. So he's probably getting used to it.

NO I think from the staff comments that I heard I think that probably the dual screens were probably the most common I think the MLD was a hard one for them to use

Have you noticed any difference in the way that of the participants have been working: P1: yeah, I think putting the Dual screen functionality of probably the dual screens and the MLD to good use and being able to see something in the background, doing their cutting and pasting or being able to type something that they can see behind or in another screen. I think probably using it more efficiently.

INCREASED PERFORMANCE LEVELS?: that's very hard to say. Probably personal happiness, comfort - (so personal satisfaction rather then a performance that you can monitor?) it's very hard to monitor the performance of that sort of thing because you'd have to sit and time them and we don't do that sort of thing

No not really. No the only comments really are good comments on the dual screens defiantly there's people there that want to have dual screens. The MLD there's probably one or two that are happy enough with them to want them but I think the dual monitor situation might be a better situation

FINAL CHOICE FOR TEAMS: The Dual screens. Yeah dual screens, MLD if it was functional if they were happy with it. But probably the dual screens as a first choice. Certainly single screens is the last choice

Manger 2

Change in the way anyones been working? - no

COMMENTS FROM PARTICIPANTS: a lot of it has been on the Monday morning and just I think absorbing what there using. Most of them were favourable comments so they've got positive things to say like they've got two screens there happy to have two screens. They've got more visibility of the systems that there using. With the PureDepth screens obviously undergoing a an adjustment but <long pause> Yeah with the PureDepth screen theres some, yeah hesitation in adjusting to the new technology. Its kind of like what have got here and what does this mean for me?

Noticable improvements in performance: NO

(So have … so has it been just like a personal satisfaction thing with how there using it that's been the most noticeable) yeah. I think they have, once they've got used to it, they've actually most of them have enjoyed having, like I say, the added advantage of seeing more on there screen at once

FINAL CHOICE FOR TEAMS - Dual followed closely by the MLD
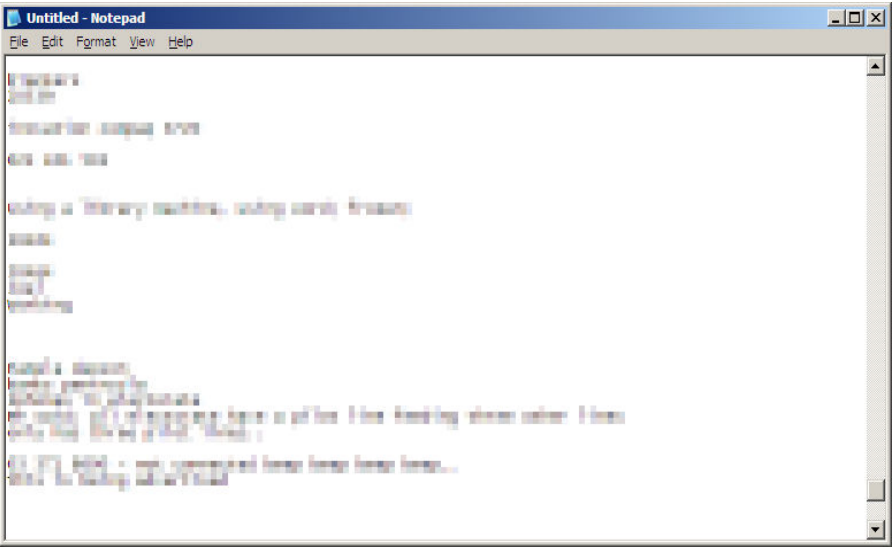
Appendix 9: Application Screenshots
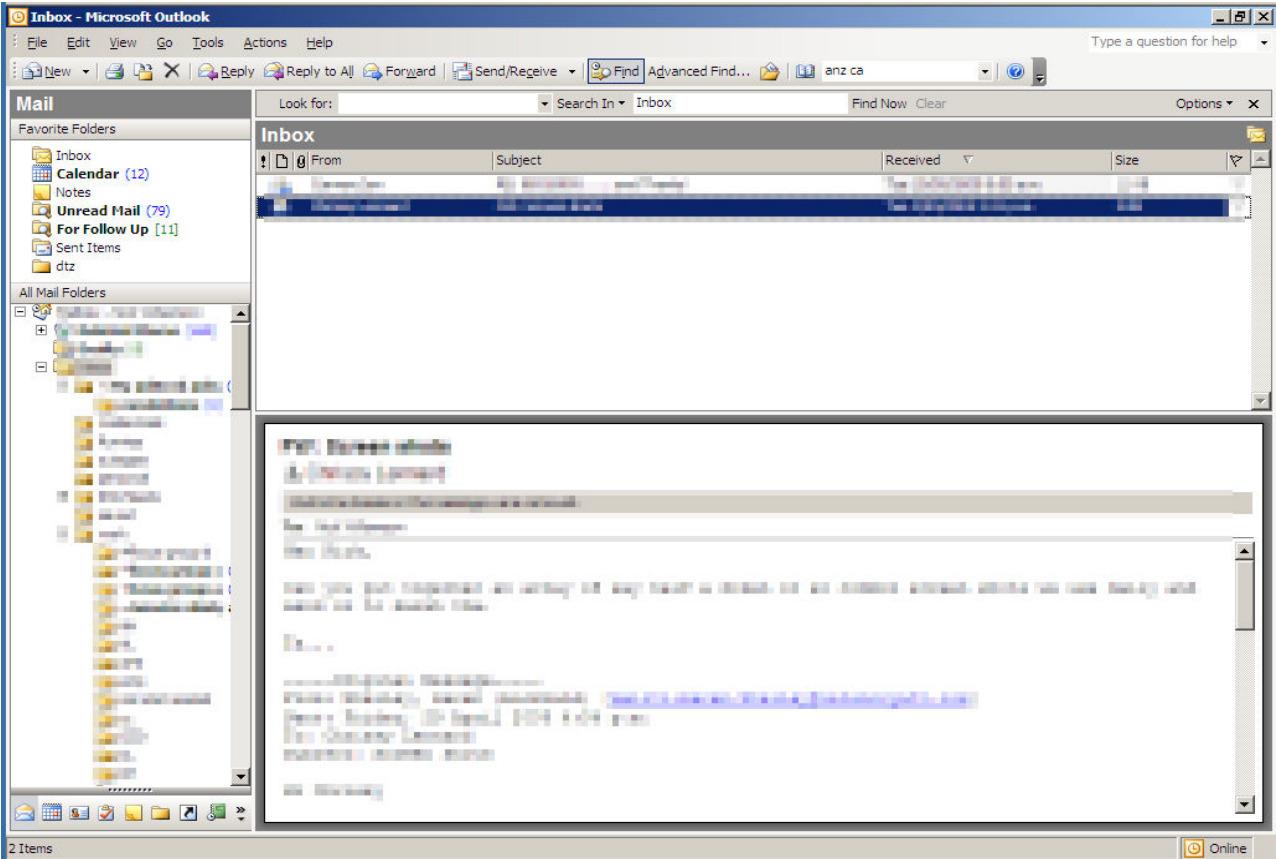
current windows display properties
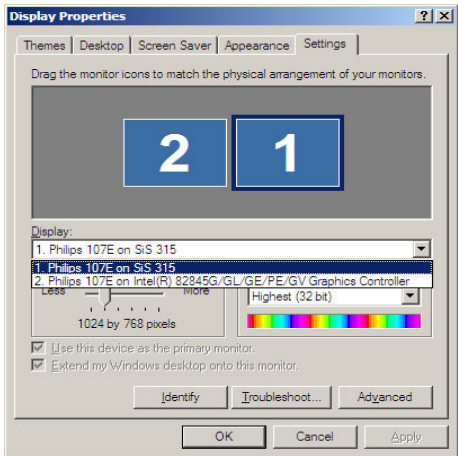
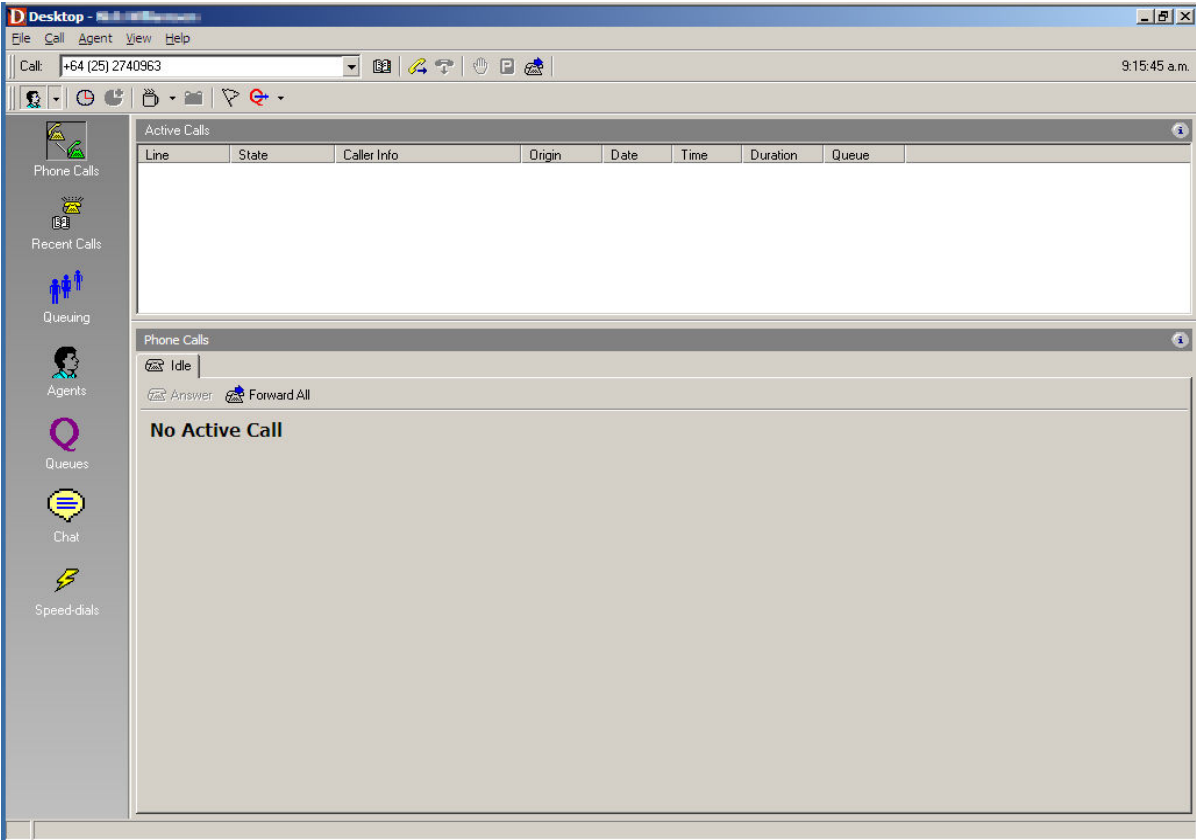jobtrak for recording jobs from my notes in windows notepad
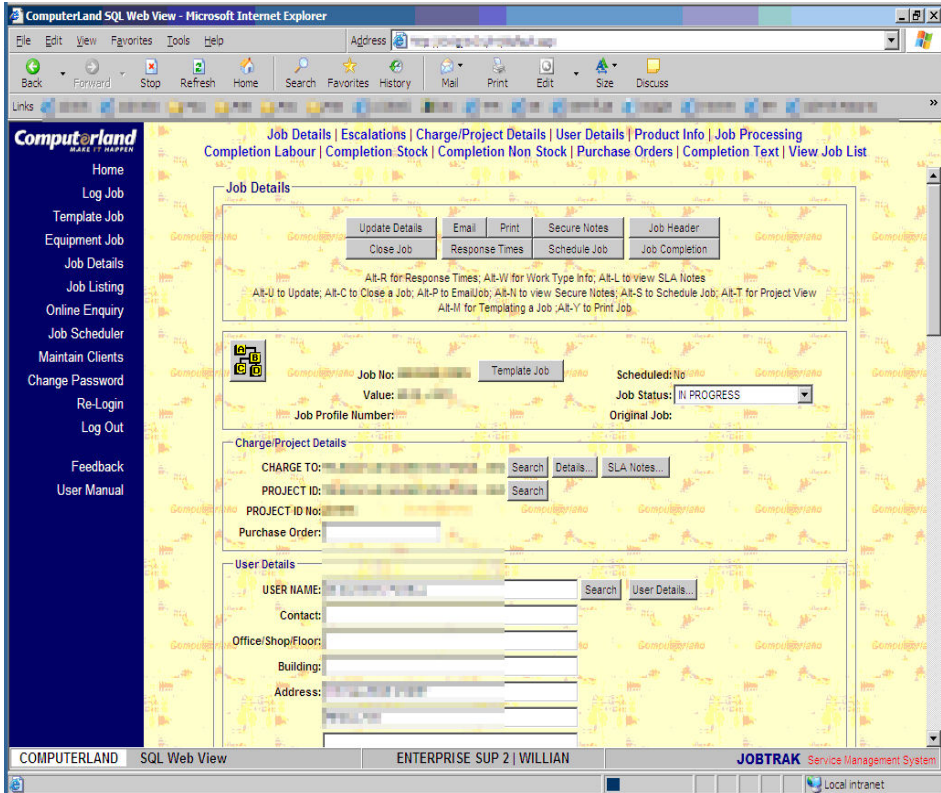
Notepad for recording jobs quickly

outlook for monitoring major outages

zeacom queue master for phone interfacing

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