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Implementation of a Customer Relationship Management System in an SME.

In One Volume

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Dedicated to My Parents

Declaration

I hereby declare that the work presented in this thesis is my own and that it has not been previously used to obtain a degree in this institution or elsewhere.

Valerie Butler.

9th August 2002.

Statement of Confidentiality

The work carried out in this thesis is a contribution to the MObile Tools and Technologies for custOmer care (MOTTO) project.

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Prologue

The research conducted for this thesis has been carried out over a two year period as part of the MObile Tools and Technology for custOmer care (MOTTO) project. The project was funded under the Applied Grant scheme administered by Enterprise Ireland and Nortel Networks Ltd. It was a partnership project between Galway-Mayo Institute of Technology, University of Limerick, National University of Ireland Galway, and a global Internet and communications company, Nortel Networks. The project aimed to investigate the enabling mobile communications technologies in eBusiness and mobile communications in the area of Business-to-Business (B2B) customer care.

The development of the application discussed in this thesis was developed in conjunction with the Galway-Mayo Institute of Technology, University of Limerick and AMT Ireland. The decision to develop the application in the Electronics Company of AMT in Limerick came about as a result of the contact established by Mark Southern from the University of Limerick. Mark was involved in overseeing the development and assisted in establishing the user requirements.

Abstract

The future of Electronic Business has been in question since the collapse of the *dotcom* companies. Recent setbacks for companies in the technology sector have exacerbated that questioning. Currently both investors and consumers are reacting nervously to an economic recession. However this pessimistic period has had one advantage, this being that the hype about e-business has disappeared and has been replaced with a new realistic view of what e-business deployment means. Companies are now looking for a strategic fit that will provide a return on their investments. E-business provides the means of being able to do things better, faster and more efficiently. It enables companies to expand geographically and to collaborate with other companies.

Mobile commerce extends e-business, by providing Internet access using mobile devices. M-Commerce enables people to partake in commercial activity anywhere and at anytime. This new technology is extending the reach of e-business to individuals without Internet access via a PC. Instead of calling it e-business, it will become more accurate to term it Ubiquitous business in the future.

Presently Irish SMEs are slow to explore the possibilities offered by e-business. Given the proliferation of SMEs in the country, it is of prime importance that they adopt positive steps to deploy e-business solutions in order to remain competitive. As more customers and businesses demand to use e-business channels, the gap between successful and unsuccessful widens.

Irish SMEs need to embrace e-business and to realise the opportunities and challenges, with resourcefulness and imagination.

This thesis is concerned with the adoption of an e-business customer relationship management solution by a Small-to-Medium size Enterprise (SME). It will investigate current and emerging wireless technologies, and discuss the importance of Customer Relationship Management considerations in the deployment of solutions.

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Glossary

1 G: Fist Generation of Wireless Technology. These networks used analogue voice signalling.

2 G: Second Generation of Wireless Technology. These networks feature digital encoding. Examples are: GSM and CDMA

2.5 G: Second Generation and a half of Wireless Technology. An upgrade to 2G, providing increased bandwidth and packet routing capabilities.

3 G: Third Generation of Wireless Technology. These networks are expected to provide broadband, high-speed data applications-both fixed and mobile.

Bluetooth: A technology specification for small form factor, low-cost, short-range radio links between mobile PCs, mobile phones, and other portable devices.

CDMA (Code Division Multiple Access): A spread-spectrum approach to digital transmission. With CDMA, each conversation is digitised and then tagged with a code. The mobile phone is then instructed to decipher only a particular code to pluck the right conversation off the air.

CDPD (Cellular Digital Packet Data): A specification for supporting wireless access to the Internet and other public packet-switched networks.

CHTML (Compact Hyper Text Markup Language): A subset of ordinary HTML. CHTML is used by the Japanese company, NTT DoCoMo, in the development of i-mode applications.

Circuit Switching: A switching technique that establishes a dedicated and uninterrupted connection between the sender and the receiver.

EDI (Electronic Data Interchange): A standard format for exchanging business data.

FDMA (Frequency Division Multiple Access): A technique used in spread spectrum radio transmission systems, such as wireless LANs and some PCS cellular systems that involve the conversion of a datastream into a stream of packets.

GSM (Global System for Mobile Communications): A TDMA based standard for digital wireless transmissions. GSM is the most widely used standard in the world and is the de facto wireless telephone standard in Europe.

GPRS: An extension to the GSM standard to include packet data services.

HDML (Handheld Device Markup Language): A modification of standard HTML, developed by Unwired Planet, for use on small screens.

HSCSD: A high-speed implementation of GSM data transfer.

HTML (HyperText Markup Language): An authoring software language used on the Web. HTML is used to create Web pages.

IMT-2000 (International Mobile Telecommunications-2000): The standard for third-generation mobile communications systems. In Europe, it is called UMTS and in Japan it is called J-FPLMTS.

MIME Types (Multipurpose Internet Mail Extensions): The standard format, developed and adopted by the Internet Engineering Task Force (IETF), for including non-text information in Internet mail.

Packet Switching: Sending data in packets through a network to a remote location.

Pagers: Small portable receiver devices.

PCS (Personal Communications Services): Two-way, personal, digital wireless communications systems.

PDA (Personal Digital Assistant): Portable computing devices capable of transmitting data.

Smart Phone: A phone with a microprocessor, memory, screen and a built-in modem.

TDMA (Time Division Multiple Access): A method of digital wireless communications transmission allowing a large number of users to access (in sequence) a single radio frequency channel without interference by allocating unique time slots to each user within each channel.

WAP (Wireless Applications Protocol): A protocol for wireless applications designed to simplify wireless users Internet access.

WML (Wireless Markup Language): An XML based language that allows the text portions of Web pages to be presented on mobile device via wireless access.

WML Script (Wireless Markup Language Scripting Language): A scripting language based on ECMAScript.

XML (eXtensible Markup Language): A markup language similar to HTML, except that it includes rules regarding how tags can be used.

Chapter 1

Introduction

1.1 Thesis Motivation

The last decade has seen the convergence of two pervasive technologies: wireless communications and the Internet. This convergence has brought about benefits, such as, new mediums of interaction, increased response times, value-added services and decentralised decision making capabilities. Ubiquitous access to information, *anywhere, anyplace, and anytime*, will characterise whole new kinds of information systems in the 21st Century. Emerging wireless communications systems have the potential to dramatically change society as individuals have direct access to their information sources and communications mechanisms.

The greatest challenge now facing electronic and mobile businesses application development is to provide customers with the business information relevant to their specific requirements

Customer experiences are a primary issue in the development of technological solutions. Technology, the Web and now the Wireless Web have changed the relationships between businesses and their customers forever.

Customer Relationship management is a business strategy used to identify, anticipate and understand the needs of potential and current customers. This concept is not new, however the fundamentals of this concept should play a pivotal role in the

development of technological solutions to ensure that the solution meets with requirements and is embraced by users.

The electronic enabling of Customer-Relationship Management, to date, has been deployed by Large Scale Organisations to enhance customer experience and provide personalised services to customers. 90% of Irish businesses are SMEs. Small and Medium-sized Enterprises (SMEs) have been reluctant to adopt CRM applications due to the complexity, expense, and risk involved in purchasing CRM vendor products. Additionally, SMEs generally maintain strong relationships with customers without technological assistance. However, in order to remain in business it is imperative that they adopt positive steps to ensure they realise the benefits of e-commerce in order to remain competitive and sustain an overall national competitiveness. The adoption of technological interactions with customers means that, in order to maintain intimacy with the customers, it is essential that there is a means of capturing, storing and analysing data.

Web-based CRM applications may provide a more financially and technically viable alternative to monitor, manage, and personalise customer interactions. Additionally, Web-based applications will enable a company to partake in e-Business services that adhere to CRM.

1.2 Thesis Objectives

This thesis is based on a project entitled the MObile Tools and Technology for custOmer care (MOTTO).
The aim of this thesis is to research the areas of Wireless and Web Technologies, Customer Relationship Management and Small-to-Medium size Enterprises with a view to amalgamating these to develop a viable solution suitable for adoption by an SME. The main objectives of the thesis can be summarised as follows:

- To carry out research in the areas of wireless technology, customer relationship management, and small to medium enterprises, in particular Irish SMEs
- To select and analyse one SME with a view to applying the research to assist the SME
- To design and develop a technological CRM system that will overcome the issues within the SME
- To analyse the development of the system
- To report on the lessons learnt from the development
- To develop guidelines for Irish SMEs, based on the findings of the research and the development process. These guidelines will address both the design and implementation of a CRM system.

1.3 Thesis Methodology

The approach to this work is as follows:

Literature Review

Study of Mobile technology
Study of business applications
Evaluation of Trends in technology
Study of Customer Relationship Management
Overview of Small-to-Medium size Enterprises

Analysis of Requirements

Carry out analysis of a specific SME to identify issues within the exiting system and develop CRM requirements on the basis of the findings.

Software Development

Development of a technological solution to enable an SME to partake in e-Business and M-Business in adherence with the concept of CRM.

Software Implementation

The implementation of a web and wireless enabled CRM solution to demonstrate cost effectiveness, ease of use and maintenance of the system using Web and Wireless technologies.

1.4 Thesis Structure

Figure 1.1 summarises the thesis structure, which is described as follows:

Chapter 1 presents the thesis motivation, objectives, methodology and thesis outline.

Chapter 2 contains an evaluation of wireless technology. The distinction between the conventional Internet and the wireless enabled Internet is discussed. An analysis of the advantages of wireless technology and the obstacles that are faced in its development is carried out. The various enabling wireless network technologies, service technologies and web technologies are described. Finally it discusses Mobile Commerce, m-commerce, the requirements of m-commerce and its future.

Chapter 3 discusses the concept of Customer Relationship Management. It analyses the evolution of CRM, the categories of CRM, the strategies that need to be employed in the development of a CRM solution, its role in a Business-to-Business environment, and the role Information Technology can play in the realisation of CRM objectives. The chapter discuses Small-to-Medium Size Enterprises and highlights the resistance among the Irish SME community in adopting eBusiness solutions. The chapter concludes with a discussion on the role of CRM within an SME environment. It addresses the reasons why an SME may consider deploying electronic CRM and how an effective Web-based application may provide CRM capabilities within the constraints of an SME budget and lack of resources.

Chapter 4 presents a detailed review of an SME. It provides an overview of the company, discussing the services provided, the structure and procedures within the company. The chapter focuses on one service area within the company, providing a more in-depth analysis on this particular area: the services provided, the process flow deployed in service provision, the information system used to retain customer and service data, and the issues and disadvantages that arise with the current information system.

Chapter 5 introduces a CRM technological solution, which is developed to address the issues that arise within the current information system. The objective, requirements, and proposed solutions, achieved from the analysis and though dialogue with the SME, are described. The technology tools are discussed and how they integrate to create a Web and WAP CRM application.

Chapter 6 provides an analysis of the development process, highlighting the issues encountered and the lessons learnt. It also provides general guidelines for SMEs planning to embark on a similar development.

Chapter 7 concludes the theses with a summary of the work done, the conclusions drawn from the work and recommendations for future work.

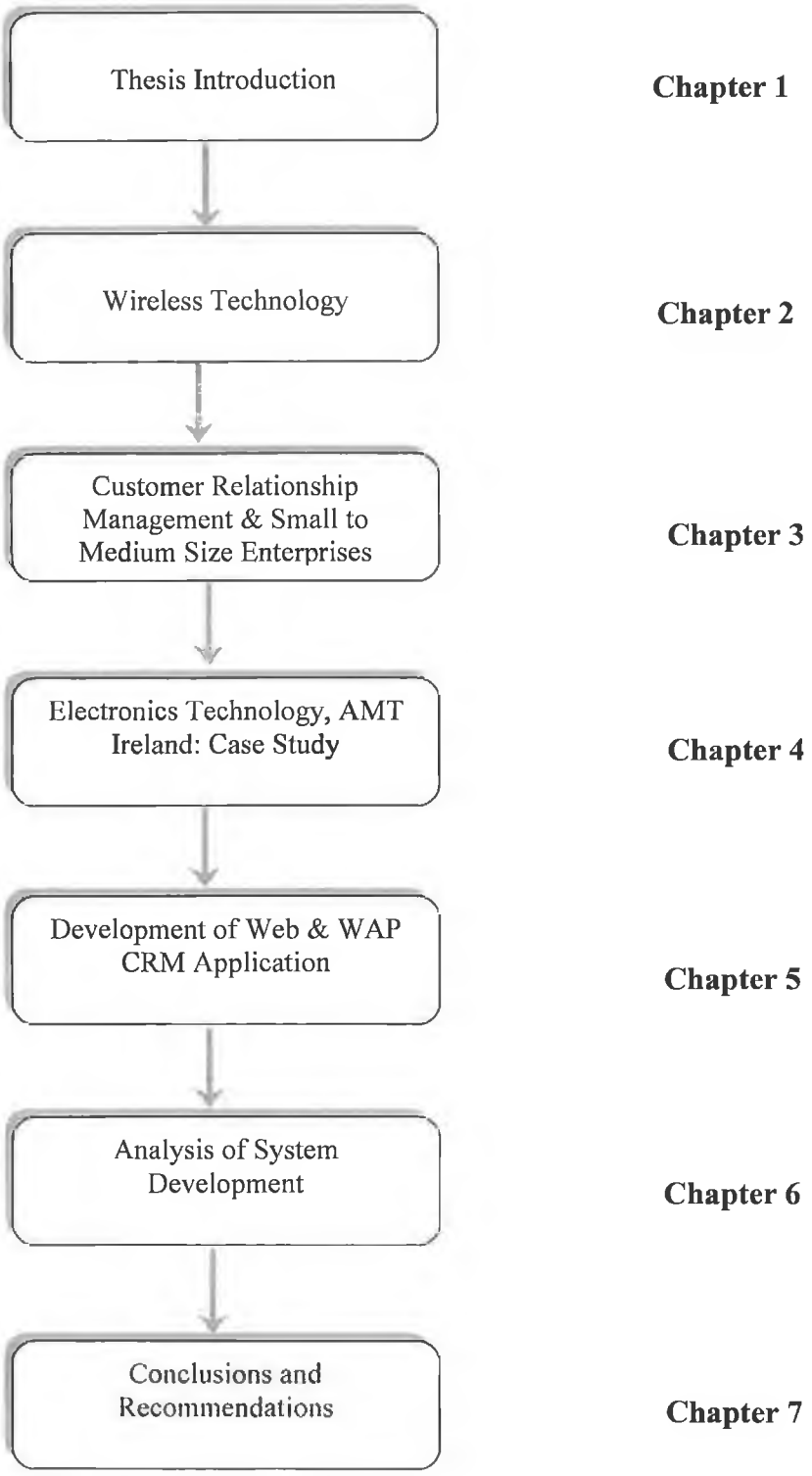


Figure 1.1 Thesis Structure

Chapter 2

Wireless Technology

2.1 Introduction

Advances in wireless network technology along with an increasing number of users of mobile devices has opened a new channel to offer customers services. This chapter will focus on Wireless Technology. It will discuss what Wireless Technology is and the difference between Wireless Internet access and conventional Web Internet access. The advantages and drivers of mobile communications will be identified, along with the development issues and constraints that exist in the deployment of the technology. The various Network technologies, including both present and future network standards, and Service Technologies will be discussed. An overview of the application areas and mobile commerce will be provided. Finally, the significance of developing wireless applications that provide valuable user experience will be discussed.

2.2 Definition and Background of Wireless Technology

Although the terms "mobile" and "wireless" are often used interchangeably, they are two different things:
Mobile pertains to the ability of an entity to be on the move.
Wireless pertains to the technology that allows transmission of signals, such as voice, data and other content through electromagnetic waves over part or all of a communication path, without being restricted to physical cables or other physical mediums. Although this definition of wireless is suitable for the context of this thesis, wireless technology may not be entirely free of physical mediums. Wireless can be divided into the following categories:

- **Fixed wireless:** The operation of wireless devices or systems in homes and offices, and in particular, equipment connected to the Internet via specialised modems
- **Mobile wireless:** The use of wireless devices or systems aboard motorised, moving vehicles; examples include the automotive mobile phone and Personal Communications Services (PCSs).
- **Portable wireless:** The operation of autonomous, battery-powered wireless devices or systems outside the office, home, or vehicle; examples include handheld mobile phones and PCS units
- **IR (Infrared Radiation):** a band of the electromagnetic spectrum used for airwave communications and some fiber-optic transmission systems. Infrared is commonly used for short-range (up to 20 feet) through-the-air data transmission. Many PC devices have infrared ports, called Infrared Serial Data Link (IRDA), to synchronise with other devices.

It is wireless technology that facilitates employee or enterprise mobility. Portable electronic components, known as mobile devices, depend on wireless technology to connect to the enterprise and conduct the transfer of content in order to fulfil the users' business needs [Computer Associates 2002].

Guglielmo Marconi invented the wireless telegraph in 1896. In 1901, he sent telegraphic signals across the Atlantic Ocean from Cornwall to St. John's Newfoundland, a distance of 1,800 miles. His invention allowed two parties to communicate by sending each other alphanumeric characters encoded in an analog signal [Brunero *et al* 1995]. Over the last century, advances in wireless technologies have led to the radio, the television, the mobile telephone, and communications satellites. The mobile telephone is the modern equivalent of Marconi's wireless telegraph, offering two-party, two-way communication. The first-generation wireless phones used analog technology. Although the devices were heavy and coverage was poor, they successfully demonstrated the inherent convenience of mobile communications. The current generation of wireless devices are built using digital technology instead of analog [Stallings 2001].

2.3 Differences between Wireless and Web technology

The wireless web represents the combination of two innovative technologies, wireless communications and the Internet. The Internet and more specifically, the web, has altered the way business, interaction, and entertainment activities are carried out. Wireless technology, through the use of mobile devices, has added a mobile dimension to e-commerce and enterprise computing [Coyle 2001]. The Internet made 24hour, 7 days per week availability a reality, adding mobile technology provides the next logical extension, giving *anytime, anywhere* access. Technologically, the major difference between a Web and a wireless system is the difference in number of networks and devices that they each must accommodate. Table 2.1 illustrates the different technical components that make up both the Web and wireless domains.

	Web Domain	Wireless Domain
Devices	Personal Computer	Smart phones, PDAs, Pagers, Web/ WAP Phones.
Presentation Standards	HTML	HTML, HDML, CHTML, XML, WML
Browsers	MS Explorer, Netscape	Phone.com UP.Browser, Nokia Browser, MS Mobile Explorer.
Bearer Networks	TCP/IP	GSM, CDMA, TDMA, CDPD….

Table 2.1 Technical components of the Web and Wireless Domains[1]

As shown in Table 2.1, in contrast to the Internet, which has only one device type (a PC) and one network (the Internet via a TCP/IP connection), wireless systems present a multitude of devices, presentation standards, browsers and networks, each offering their own distinct features and functions.

Figures 2.1 and 2.2 provide diagrammatic illustrations of the architectures for both a Web site model and a wireless system model.

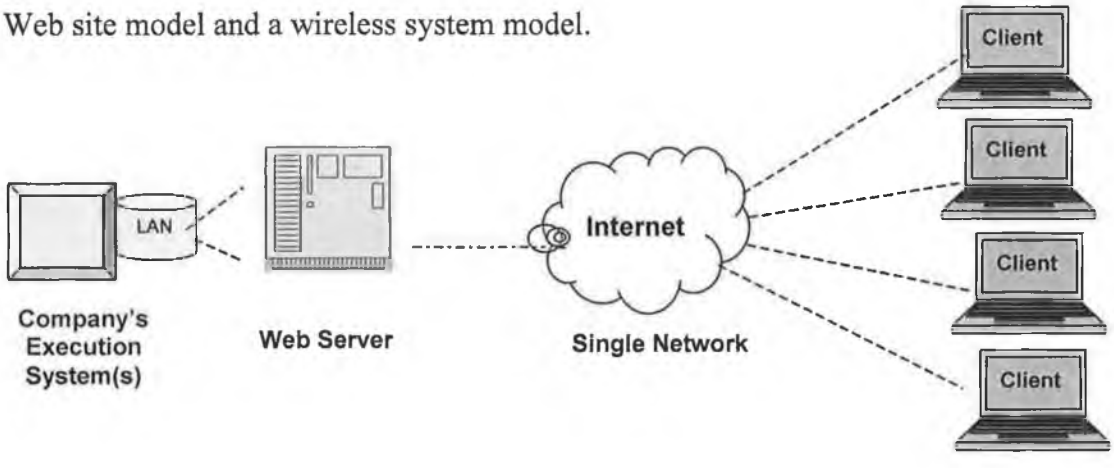


Figure 2.1 A Web Site Model [Fradkov 2000]

[1] See Glossary for definition of Terms

As shown in Figure 2.1, the web is an example of client/server computing in which networked computers share the work of a task. A client program, such as Netscape Navigator or Internet Explorer retrieves information from a server computer. The server is responsible for transmitting the document, while the client software is responsible for displaying it.

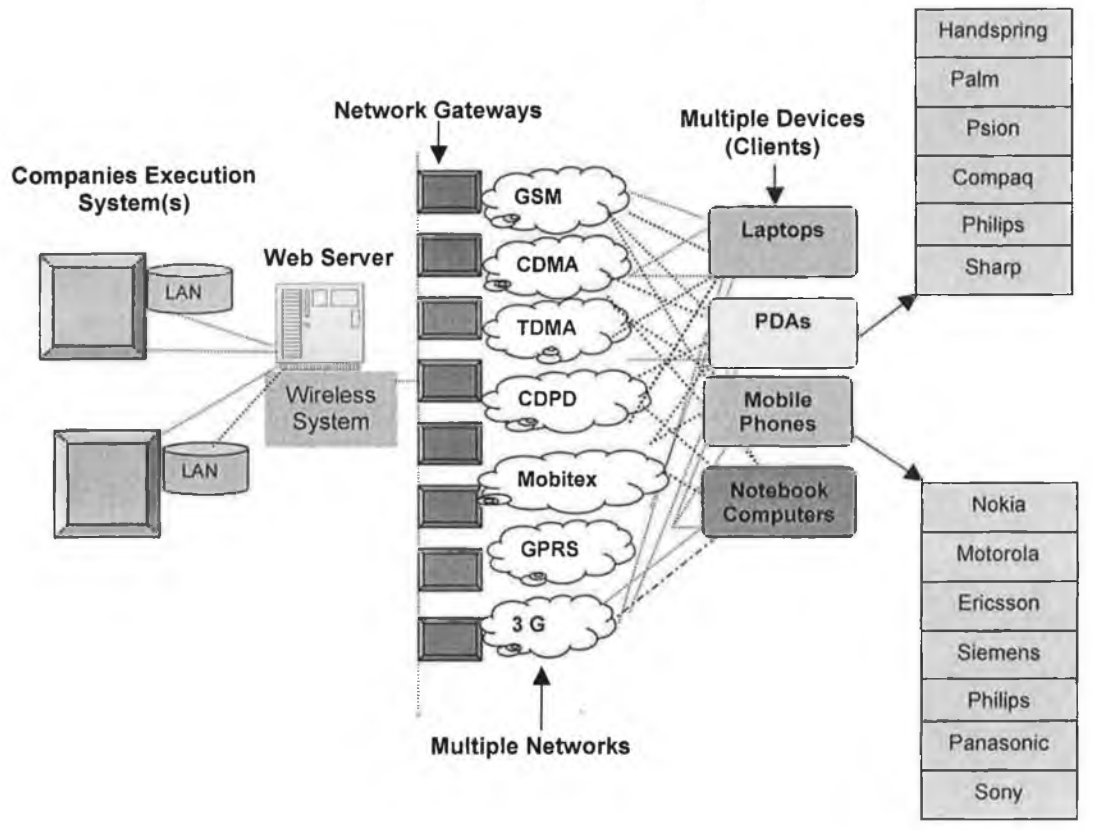


Figure 2.2 **A Wireless System Model** [Fradkov 2000]

Figure 2.2 show the components that can make up a wireless system. The devices and networks will be discussed in greater detail in this chapter.

An effective wireless system should operate in the following manner [Fradkov 2000]:

- The wireless device must connect through the supported wireless network to a network-specific gateway.
- The network gateway can then pass information from the device to the wireless application server, which passes the information according to the device type.

- The server can then deliver this information to the organisation's system for processing.
- Once the information is processed in the system, the results can be returned back to the wireless application server.
- The server can then format the information according to the device type and deliver the new information through the network gateway and back to the wireless device, where it can be presented to the end user by the device software.

2.4 The advantages of Mobile Technology

The drivers for adoption of mobile business within the enterprise and with consumers are numerous as shown in Figure 2.3.

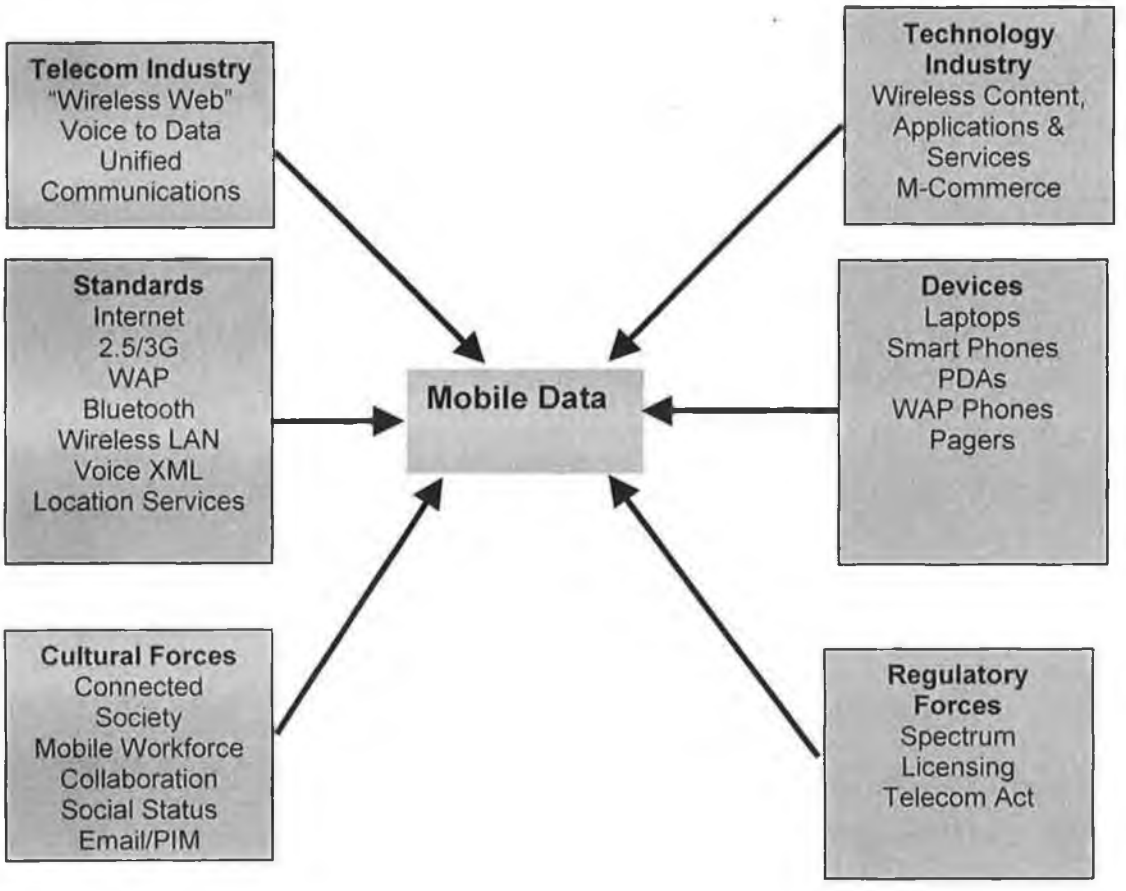


Figure 2.3 Drivers of Mobile Adoption

As outlined in Figure 2.3, the drivers include the following:

- Increasing mobility of the workforce [Sandler *et al* 2001]
- Convergence of telecommunications and software industries [Secchi 2001]
- Increasing need for information and transactions anytime and anywhere [Sandler *et al* 2001]
- New types of wireless handsets coming on the market [CISS 2001]
- Revenue opportunities created via M-Commerce
- Productivity improvements to be gained via wireless extensions to enterprise applications and processes [Cysive 2001]
- Improvements in bandwidth brought about by the migration from 2G to 2.5G and 3G networks [Barnard 2001]
- Adoption of wireless standards such as WAP and Bluetooth
- Cultural and regulatory drivers in various countries

If these drivers are distilled into their primary forces, it is apparent that the forces of industry convergence, improvements in wireless technology and standards, together with cultural and regulatory effects are driving global adoption of mobile business. Wireless connectivity for corporate information access offers a variety of potential business benefits driven by user convenience, timeliness of information, and increased ability to transact business.

Mobile computing provides the enterprise with several compelling competitive advantages including:

- Faster, decentralised decision making
- Increased responsiveness to customers
- Increased sensitivity to market changes
- Lowered commuting costs/time for staff
- Increased staff morale and productivity
- Reduced travel costs company-wide
- Decreased facilities costs

Wireless holds much promise for mobile computing, from real-time access for mission critical applications to automated dissemination of competitive information.

Though wireless has substantial potential and some interesting uses today, many applications may prove more useable via wire line connections. Many companies find a hybrid mix of wire line and wireless to be a more realistic approach. Depending on their changing circumstances and location, users may employ whatever type of connection is available at any given moment. Other companies find the higher costs and lower performance of today's wireless networks to be unacceptable [Synchrologic 2002]. The decision on connectivity should be based on circumstances, cost considerations, the value the application adds to the user, frequency of information update, geography, and business processes supported.

2.5 Obstacles facing Mobile Technology Development

Developing systems for the wireless domain is significantly more complex than developing traditional Web systems. The primary challenge is that a fully functional wireless system must be capable of providing services across a constantly increasing number of different kinds of wireless network and device types, each with their own operating systems, functionality and user interface requirements [Fradkov 2000]. Additional challenges include integration, security and ongoing maintenance. Supporting wireless connectivity also has the potential to increase certain challenges. These challenges are central to mobile computing solutions in general, regardless of the connectivity option chose. However, the relative immaturity of public wireless networks does tend to exacerbate them. These challenges include:

Numerous Device Types

Wireless devices come in all shapes and sizes, and use different display formats and data-markup languages. Developing mobile applications is challenging, since developers have to carefully prioritise text and graphics to fit onto the smaller screens of mobile devices. Adapting content and applications to fit multiple device types and markup languages brings additional slowdowns to the application development process [Dale Gonzalez 2000].

Network Performance and Reliability

Wireless device users are generally mobile users. This creates new kinds of demands on network resources, a user might be driving through Dublin one day, and travelling to Connemara the next. The network infrastructure will have to possess the intelligence and coverage, to give that user maximum performance no matter where he or she is, and no matter what device he or she is using. The network will have to offer high reliability and availability as a matter of course. This is particularly pertinent to enterprise wireless applications, where the applications performance will most likely be business critical [Air2Web 2002].

Security

As users become more mobile, network security and data privacy become increasingly critical. Just as the wireless industry is now in its infancy, so are security methods just now being developed to meet the stringent security requirements of mobile corporate users. Hence, security will play a critical part in an enterprise wireless strategy, because it will be one of the key factors corporate organisations will have to address and resolve [Air2Web 2002].

Many companies, in particular Small-to-Medium size Enterprises (SMEs), do no have internal technical expertise. For these companies the development of a wireless system, such as the one described in Figure 2.2, is a complex task. The following issues and potential problems make internal development of a wireless system a complicated, lengthy and risky endeavour [Fradkov 2000]:

- **Device Specific Programming Expertise**: Individual devices have their own programming environment and introduce difficulties for development because of their limited capabilities. Companies will require specialists to develop the system to accommodate each individual device. In addition, these specialists will have to ensure that all devices are working adequately.
- **Network Specific Programming Expertise**: Each network provider maintains different protocols for connecting to wireless devices. Different interfaces and infrastructures exist to connect the company's system to that of the network provider. Thus, throughout the device development the

idiosyncrasies of each protocol will need consideration. Therefore, in order to create a complex wireless system internally, a company would have to invest significantly into building and maintaining a communications infrastructure.

- **Continuous Infrastructure Development**: Each service provider has developed individual proprietary server-based offerings that content providers must utilise in order to supply their services through these providers. Working with these providers requires building communication infrastructures and supporting the proprietary interfaces to their servers.
- **Ongoing System Development and Maintenance**: New devices and service providers are appearing all the time, making it difficult to maintain the cross-platform capabilities of the system.

The development of such a highly complex system, for many companies, extends beyond their existing internal expertise and budget expenditure. To develop such a system internally, the necessary skill sets would have to be acquired and maintained by the company. This requires a significant investment in what does not constitute as a core expertise of most companies, and may stand significant risk of product failure.

Upon analysis of the obstacles facing wireless technology issues it is evident that many of the concerns are similar to those experienced a few years ago in relation to the wired Internet. Typical concerns then included the primitive graphical user interface of the Web browser versus the richer user interface of client/server applications, the lack of security, and the low bandwidth. Enterprises were not convinced that the Internet technologies were robust enough for their critical applications.

As the wireless industry continues to evolve, innovative technology companies and wireless carriers are providing solutions to these technology obstacles and assisting in driving adoption [Evans 2001]. Even with a lack of reliable standards, inadequate bandwidth, incomplete coverage, and a wealth of devices and software on the market, it is possible to design and implement highly effective applications within the enterprise that provide a good return on investment.

2.6 Mobile Network Technologies

A mobile network is based on the concept of client-server. The mobile device becomes the client accessing services offered by a host. Network technologies have evolved over the years from analog to digital and from packet switching to circuit switching. This evolution over the years has been categorised as first-generation (1G), second-generation (2G), 2.5G and third generation (3G) technologies. Among these only 1G is based on analog technology.
Some of the main standards for each generation are:

- **First Generation (1G) technology:** Advance Mobile Phone System (AMPS) in North America, Total Access Communication System (TACS) in UK, Nippon Telegraph & Telephone (NTT) in Japan and Code Division Multiple Access One (CDMAONE).
- **Second Generation (2G) technology:** Global System for Mobile Communication (GSM) is an accepted worldwide open standard that has many versions for different countries, Code Division Multiple Access (CDMA) and High Speed Circuit Switched Data Technology (HSCSD).
- **Two point five Generation (2.5G) technology:** General Packet Radio System (GPRS)
- **Third Generation (3G) Technology**: Universal Mobile Telephone Standard (UMTS).

2.6.1 Global System for Mobile Communication (GSM)

The Global System for Mobile communication (GSM) is a second generation standard for mobile communication [Dornan 2000]. GSM users can send and receive data at rates up to 9600 bps [Gupta 2001]. GSM currently accounts for approximately 70 percent of the total digital wireless market and spans over 170 countries, providing almost complete coverage in Western Europe. GSM technology is in use by more than one in ten of the world's population and growth is

accelerating. The number of subscribers worldwide expected to surpass one billion by the end of 2003 [GSM Association 2002]. Its popularity is mainly attributed to its early standardisation by European governments. Another advantage is that it is easily upgradeable to higher data rates, a deliberate decision on the part of its inventors.

GSM uses digital techniques primarily for voice transmission and control. The techniques used are Space Division Multiple Access, Time Division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA) to share the radio bandwidth for conversation. Space Division Multiple Access allows the possibility of a system based on a series of base stations each covering a limited area. This cellular principal of space division multiple access is common to all three generations of mobile telephone technologies. FDMA slices the radio spectrum into re-usable 200 kHz chunks of frequency while TDMA enables 8 voice channels in each of this 200 kHz chunk of frequency. GSM operates in the frequency range of 900/1800 MHz in Europe and 1900 MHz in USA [Kramer *et al* 1999].

The GSM system now operates on four different frequency bands. It was originally designed for frequencies around 900 MHz, to reuse the spectrum intended for Europe's analog network. It was later adopted to bands around 1800 MHz, licensed in Europe specifically for GSM, and then to the 1900 MHz band in America for several different networks.

2.6.2 High Speed Circuit Switched Data. (HSCSD)

High Speed Circuit Switched Data (HSCSD) is a very simple upgrade to GSM that gives each user more than one time slot in the multiplex. Standardised by the ETSI in 1997 and first released commercially in 2000, it is the equivalent of tying two or more phone lines together and aggregating their capacity [Dornan 2000].

All HSCSD capable networks or terminals use the enhanced data codec, so that each channel allows rates of 14.4 kbps. The standard allows up to four of these to be tied together, for a maximum of up 57.6 kbps. Intermediate steps of 28.8 kbps are also

possible, and actually more common. It is also possible to have asymmetric data rates, for example, three slots from the base station to the mobile and only two the other way [Dornan 2000].

2.6.3 Code Division Multiple Access (CDMA)

The CDMA technology used in North America is based on the IS-95 protocol standard first developed by QUALCOMM. Work on developing the CDMA standard is conducted mainly by the CDMA Development Group (CDG), a consortium of the main CDMA manufacturers and operators formed to standardise and promote CDMA technology [Kramer *et al* 1999].

CDMA takes an entirely different approach from GSM. CDMA, after digitising data, spreads it out over the entire bandwidth it has available. Multiple calls are overlaid over each other on the channel, with each assigned a unique sequence code. CDMA uses digital encoding spread spectrum radio frequency techniques [Zegras *et al* 2000]. The goal of spread spectrum is a substantial increase in bandwidth of an information-bearing signal, far beyond that needed for basic communication. The bandwidth increase, while not necessary for communication, can mitigate the harmful effects of interference. The interference mitigation is a well-known property of all spread spectrum systems. Like GSM, CDMA operates in the 1900-MHz band as well as the 800 band. CDMA provides speeds between 9600bps and 1.23Mbps.

2.6.4 General Packet Radio Service (GPRS)

General Packet Radio Service (GPRS) is the designed for data, as oppose to voice transmission [Bell 2002]. It promises to give every user a permanent and high-capacity connection to the Internet. GPRS was envisaged as an upgrade to any TDMA-based system, but in fact works only with GSM. The first generation of terminals supports data rates less than that of the more primitive HSCSD technology, rather than the 115.2 kbps seen in promotional literature. It also arrived late, with

products announced in 1999 that had still not been shipped a year later [Dornan 2000].

Nevertheless, GPRS represents a major step forward in mobile networks. Its key improvement is packet switching, which for most data applications is more effective than circuit switching [Bell 2002]. Under GSM or HSCSD, each user has to keep open a full circuit of 9.6 kbps or more for the duration of their time online, even though users spend more time reading web pages than actually transferring information. This is wasteful both for the customer and the operator, one is paying call charges for an idle connection, while the other is committing spectrum that could be more profitably deployed elsewhere.

Packet switching uses bandwidth only when needed, freeing up gaps in the data stream for other users. Under GPRS, a single 14.4 kbps time slot can be shared by hundreds of people, provided they do not all try to use it at the same time. Each has a continuous connection at a very low data rate of 0.1 kbps or less, which bursts to higher speeds when they receive email or click on a hyperlink [Secchi2 2001].

Due to the greater efficiency provided by GPRS, the full spectrum calls for terminals capable of using all eight time slots at once. This would effectively eliminate the rigid TDMA structure, allowing each user up to 115.2 kbps [Bell 2002]. However, such speeds have so far proved elusive.

2.6.5 Third Generation Wireless Technology (3G)

For many reasons, the world of cellular telephony evolved along three different paths in three different places: Europe, the United States, and Japan. All three started with their own analog standard, as no one expected their mobile phone to work in some other country. However, from those first-generation analog systems the world turned digital and issues started to arise. The International Telecommunications Union (ITU), along with all the member nations, started a program called IMT-2000 (International Mobile Telephone). The goal of the program is to develop a single, digital standard that will work all over the world.

3G is a collection of air-interface standards for wireless access to the global telecommunications infrastructure capable of supporting a wide range of voice, data, and multimedia services over a variety of mobile and fixed networks [Secchi2 2001]. The 3G system will integrate different service coverage zones, macrocell, microcell, and picocell terrestrial mobile systems, cordless telephone systems, wireless access systems, and satellite systems. The 3G system is intended to be a global platform and the necessary infrastructure for the distribution of converged services, whether mobile or fixed, voice or data, telecommunications, content or computing [Smolek *et al* 2001]. The ITU has identified the following main objectives and attributes for 3G networks:

- Increased network efficiency and capacity
- Anytime, anywhere connectivity
- High data transmission rates, specifically:
    - 144Kbps in high mobility circumstances (e.g. while driving)
    - 384Kbps in low mobility circumstances (e.g. for pedestrians)
- Interoperability with fixed line networks and integration of satellite and fixed-wireless access services into the mobile network
- Worldwide seamless roaming across dissimilar networks
- Bandwidth capable of supporting high-quality multimedia services
- Increased flexibility to accommodate backwards compatibility to 2G networks

However, setting a standard for 3G is very complex. There is a conflict between GSM and CDMA networks as interested parties on either side want to see their particular network succeed [Shosteck Group 2001].

Additionally, there are huge costs to be incurred. Migrating current 2G networks to 2.5G requires network operators to collectively spend approximately $4 billion. This migration is spared the spectrum-related cost because 2.5G networks use the same GSM band that they used to carry voice signals. By contrast, migration to a 3G environment requires an investment of between $225 billion and $250 billion [Smolek *et al* 2001]. A slow down in the global economy has also reduced the market capitalisation of investors. Universal Mobile Telecommunications System

(UMTS) is one of the proposed 3G standards. Figure 2.4 displays the mobile data services users by bearer networks from the years 2000 to 2005.

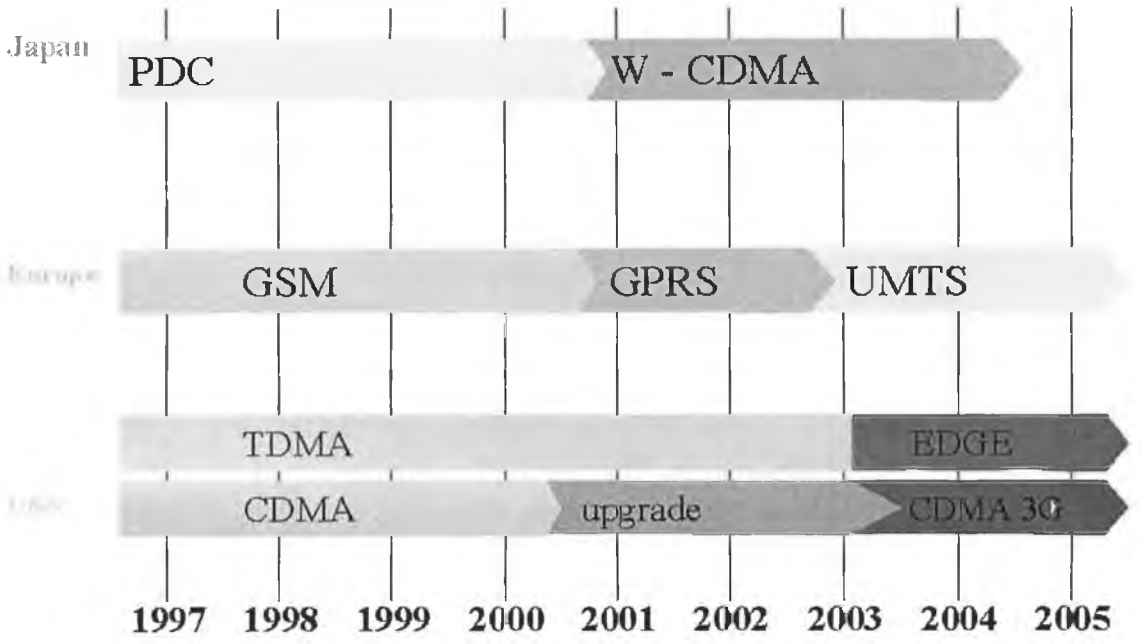


Figure 2.4 Possible Evolution Timeline for Transmission Technologies

2.6.6 Universal Mobile Telecommunications System (UMTS)

Since 1996, the planned European Wideband CDMA (W-CDMA) standard has been known as the Universal Mobile Telecommunications System (UMTS). The UMTS forum outlined its development, an industry and government group who were responsible for the development of a successor to GSM. The UMTS forum succeeded in developing a draft W-CDMA proposal that was compatible with GSM, but it underestimated the worldwide demand for mobile communications. Before a full UMTS standard could be tested and ratified by Europe's procedures, the Japanese picked up the proposal [Dornan 2000]. Their operators needed a new 3G system fast because they were so short of 2G capacity. The first W-CDMA networks are being deployed in Japan by the NTT DoCoMo and J-Phone.

2.7 Wireless Service Technologies

2.7.1 Wireless Application Protocol

WAP stands for the Wireless Application Protocol. The purpose of WAP is to provide operators, infrastructure, terminal manufacturers and content developers a common environment that should enable development of value-added services for mobile phones [Taylor *et al* 2000]. Essentially, WAP is the technology that makes it possible to link wireless devices (such as mobile phones) to the Internet by translating internet information so it can be displayed on the display screen of a WAP enabled mobile telephone or on other portable devices [Toschi *et al* 2000]. WAP is an open, global specification developed by WAP forum that has over 500 members. Motorola, Nokia, Ericsson and the US software company Phone.com (formerly Unwired Planet) were the initial partners that teamed up in mid 1997 to develop and deploy WAP [Wap 2001]. WAP is an attempt to define the standard for how content from the Internet is filtered for mobile communications. Content is now readily available on the Internet and WAP was designed as the way of making it easily available on mobile terminals.

The key elements of the WAP specification are the following [Bennett *et al* 2000]:

Wireless Markup Language (WML) and **WMLScript (WMLS)**: This is a markup language that adheres to XML standards and is designed to enable powerful applications to operate within the limitations of handheld devices. However, many of the standards are not yet fully implemented in existing WAP gateways and clients. For example, early WAP devices do not support the latest version of WML, and support for security and telephony functions varies greatly between providers of gateways and client devices.

Micro-browser specification: This is a specification for the micro-browser that controls the user interface and is equivalent to a standard Web browser.

Wireless Telephony Applications (WTA) framework: This allows access to telephony functionality, such as call control, phone book access and messaging from within WML Script.

WAP stack: This is a lightweight protocol stack that minimises bandwidth requirements, thus guaranteeing that different wireless networks can run WAP applications in a secure manner. Figure 2.5 illustrates the various layers in the WAP stack:

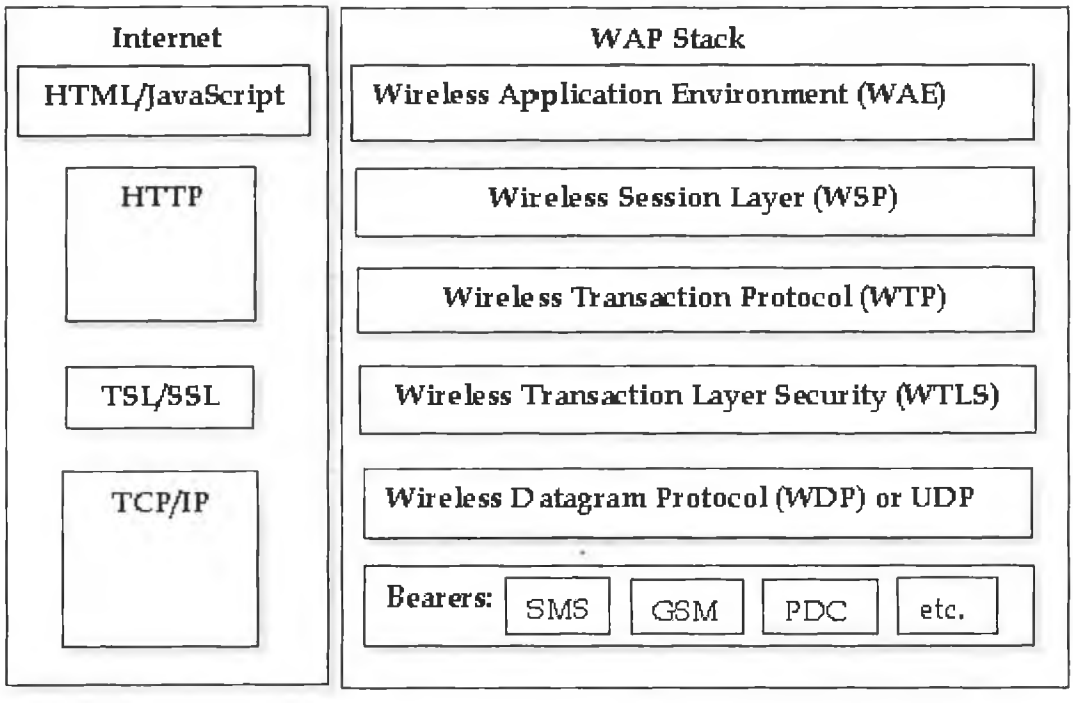


Figure 2.5 Layers of the WAP compared with the Internet

As shown in Figure 2.5 the WAP stack contains a set of protocols dealing with the whole process of content delivery, from the transport of content to the security measures involved. The WAP stack is made up of the following layers [Leisebore 2000]:

Network layer: This is where the various wireless networks are located.

Transport layer: This contains Wireless Datagram Protocol (WDP), which is the wireless version of User Datagram Protocol (UDP). UDP is a communications method (protocol) that uses the Internet Protocol to actually get a data unit (called a datagram) from one computer to another.

Security layer: This contains Wireless Transport Layer Security (WTLS), which provides encryption and authentication for server-to-client security. This prevents fraudulent access to WAP transactions and opens the way for e-commerce and Internet applications.

Transaction layer: This contains Wireless Transaction Protocol (WTP), which is an optional layer in the WAP stack and is the wireless equivalent of HTTP.

Session layer: This contains the Wireless Session Protocol (WSP), which is the interface between the WAE layer and the rest of the WAP stack. The main functionality of WSP is to set up a session between a client and the WAP Gateway.

Application layer: The application layer contains the Wireless Application Environment (WAE), which essentially contains the WML and WML Script specifications. The WAE also includes specifications that deal with how WAP applications can access mobile phone functionality.

WAP Communication Protocols

Internet protocols cannot be used over mobile networks, primarily because of the differences between the two types networks. Most mobile networks do not support IP addresses, and many impose limits on packet size; extra network roundtrips are very costly, and simple recovery from interruptions is vital. To provide these and other features, the WAP protocols define an entirely new-layered model [Bennett 2001].

Web and WAP Protocols

WAP defines a Wireless Session Protocol (WSP) that provides HTTP-like functionality but with added mobile features, including session support. The Wireless Transaction Protocol (WTP) provides TCP/IP-like functionality with added support for transactions and reduced handshakes. The Wireless Datagram Protocol (WDP) provides a low level, UDP-like protocol that maps to the underlying mobile bearer (or IP) network layer. An optional security layer, similar to the Transport Layer Security (TLS—formerly named Secure Sockets Layer or SSL), is provided by Wireless Transport Layer Security (WTLS) [Bennett 2001].

WAP Network

Figure 2.6 outlines the elements that make up a WAP Network:

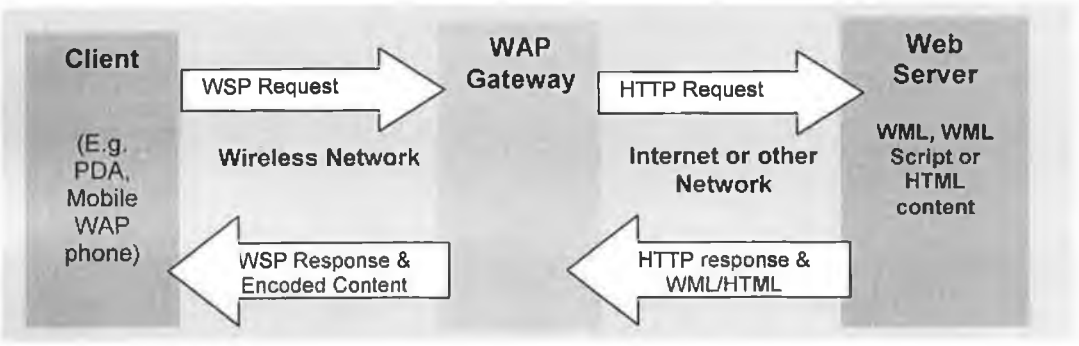


Figure 2.6 Interaction between elements in the WAP Network [Toschi *et al* 2000]

As Shown in Figure 2.6 there are a number of components that make a WAP Network operational these include:

- **WAP Gateway**: The WAP gateway is the mediator between a mobile client and a Web server. Other configurations are possible, including intranet deployment and integration of the WAP gateway and Web server; however, the WAP gateway remains the contact between the mobile device and content sources [Taylor *et al* 2000].

- **WAP Client:** The WAP client (the mobile device) does not communicate directly with a Web server, as is the case with a typical Web client/browser. Instead, the WAP client talks to a WAP gateway via a mobile. The gateway translates between the WAP protocol, understood by the client, and the Internet protocols required by the Web server. The gateway communicates the WAP clients' request, appearing to the Web server as a normal Web client. The gateway also reduces the processing load on the client in a number of ways, including content encoding, session support, and caching [Taylor *et al* 2000].

- **Wireless Application Environment (WAE)**

  The WAE is a vendor-neutral application architecture based on Internet standards. The WAE specifications outline an application programming model that supports browsing, scripting, and extensions that enable mobile network operators to offer network services within WAP. Like the protocol stack specifications, the WAE standards are customised to suit the requirements of mobile devices and networks.

  The WAE defines user agents, services, and formats. User agents are applications that run inside a WAP-capable device. The services that comprise the WAE include Wireless Markup Language(WML), WML Script and supporting libraries, as well as telephony services provided by the Wireless Telephony Application libraries. Each class of information within the WAE is identified by a unique format. Encoding and decoding of content (i.e., WML) ensures that information sent between a user agent and the WAP gateway uses minimal bandwidth [Bennett *et al* 2000]

- **A WAP Request**

  The client hosts a WAE user agent. It makes an encoded request to the gateway via the WAP protocol. The request is directed to a proxy, which translates it into a standard HTTP Post or Get message directed to a target URL. When a server satisfies the request by supplying static or dynamically created WML content to the gateway over HTTP, the gateway encodes the content and returns it to the client using the layered WAP protocol. The client device decodes and displays the information.

- **Security**

  Information can be encrypted between client, gateway, and server; however, this is not available from all clients and gateways. WTLS provides encryption from client to gateway, and TLS between gateway and server. Due to this two-part encryption scheme, all data must be decrypted into plain text at the gateway prior to retransmission. Highly secure WAP services must use a dedicated WAP gateway, with intense work dedicated on end-to-end encryption schemes.

2.7.2 IMode

iMode is a mobile internet access system. "iMode" is also a trademark and/or service mark owned by NTT DoCoMo. It was launched by NTT DoCoMo (Japanese for "anywhere") in Japan. Technically iMode is an overlay over NTT DoCoMo's ordinary mobile voice system [Eurotechnology 2000]. While the voice system is circuit-switched (i.e. the user needs to dial up), iMode is packet-switched [Dornan 2000]. This means that in principal iMode is always connected, provided the user is in an area where the iMode signal can reach them. When the user selects an iMode item on the handset menu, the data is usually downloaded immediately. There is no delay for dialling to set up a connection. However, there is delay while the data reaches the user. This delay is similar to the delay on a regular PC based Internet connection after clicking on a link, or after typing in an URL and pressing the return button. Of course there are further delays, if the information downloaded is too big, or if the network is overloaded [Dornan 00].

iMode uses cHTML (compact HTML), which is a subset of ordinary HTML. However, in addition to HTML tags, there are some special iMode specific tags (for example a tag to set up a link, which when pressed dials up to a telephone number, or another iMode specific tag, informing search machines that a particular web page is an iMode page) [Eurotechnology 2000].

Imode's success is due, to a large extent to the fact, that NTT-DoCoMo made it easy for developers to develop iMode websites. Additionally, because local access charges are very expensive in Japan, people do not use PCs for Internet access as much as in the US or Europe. Here is a list of other possible reasons [Bell *et al* 2002]:

- Relatively low price to consumers for iMode enabled handsets at point of purchase.
- High mobile phone penetration (60+ million mobile subscribers)
- iMode uses packet switched system: "always on" (if iMode signal reaches handset), charges are based according to information accessed not usage time, relatively low fees

- Efficient micro-billing system via the mobile phone bill. A micro-billing system makes it easy for subscribers to pay for value added, premium sites, and attractive for site owners to sell information to users
- Fashion and efficient marketing
- Uses cHTML, which makes it easy not only for developers but also for ordinary consumers to develop content

2.7.3 Mobile Messaging Services

All digital systems, and some analog mobile systems already incorporate some form of messaging. This allows subscribers to receive and send short text messages. It is essentially the same concept as paging, but with data appearing on a mobile device instead of a separate pager [Dornan 2000].

In theory messaging services should allow people to receive email through their mobile and to dispense with pagers entirely. However, in practice, neither of these objectives has been achieved. The reasons are partially technical, as there is a length limit imposed by the very low data capacity, but the main reason is commercial.

Most operators charge for Short Message Service (SMS) using the same model as for phone calls, i.e. whoever sends the message pays for it. This allows the customers to control their own costs. Additionally, mobile operators are not equipped to deal with the type of services offered by paging companies. Most of the messages sent to a pager originate on the traditional telephone network. In order to page someone, the user calls a human operator, who transcribes the message and transmits it.

Operators have made slightly more progress in interconnecting their own messaging networks so that customers of one operator (e.g. Vodafone) can send messages to those of another (e.g. O2).

Digital mobile phones use three types of messaging services.

These are summarised in the Table 2.2.

Service Name	Message Length	Phone System	Direction
SMS (Short Message Service)	140-260 bytes	All digital technologies	Two-way and one-way
CBS Cell Broadcast Service)	1395 bytes	GSM only	One-way only
USSD (Unstructured Supplementary Services Data)	182 bytes	GSM and UMTS	Two-way only

Table 2.2 Messaging Services for Digital Mobile Devices

Short Message Service

The only messaging standard to have achieved widespread acceptance is Short Message Service (SMS). It began as part of the original GSM specification, but has since spread to all other digital systems [Dornan 2000]. The Short Message Service (SMS) is the ability to send and receive text messages too and from mobile telephones. The text can comprise of words or numbers or an alphanumeric combination. The first short message was sent in December 1992 from a Personal Computer (PC) to a mobile phone on the Vodafone GSM network in the UK [Buckingham 2001]. SMS is limited in that, as its name implies, the messages have to be short. GSM imposes a limit of 160 bytes, or characters in length. SMS is a "store and forward" message system, which means that the SMS is not sent directly from sender to recipient, but always via an SMS Center instead. Each mobile telephone network that supports SMS has one or more messaging centers to handle and manage the short messages. Once the message is received at the other end, an optional confirmation message is sent back to the originator. This, in effect, guarantees delivery. Unlike when paging, users do not simply send a short message and trust that it gets delivered. Instead the sender of the short message can receive a return message back notifying them whether the short message has been delivered or not. Due to the fact that SMS messages are sent in the channel control, messages can be sent and delivered even if the phone's voice/data channel is occupied. There are

means of sending multiple short messages available. SMS concatenation (stringing several short messages together) and SMS compression (getting more than 160 characters of information within a single short message) have been defined and incorporated in the GSM SMS standards.

To use the Short Message Service, users need the relevant subscriptions and hardware, specifically:

- A subscription to a mobile telephone network that supports SMS
- Use of SMS must be enabled for that user (automatic access to the SMS is given by some mobile network operators, others charge a monthly subscription and require a specific opt-in to use the service)
- A mobile phone that supports SMS
- Knowledge of how to send or read a short message using their specific model of mobile phone
- A destination to send a short message to, or receive a message from. This is usually another mobile phone but may be a fax machine, PC or Internet address.

Cell Broadcast Service

In cases where it is necessary to send the same information to many different users, broadcasting is more efficient than transmitting separate transmissions to each one. While SMS is a service of individual messages, Cell Broadcast Service is capable of broadcasting one single message to reach all mobile handsets in an area as small as one radio cell and as big as the entire country. Only handsets that have CBS-channels activated will receive the messages. Cell Broadcast was defined in 1993 in phase 2 of the GSM standard. It was not until May 1996 that a German operator started a project to investigate the possibilities of a commercial Cell Broadcast

Service. The first commercial system was launched in March 1998 in Lebanon. Since then various companies have released Cell Broadcast systems and applications that provide some form of cell broadcast functionality. In 2002 Cell Broadcast systems are being deployed in many GSM networks all over the world. Especially the Chinese market has proven to be a rapid growing market for cell broadcast [Cell Broadcast Forum 2002].

Each message is known as a page and can only be ninety three bytes long, however up to 15 pages can be concatenated for a total message length of 1395 bytes, enough for several paragraphs of text or a short program [Dornan 2000]. CBS allows a text or binary message to be defined and distributed to all mobile terminals connected to a set of cells. Whereas SMS messages are sent point-to-point, Cell Broadcast (SMS-CB) messages are sent point-to-area. This means that one SMS-CB message can reach a huge number of terminals at once. In other words, SMS-CB messages are directed to radio cells, rather than to a specific terminal. SMS-CB is an unconfirmed push service, meaning that the originator of the message does not know who has received the message, for this reason it offers operators no way to charge for the services. In theory, there should be a way to overcome these using GSM's encryption facilities, but to date no operator has achieved it. A Cell Broadcast Entity (CBE) is a multi-user front-end that allows the definition and control of SMS-CB messages. A CBE can be located at the site of a content provider. At the site of the operator a so-called Cell Broadcast Center (CBC) is located. The CBC acts as a server for all CBE clients. It takes care of the administration of all SMSCB messages it receives from the CBEs and communicates towards the GSM network. The GSM network itself takes care of delivering the SMS-CB messages to the mobile terminals.

Unstructured Supplementary Services Data (USSD)

Unstructured Supplementary Services Data (USSD) is a means of transmitting information or instructions over a GSM network. USSD has some similarities with SMS as both use the GSM network's signalling path. Unlike SMS, USSD is not a store and forward service and is session-oriented such that when a user accesses a USSD service, a session is established and the radio connection stays open until the user, application, or time out releases it. This has more in common with Data than

SMS. USSD text messages can be up to 182 characters in length. [M2 Presswire 2002]. According to Nokia, the USSD operates up to seven times faster than existing short message service platforms [RCR Wireless News 2001]. USSD is designed to be accessed by programs running within a phone rather than directly from a menu-driven user interface.

ENHANCED MESSAGING SERVICE (EMS)

The Enhanced Messaging Service (EMS) is the ability to send a combination of simple melodies, pictures, sounds, animations, modified text and standard text as an integrated message for display on an EMS compliant handset. EMS is an enhancement to SMS but is very similar to SMS in terms of using the store and forward SMS Centres and the signalling channel to realise EMS. The Enhanced Messaging Service (EMS) came about as a submission to the standards committees by Ericsson. Support for the Enhanced Messaging Service (EMS) has been standardised by extending the use of the long established and widely used User Data Header (UDH) common in SMS. In SMS, the UDH makes it possible to include binary data in a short message prior to the text message itself. EMS has little or no impact on the SMS Centres. The introduction of EMS should be totally transparent to SMS Centres since they already support the User Data Header. The burden of composing the enhanced message will be handled away from the SMS Center, using either a user interface on the handset itself or more likely on an Internet site. The principal modification to existing SMS Centres would be in the case that mobile network operators wanted to charge differently for EMS, in such a case, the SMS Center would have to record the relevant technical values and generate Call Detail Records accordingly. SMS concatenation, stringing several short messages together, will be a key technical feature to enable the Enhanced Messaging Service for the simple reason that complicated enhanced message designs such as sending every alternate character in bold format would occupy a large number of octets in the User Data Header and concatenation would be needed [Mobile Stream 2001].

2.8 Wireless Applications

A wireless application can be defined as any application that interoperates with other applications or server processes via wireless communications. A much broader definition, more accurately referred to as a mobile application, is an application accessed via a mobile computing device such as a PDA, laptop, or mobile phone. Mobile applications do not necessarily have any sort of wireless communication capability. Information could be interchanged with a server via a process known as syncing, commonly used with PDAs [Plesman 2000]. It is the development of applications that give wireless communications usability. Mobile applications provide the following advantages to users [Synchrologic 2001]:

• **Access to Corporate Data:** Whether in the office or travelling, professionals may have access to the corporate data and applications that keep them connected to their organisation's processes. For example, sales staffs may have access to the latest product information for customer presentations. Managers may get the latest data to make decisions when they are away from their offices.
It is access to data communications connections wherever and whenever they are needed that is driving the market.

• **Customer Service:** Retailers and advertisers will bring consumers closer to the point of purchase with more interactive communications using detailed customer profiles. Customers can be notified of new products that have arrived, place orders and have their purchases delivered.

• **Ease of travelling:** Vendors and navigators on the Internet will replace or augment traditional channels. For example, while travelling to the airport, an individual may use their smart phone to select their aisle seat, check in, and reserve a special meal. Navigation around an unfamiliar area is made easy via the global satellite-positioning devices that can be built into the rental car as well as the phone.

• **Personal area networks:** These networks will enable handheld information devices to swap information with any other device in close proximity, automatically. For example, a laptop in a bag could use the mobile phone for Internet connectivity. Or the phone could pull a phone number from the desktop of a nearby associate. Visiting knowledge workers or temporary staff can arrive at a branch office and immediately make connections to the network without having to wait for a hardwired port.

Mobile-enabling applications will be a key IT and business challenge during the next three to five years. Currently 15%-20% of organisations globally have mobile applications projects underway [Firstbrook 2001].

2.8.1 Categories of Application Users

Applications for M-Business within the enterprise can be broken into those that affect employees, customers, suppliers, and business partners. The broad categories of wireless users within the enterprise can be listed as follows:

- Wireless Business to Employees (B2E)
- Wireless Business to Customers (B2C)
- Wireless Business to Business (B2B)

The B2B category includes supply chain management, enterprise resource planning, and electronic marketplaces. The B2B category includes providing traditional business services and value added services to customers via a wireless device. The B2E category includes the sales force and field service workers in addition to executives, managers, and office workers.
It is important that a holistic strategy is adopted for these categories of wireless applications. For example, employees may well need to gain access to the same applications, processes, and information as customers or partners.

2.8.1.1 Wireless Business to Employees

Wireless empowerment for employees is basically about giving employees the access to the information and transactions they need in order to perform their work-related activities. Wireless empowerment can take the form of an extension of existing enterprise applications into the wireless domain. Or it can take the form of entirely new applications built from the ground up (either package or custom) specifically for use in a wireless or mobile scenario. These applications can have a profound productivity improvement for employees, the sales force, the field force, and for executives within an enterprise.

Some of the application areas of opportunity for wireless empowerment of employees are listed below:

- Communications
- Basic e-mail, SMS text messaging, unified messaging, alerts and notifications
- Personal Information Management (PIM)
- Calendar, contacts, tasks, to-do lists, memos
- Intranet Access
- Company directory, office locations, employee directory, hotel/room reservations, travel arrangements, time and expenses reporting, company news
- Internet Access
- Company Web site and applications, competitive intelligence, news
- Sales Force Applications
- Customer/account information, product/ service information, order entry and quoting, inventory management, pricing information, customer service history, lead/opportunity management, competitive information, sales reporting, training
- Field Force Applications
- Dispatch, project lists, service histories, inspection forms, proposals, product and part information, order processing, time and expense reporting, training
- Enterprise Resource Planning Applications
- Executive Dashboard / Business Intelligence Applications

- Key performance indicators, alerts and notifications, financial monitoring, operations monitoring, reporting, balanced scorecard reporting, categorised and prioritised content

Some application benefits of wireless empowerment of employees may be as follows:

- Productivity: Improved employee productivity, Improved sales force productivity, Improved field force productivity
- Delivery of Time-Sensitive and/or Location-Relevant Information
- Cost Reduction
- Reduced Asset Downtime
- Reduced Resource Costs (such as phone, fax, printing, mailing)
- Revenue Generation
- Increased sales
- Knowledge/Decision Making
- Improved Executive Reporting
- Delivery of Time-Sensitive and/or Location-Relevant Information
- Improved Data Capture and Accuracy
- Satisfaction
    - Employee satisfaction
    - Customer satisfaction
    - Customer service
- Positive cultural effects
- Increased competitive advantage

2.8.1.2 Wireless Business to Customers Applications

Wireless empowerment of customers can take many forms: branded cell phones or pagers to increase customer loyalty; access to hotel and airline reservations and information; telematics services for emergency location and assistance; M-Commerce transactions for wireless purchases such as stocks; wireless access to

order status information; product and service information via wireless empowerment of a corporate Web site; alerts and notifications on items of interest; location-based services for marketing; unified messaging for customer support; wireless gaming; informational applications such as news and weather.

The challenge on the business-to-consumer side for the enterprise is to use wireless technologies and applications in order to deepen the relationship with the customer. This needs to be done while providing applications that are easy-to-use, fulfil a need on the customer end, are actionable or informational, and support the diverse set of devices, networks, and standards in use by consumers and business customers. The application areas of opportunity for wireless empowerment of customers are listed below:

- Communications/Collaboration
- E-Mail, SMS text messaging, unified messaging
- Content
- Advertising, loyalty/ branding, travel reservations, product and service information, alerts and notifications, personal information management (PIM), location-based services, telematics, wireless games, remote monitoring
- Transactions/Commerce
- M-Commerce, digital wallet, preferences
- Customer Relationship Management
- Advertising, marketing campaigns, order entry, order status, customer service and support

Some of the application benefits for wireless empowerment of customers are listed below:

- Ability to Enter New Markets
- Ability to Offer New Products and Services
- Increased Revenues
- Reduced Costs
- Increased Customer Satisfaction
- Increased Customer Loyalty
- Competitive Advantage

2.8.1.3 Wireless Empowerment of Partners and Suppliers

Wireless empowerment of partners and suppliers can take on many aspects based upon the role of the partner or supplier. Partners may be resellers, value-added resellers, distributors, wholesalers, suppliers, industry associations, and electronic marketplace participants. The supply chain can benefit from wireless empowerment in almost every process, including purchasing, manufacturing, distribution, and customer service and sales. Mobile technologies have long been used within the supply chain and have typically consisted of bar code scanners for improved data capture and asset management. Additional means of connectivity including wireless LANs and wireless WANs mean that supply chain operations have a full range of alternatives for how, where, and when information is captured and acted upon. Information, goods, and fund flows between partners in the supply chain can now move in real-time versus near real-time or nightly batch operations.

As various industries buy and sell products and services through public or private electronic marketplaces, there is a need for continuous communications with these marketplaces in order to gather pricing information, news and events, order status, bid status, approval requests, and sales histories. Extending these public or private electronic marketplaces with access via wireless devices can provide a solution to this need for continuous information and transactions. One examples is being alerted to bidding events such as an out-bid notification during an online auction.

The time critical nature of the auction process means that wireless access to the marketplace is an essential tool for many participants.

Some of the application areas of opportunity for wireless empowerment of partners and suppliers are listed below:

- Supply Chain Management
- Incident reports
- Instructions and sales orders
- Just-in-time inventory management
- Pick orders
- Delivery and receipt confirmations
- Logistics tracking
- Reports and printouts
- Vendor performance monitoring
- Inventory management
- Warehouse management
- Asset management
- Mobile inventory tracking
- Inspections
- Proof-of-delivery
- Alerts and event notification
- Electronic Marketplaces
- Real-time personalised alerts based on trading events
- Order status
- Collaboration with trading partners

Some of the benefits of the applications for wireless empowerment of partners and suppliers are listed below:

- Productivity
    - Increased productivity of trading partners
    - Increased employee productivity

    - Improved supplier management and productivity
- Revenue Generation
- Improved partnerships
- Cost Reduction
- Improved quality
- Reduced inventory
- Higher service levels
- Satisfaction
    - Increased customer satisfaction
    - Increased customer loyalty
    - Increased business partner satisfaction
- Knowledge/Decision Making
- Improved enterprise latency
- Actionable information
- Improved data accuracy
- Increased velocity, variability and visibility within the supply chain
- Competitive Advantage

2.8.2 The Evolution of Application Development

Figure 2.7 diagrammatically represents the evolution of services provided as mobile application developments and technologies improve.

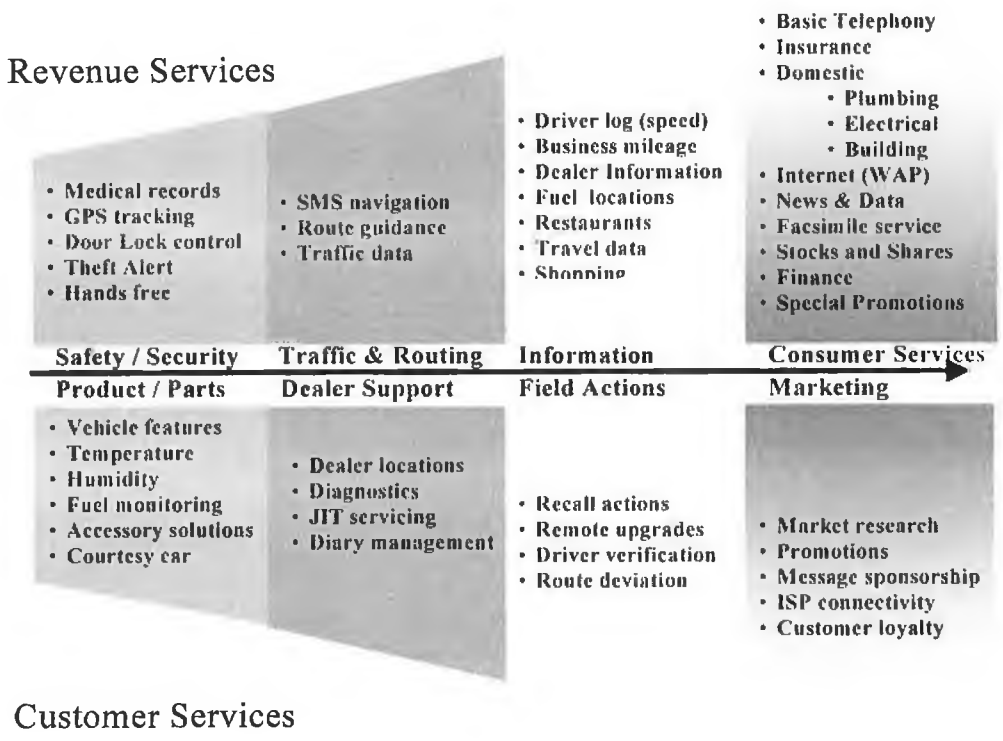


Figure 2.7 Evolutions of Mobile Services

Figure 2.7 presents the evolution of mobile service applications. The realisation of future applications is dependent on the development of the network and service technologies discussed previously.

2.9 Mobile Commerce

Despite the current world economic downturn and the enormous amount of change experienced in recent years, European executives remain enthusiastic about the potential of new technologies. According to an Accenture study, "The Unexpected e-Europe," 83 per cent of executives are expecting new technological change to provide more opportunities than traditional e-Commerce. The study was conducted with executives across 25 countries, focused primarily on Europe, but also included India, Japan, South Africa and the US [Accenture 2001].
The opportunities for mobile commerce services are potentially huge. As the mobile phone becomes an information tool and then a transactional device, the commerce value chain will potentially be disrupted and the revenue will be redistributed to different entities in the value chain. Without m-commerce, the mobile phone is just a voice and data tool, m-commerce makes it a transactional device.

2.9.1 Definition and Background of Mobile Commerce

Perhaps the broadest definition of mobile commerce comes from Durlacher:
"Any transaction with a monetary value that is conducted via a mobile telecommunications network" [Durlacher 1999],

"The term m-commerce refers to the use of mobile devices to complete economic transactions; it also includes the development of infrastructure, applications, and devices to support such transactions" [Ghosh *et al* 2001].

Business has been conducted electronically for more than a century using technologies ranging from the telegraph, telex and fax machines through to credit cards, computer banking and the Internet. With the advent of computer and Internet there has been a tremendous change in the way commerce has been carried out. Exponential increases in capacity and decreases in cost of communications have revolutionised the degree of sophistication of electronic relationships. Electronic commerce (e-Commerce), Electronic Business (e-Business) and Internet Commerce

(i-Commerce) are terms that are used interchangeably to describe the process of carrying out business transactions via an electronic channel. e-Business provide a means of doing business by companies of all sizes, to create new relationships and extensions to existing business built on relationships, networks and webs of activities.

The introduction of new technology promises to fuel the growth of E-Commerce. The technology will provide a means of transacting and purchasing while on the move. This technology is referred to as mobile e-Commerce, Wireless e-Commerce, or m-Commerce.

At the onset of the mobile Internet, mobile commerce was envisaged as "the internet in your pocket". Just like the "paperless office", the "wire free world" came about as a result of media hype and raised expectations [Dornan 2000]. The reality of the situation failed to meet these expectations. Mobile commerce has experienced a similar scenario to that of e-commerce services, many Internet services that were launched in 1995 took many years to become profitable and many have failed [Sheedy 2001]. Wireless technology appears to be moving through the classic technology lifecycle identified by an information technology advisory service group known as the Gartner Group. The Gartner Group describes the concept of a "technology hype curve." This curve represents the life of a new technology from the time it comes into existence until the time it is supplanted by a newer technology [Coyle 2001].

Figure 2.8 **The Gartner Technology Hype Curve** [Coyle 2001]

As Figure2.8 illustrates, the lifecycle begins with excitement and anticipation at what a new technology can achieve. As early implementation approaches, however, marketers fuel the initial excitement up a slope of inflated expectations. Hopes are raised beyond what the technology can realistically deliver. When the initial rollout falls short of marketing promises, expectations are dashed and technology acceptance falls into a trough of disappointment and disillusionment. Then, when the hype has abated, the technology moves up a gradual slope of enlightenment and steady progress.

The hype curve has proven true to date in the case of e-commerce history [Zornes *et al* 2001]. Currently the e-commerce hype has died, with the demise of many dot.com companies and is now veering towards the slope of enlightenment. Mobile Commerce has already been through the Peak of Inflated expectation as expectations for wireless rose sharply as marketers proclaimed the coming of WAP (Wireless Application Protocol) as "the Internet in your hand." Telecomm carriers paid enormous sums to capture this market. Auctions in the UK and Germany garnered winning bids of $35 billion and $46 billion, respectively, for licenses to deliver third-generation (3G) 2 Mbit/sec bandwidth. M-Commerce then experienced the trough of disillusionment, as WAP was unable to live up to its hype. The "wireless Internet in your hand" was far from what mobile users encountered. What they found instead were small screens, user interfaces that required dozens of keystrokes to accomplish even the simplest of tasks, and bandwidth on the order of a frustratingly slow 1980s modem [Coyle 2001]. Presently m-commerce is veering toward the slope of enlightenment as companies are realising that wireless is fundamentally different from wired connectivity.

2.9.2 Requirements for M-Commerce

There are many requirements for m-commerce to be successful. Figure 2.9 illustrates the major requirements for a fully-fashioned m–commerce solution. The elements in the figure are then discussed in greater detail.

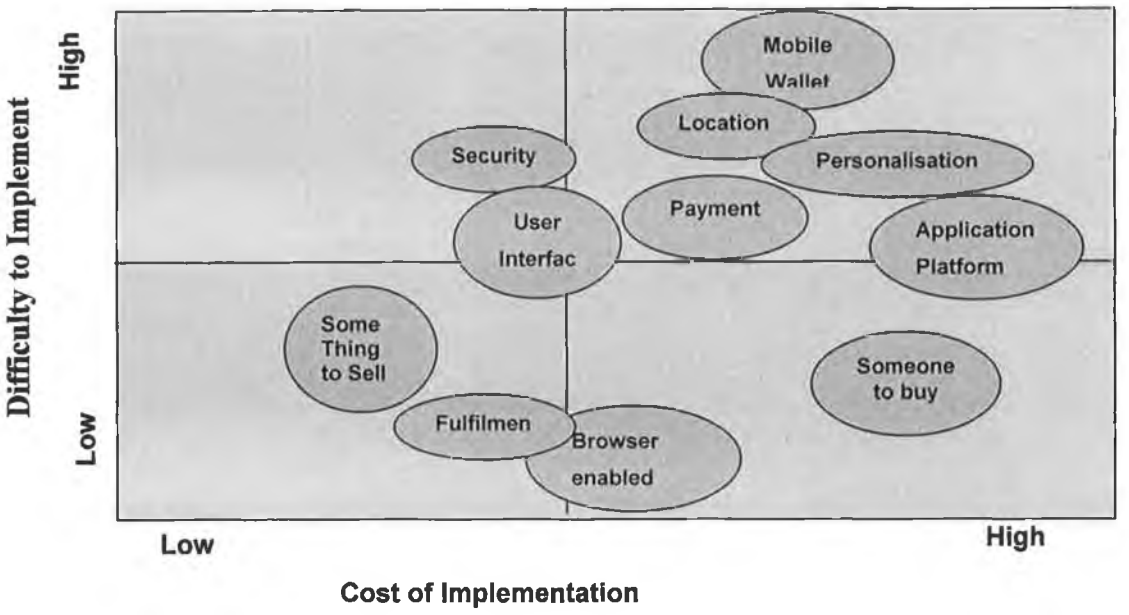


Figure 2.9 **Elements of Mobile Communication, the cost and complexity of Implementation** [Sheedy2 2001]

Something to Sell

The obvious requirement for a successful m-commerce solution is to provide a product or service to sell. The product or service must be delivered across the mobile device or within a short time of the mobile user accessing the service. Individuals using the solution will generally be moving; therefore the requirement will usually be that they need the product or service they have requested immediately.

Someone to buy it

Regardless of how competent the m-commerce solution is, if it does not address or appeal to customers it will fail. There are many m-commerce solutions that will provide usefulness and added value to customers, and there are many that do not. The solutions that individuals do not want will be driven off the market.

Browser-Enabled Device

A very significant factor in the provision of m-commerce solutions is that the individuals using the service are equipped with the appropriate equipment to access the solution. SMS has proven a great carrier for m-commerce solutions; however, it does not have the real-time capabilities and the security to position itself as a

mainstream carrier. Therefore, users need browser-enabled devices, such as a WAP phone or an i-Mode enabled device that enables access to services and security in order to complete transactions.

Security

Security is an obviously important element. Without security individuals will discard m-commerce services. Another obstacle is the users perception of security, even if the operators and developers deem a solution secure, convincing the user of this may prove significantly challenging. As with the adoption of e-commerce solutions, end-user perception of security may prove to be an inhibiting factor for the adoption of m-commerce solutions.

An Interface that is Easy to Use

On the fixed line Internet the display of content can be vast, all of which is displayed on the monitor. In wireless communication the content cannot be crammed into the small wireless screens, as it results in extensive menus that further slow down the already slow system and frustrate the customer. Users are not concerned with the underlying technology; they care about receiving relevant information. Therefore, the content must be minimal but must capture the customer. Every word must begin to build the customer experience so that the customer will value more the tangible value of the product or service itself [New *et al* 2001]. It is for this reason that Personalisation plays a key role in the delivery of relevant individual data.

Payment Facility

If the service is in the Business-to-consumer arena, the provision of a secure payment facility is of utmost importance.

Personalisation

Personalisation is important for m-commerce solutions and mobile Internet solutions in general. Personalisation leads back to the point regarding easy-to-use interfaces. Providing users with content relevant to their profile will eliminate some of the content (i.e. the content non-applicable to the individual). With small display screens and more complex programming devices, it is necessary to acquire detailed

information about users in order to deliver services that they will use. This also adheres to the principal of CRM.

Location

Location is also relevant in realising m-commerce potential. Location is one of the main advantages the mobile Internet has over the fixed-line Internet. Location, along with personalisation, can enhance the user experience for an m-commerce service. It can provide more useful and relevant service to the customer wherever and whenever.

Mobile Wallet

The concept of the mobile wallet is basically the use of the mobile device as a wallet that holds virtual money on their SIM or smart card within the phone, or accessing an account with an operator. The reality of this is still many years away. Mobile wallet services have the potential to alter the means of interaction between consumers and vendors. However, there will have to be changes in infrastructure, retail and commercial services before mobile wallet services become a reality [CISS 2001].

Fulfilment Capabilities

This is the delivery of product or service to the customer as initially anticipated by the customer. This is equally significant in e-commerce. If customer expectations fail to be fulfilled the e-commerce or m-commerce solution will be discarded.

Application Platform

M-commerce solutions are not easy to develop. They often involve the integration of many existing applications with newer applications. Without standards in place to achieve this, developers have a big task to combine different services together.

2.9.3 Opportunities of M-Commerce

The m-commerce market is best described as nascent, with different vendors promoting their own ideas on how the world of m-commerce should operate, in an attempt to attain the attention of carriers, merchants and subscribers. Very few operators have deployed systems that make m-commerce easy to access, and very few companies have deployed easy to use m-commerce solutions [Probe Research 2001]. At present the perception of security is inadequate in the consumers mind, and therefore in the short-term mobile commerce solutions will not become popular for the average mobile user. However, mobile commerce services are in use. As the business world begins to embrace m-commerce opportunities, more m-commerce services will become available. M-Commerce has the ability to deliver e-commerce to the mobile user [Sheedy 2000].

The potential benefits of m-commerce include:

- A new medium to interact with customers
- Provision of value-added services to customers
- Increased Customer Loyalty
- Increased profitability
- Increased Revenue

Companies that have found the right mix of commerce solutions for the mobile user will reap the benefits of m-commerce. The primary focus of all m-commerce development must be based on providing consumer benefits form the solution. The concept of Customer Relationship Management (CRM) plays a vital role in realising this. The basis of CRM lies in finding ways to make customers' lives easier and more convenient for them to do business with a company, to out perform competitors on the dimensions that matter to the customer: control, experience, intelligent value, instant information and recognition [Newell *et al* 2000].

The key success factors for m-commerce include:

- **Customer ownership and Control**: Subscriber data is important to the m-commerce market, which is shown by the recent boom in operator takeovers in the mobile industry. The user's personal data and preferences are the primary means of discovering mechanisms to add value to the user's experience.
- **Personalisation** is a major feature, which can be achieved by creating services that customise the end-user experience for the individual subscriber. It can be further enhanced if intelligent personalisation platforms are added, which will optimise the interaction path for individual subscribers.
- **Location sensitive information** is significant as it provides easy access to relevant data sources at the locations where they are needed. The main target group are travelling subscribers, which have diverse needs for high-quality information.
- **Ubiquity**, this means making services available at any time, anywhere. Time-critical applications, which offer the ability to receive information and perform transactions from any location. A major challenge will be to provide mobile users with a similar level of access and information than now is available in a fixed line environment.
- **Instant Information.** The value of information that is inherent in its immediate delivery is a determining factor for the success for mobile operations.
- **Convenience.** M-commerce solutions that provide added convenience to the users are an important element. The proposal is that if the use of technology should enhance the quality of life, then technology becomes valuable. The operators of the m-commerce value chain play a principal role to make this happen, and it may be possible to find ways to carry out business process re-engineering activities in this value chain. The perceptions and the substance of what creates convenience for the users will be different for users of different cultural backgrounds, and it will be a challenge for global operators to find ways to diversify and adapt their services to different user groups.

2.9.4 Future of M-Commerce: Ubiquitous Commerce

E-Business and M-Commerce share the need to manage customer expectations, while simultaneously, understand the customers' needs and behaviours. The third generation of technology will bring about ubiquitous commerce or u-commerce. U-commerce is a dynamic convergence of the physical and the digital, the interface of traditional commerce with Web-based wireless and other next-generation technologies in ways that will create new levels of convenience and value for buyers and sellers. It is about the integration of more value-added information into each transaction, in ways that benefit both consumers and businesses. U-Commerce is the combination of new and traditional forms of e-commerce. The new forms of commerce include wireless, television, voice and silent commerce. Figure 2.10 shows the transitions that are occurring in the field of electronically enabled commerce:

Figure 2.10 Transitions in electronically enabled commerce [Accenture 2001]

As shown in Figure 2.10, m-commerce is a component of electronically enabled commerce. With advancements in 3G technologies and other areas of electronically enabled commerce, such as e-commerce and silent commerce, m-commerce will eventually merge and integrate with these components to realise Ubiquitous Commerce (U-Commerce).

Figure 2.11, outlines the stages of development of each of the components in the realisation of ubiquitous commerce:

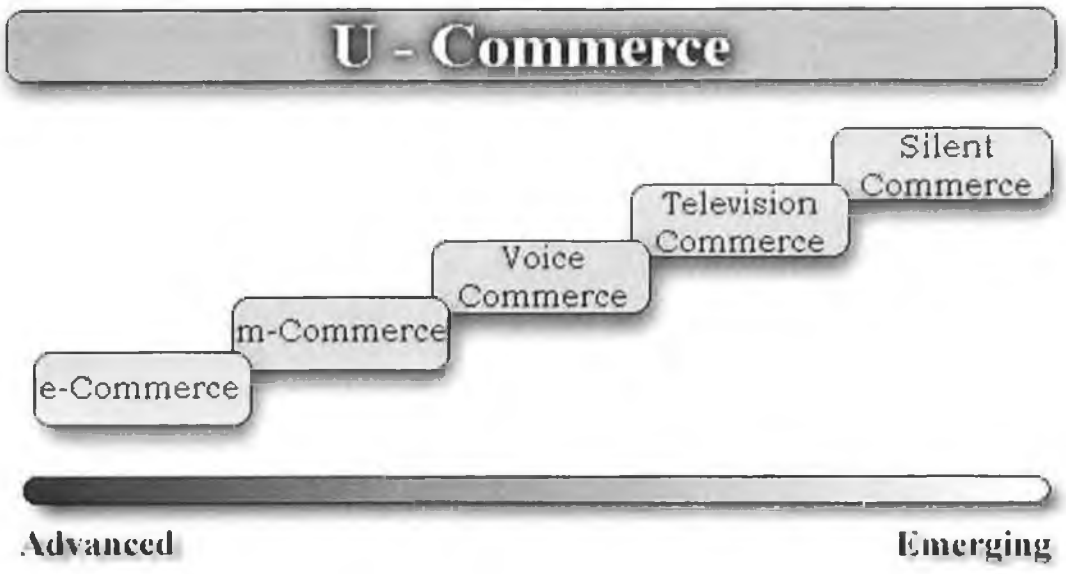


Figure 2.11 **The State of U-Commerce** [Accenture 2001]

As shown in figure 2.11, the realisation of both e-commerce and m-commerce are ahead of other elements in u-commerce. Given that e-commerce and m-commerce are still going through the "technology- hype curve", without either having reached the true "slope of enlightenment" (see figure 2.8), it is fair to assume that the realisation of u-commerce is still in the distant future.

2.10 The Wireless Customer Experience

The customers' permission is very important to the success of an m-commerce development. With e-business the customers are using a computer on a fixed line [Vyas 2001]. In this respect the customer grants the permission to the company. They choose when, how and to what extent they access a business.
Wireless communication presents new opportunities in that with 2.5G network technologies the customer is "always on". They are always reachable, contactable, and receiving. Therefore they can always be interrupted. It is essential that the

customer does not perceive the m-commerce applications they encounter as interruptions, as the failure of such applications is inevitable. Developing applications that acceptably interact with customers, on their terms, must be the primary consideration of any m-commerce endeavour. It is critical to enterprise agility that Information Technology and business objectives work together to focus on customer data management and analysis, as information assets. Therefore, m-commerce should not be based on bombarding customers and prospects with selling messages. Instead, it should be about finding new ways to provide the customers with new, easier and convenient ways to do business with a company, and thereby to out perform competitors on the dimensions that matter to the customer: control, experience, time, intelligent value, instant information, and recognition.

[Treacy *et al* 1997] indicates that an organisation can be competitively successful only when it excels in one of three competency areas, while maintaining proficiency in the other two categories, these are:

- Customer intimacy
- Product leadership
- Total lowest-cost solution (i.e. operational excellence) [Treacy *et al* 1997]

Having a focus on the initiatives that support an organisations core competency provides competitive edge and is critical to the enterprises success. A common error of organisations is to ignore customer preferences in determining their core competency. Not understanding what the customer wants, and is willing to pay for can be fatal [Bischoff 2001]. An example of this is Apple Computers, which in the 1990s incorrectly assumed that product leadership was the only measurement. As a result, it kept the prices of software and hardware at higher prices, with less customer intimacy, and lost the opportunity to gain market share.

A good example of a mobile application that delivers real customer care is one developed for Swissair customers: Swissair enables passengers to check in for their flights at Zurich Airport, using their WAP-enabled cell phones. Passengers can confirm flight number, departure time, gate and seat assignment, and they can be notified if there are any changes to the flight. Swissair has also added a "Fast Track System" that provides passengers with a card containing an embedded microchip that identifies the passenger wirelessly at passport control, thereby allowing the passenger

to bypass additional check-in procedures and proceed directly to the gate without a paper ticket. The card also activates at the customs window, wirelessly bringing up passport information on the computer. The card also serves as an identification mechanism for duty free shopping, and reports to Swissair when the customer enters the terminal. If the customer has not boarded the plane, he/she can be messaged to come to the appropriate gate.

A good wireless customer experience involves much more than usability or interface design. The service needs to make sense within the constraints of wireless technology and small, handheld devices. The wireless feature must provide a customer experience that is better than existing alternatives. For example, wireless Internet access in Japan is more convenient than wired (PC) Internet access because of low PC penetration and a variety of other cultural and economic factors [Hurst *et al* 2000].

2.11 Conclusion

This chapter has discussed Wireless communication and the pertinent issues that surround the relatively new wireless technologies. It has identified the difference between the traditional Web and the Wireless Web. It has discussed the advantages that may be realised in the deployment of Wireless technologies and applications. It has also highlighted the obstacles that present themselves in the development of wireless solutions. Wireless networking, service technologies and application categories have been identified and discussed. The identification, requirements and future of Mobile Commerce have been addressed. At the latter part of this chapter the concept of providing valuable customer experiences has been introduced.
It is critical to the success of any solution that it addresses a problem. This is basic common sense, however, as technology becomes a more integral part of a business customer interaction with its customers, it is essential that the customers requirements are still the prime focus. The next chapter discusses CRM. Adherence to the principal of CRM (i.e. customer focus) is vital to ensure the success of technological developments.

Chapter 3

Customer Relationship Management and Small to Medium Size Enterprises

3.1 Introduction

This chapter will discuss the concept of Customer Relationship Management (CRM), establishing what CRM is, how it has evolved, the various categories and areas of CRM, and the role technology plays in the realisation of electronic CRM. The chapter will then discuss Small to Medium size Enterprises (SMEs). It will discuss the resistance among the Irish SME community in adopting eBusiness solutions, and the benefits that can be realised by SMEs who do adopt eBusiness solutions. Finally, the role of CRM within an SME environment will be addressed, and the reasons why an SME should consider the concepts of CRM prior to the implementation of any technological solutions.

3.2 Customer Relationship Management (CRM)

Customer Relationship Management (CRM) is also known by other terms such as relationship marketing, customer management and customer care. The term *CRM* was first introduced in the mid-1990s [Lee 2002].

3.2.1 Definition of CRM

Hector D. Trestini [Trestini 2000] states that Customer Relationship Management (CRM) can be defined *"as a business model that has, as its principal goal, the identification, anticipation and understanding of the needs of potential and current customers, to increase retention, growth and profitability"*. CRM may include a series of business and technology functions that contribute to the successful management of the lifecycle of customer and partner relationships: from marketing and acquisition, to service and retention. As such, "*CRM is a business strategy, and not a technology. However, technology is critical to accomplishing this goal, since CRM is dependant upon the capture, storage and analysis of customer-related data*". It can be seen as a business model that utilises technology functions in order to deliver personalised services to customers and partners [Trestini 2000].

Customer relationship management (CRM) can also be defined as a business strategy to select and manage the most valuable customer relationships. It requires a customer-centric business philosophy and culture to support effective marketing, sales, and service processes. CRM applications can enable effective customer relationship management, provided that an enterprise has the right leadership, strategy, and culture [Thompson 2002].

3.2.2 The CRM Concept

It is imperative that CRM strategies have a well-defined, acceptable set of business processes to support initiatives. CRM is the process of acquiring, retaining, and growing profitable customers. It requires a clear focus on the service attributes that represent value to the customer and that create loyalty.

CRM itself is not a technology, but a process of gathering and retaining information about customers and their interactions with a company. CRM was practiced by businesses long before CRM technology came along. In a small business environment CRM may be practiced every day, the owner, manager or employees know the customers individually and what services they tend to require. However, when the customer base extends to hundreds or thousands of customers across the globe, this intimate knowledge of individual customers becomes impossible. Therefore it becomes necessary to employ databases and automated tracking tools to provide the same personalised services.

It is widely acknowledged that how customers are treated greatly determines a company's future profitability. Technology has reduced time and distance, resulting in a rise of customer expectations. Instant access to companies and information has shifted the balance of power in the buyer-seller relationship to customers. Customers can decide how, when, and where they will interact with companies. The quality of customer relationships is regarded as a key factor in sustaining competitive advantage. Therefore, reorganising the company around the customer has become a competitive mandate. The concepts of CRM have come into being as a result of several factors, these include:

- The failure of enterprise resource (ERP) planning systems to provide a lasting competitive advantage for companies [Cripps 2001].
- The time frame of innovation-to-production-to-obsolescence has expedited, providing an abundance of options for customers and reducing market opportunities for businesses.
- Customers with Internet access can obtain information about competitor's offerings, and transfer quickly and easily.

3.2.3 Background to CRM

In the early 20th century the sale of goods was production orientated. Understanding the customer and identifying their needs was unnecessary for many businesses. Customers made purchasing decisions based on what was offered, as opposed to what they necessarily wanted. Customers were somewhat limited, in that their expression of preferences was made through purchasing decisions [Newell *et al* 2001].

This *production orientation* continued into the 1920s. Manufacturers then experienced increased competition and began to emphasise selling as the foundation of their business initiatives. This *sales orientation* focused on finding customers to buy the products manufactured by a company. Still, there was little attention paid to individual customer needs or trying to understand the customer.

By the middle of the 20th century, companies began to take a more customer-orientated view. This orientation became known as the *marketing concept*. It is based on three objectives: a customer orientation, the coordination and integration of all business activities, and a focus on the long-term profitability of the organisation.

The *new* view of business, which began to emerge in the 1950s, represented something of a breakthrough in management thinking. During the next 40 years, the concept of marketing came to be very closely aligned with McCarthy's "four Ps"; product, price, promotion, and place [Gordon 1998]. The implication behind this view of marketing is that if these four elements of the marketing mix work in harmony; the outcome is a business success.

The value of the marketing concept was that it focused attention on the customer. The objective was on what a company could do to attract the customer. The disadvantage of this concept was that the view of what would satisfy a customer was rather narrow in scope. The assumption was that a better product, priced competitively, and advertised widely, would ultimately ensure success. Customers were seen to be passive.

As the field of marketing matured, managers and academics began to realise that customers did recognise value and that customers are not all alike [Barnes 2001]. Companies began to focus more attention on taking a strategic approach to business, as previous approaches proved unfocused, wasteful and demeaning to customers. The result was a new era of business, one dominated by great progress in a strategic approach toward market segmentation, product and brand positioning, differentiation of the product offering, and really understanding what customers want and need. The reasons for this change of approach was brought about due to the following factors:

- **The Cost of Losing Customers**

  Information systems in many firms were being refined to the point that managers, many for the first time, were able to calculate at least a rough estimate of the value of a customer and therefore of the cost of losing that customer [Lee 2002]. The economics of customer turnover became obvious. The revolving-door view of customers, which saw a firm working very hard and spending significantly to attract new customers who were merely replacing those who were leaving, became very unattractive. The cost of replacing defecting customers became obvious. As a result, many firms began to focus for the first time on strategies to satisfy and retain existing customers, as well on trying to attract new ones [Sanders *et al* 2002]. For many of them, it was the first time they had been able to treat the customer as an asset or an investment to be managed.

- **Quality of Service**

  With the growing emphasis on the rapidly expanding service sector and on services in business in general, more attention was paid to the companies' interaction with its customers, and how the customer perceived the company. With advances in services marketing thinking came a realisation that many factors contribute to whether or not a customer comes back.

- **E-Business**

  The emergence of the e-business introduced a new opportunity for customer relationship building. Search engines made it easier for customers to find online merchants and interact with them. The Internet simplified bi-directional communication, for the first time offering a better way for the customer to relay information to the merchant. Instead of having to wait for a letter or wait on a phone line, a perspective customer only had to click a send button. This resulted in shorter delivery time, improved accuracy, and often a higher positive perception [Dyche 2001].

- **Competition**

  Currently, not only has competition become global, it has been raised to a new plane. Some years ago, those firms that were able to deliver products of high quality gained an advantage over their competitors. Presently, in most manufacturing industries production standards and advances in technology mean that products rarely fail. Similarly, in many service industries the delegation of service provision to technology and generally increased service standards mean that service provision is often accomplished without error or disruption. Companies now compete by trying to develop genuine relationships with their customers, with the realisation that having good products/services is no longer enough. The focus of a relationship-based approach to doing business is an understanding of what the customer wants and needs and a view of the customer as a long-term asset who will provide a stream of earnings as long as his or her needs are satisfied. The view that successful business meant having a great product and a great price was no longer seen to be sufficient. That is not to say that product and price are not important, they are, but rather that having them is not sufficient to guarantee business success in the form of customer loyalty and a long-term mutually beneficial relationship [Barnes 2001].

3.2.4 Evolution of Service and Maslows Hierarchy of Needs.

In the late 1960's Abraham Maslow, a humanistic psychologist developed a hierarchical theory of an individuals needs [Connect 2001]. Maslow focused on human potential, believing that humans strive to reach the highest levels of their capabilities. Maslow developed a hierarchical theory of needs, which is shown in Figure 3.1.

Figure 3.1 Maslows Hierarchy of needs

As illustrated in Figure 3.1, all the basic needs are at the bottom, and the needs concerned with human's highest potential are at the top. The hierarchic theory is often represented as a pyramid, with the larger, lower levels representing the lower needs, and the upper point representing the need for self-actualisation.

Figure 3.2 outlines how the evolution of customer service has similarities with Maslows Hierarchy of needs.

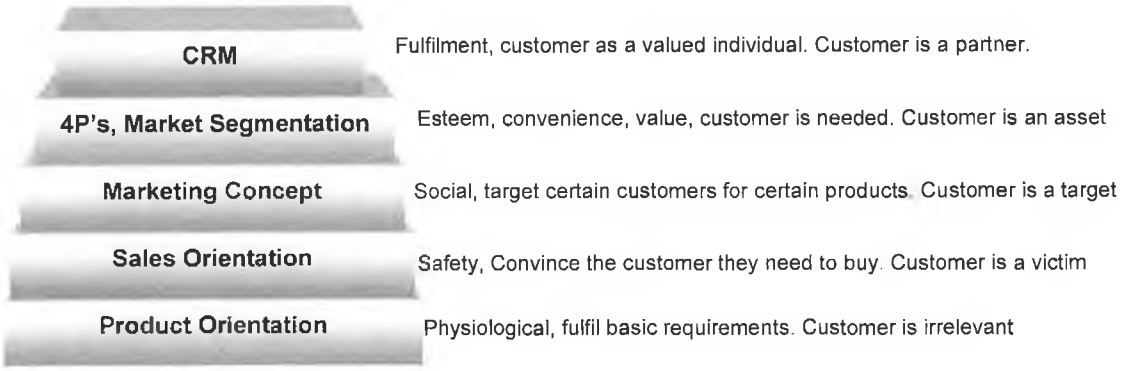


Figure 3.2 Evolution of Customer Service

Figure 3.2 compares the evolution of customer service with Maslows Hierarchy of needs. Businesses began by providing basic necessities; customers became accustomed to having these requirements satisfied and began to demand more, this continues from each level to the next. At each stage the customer is becoming more powerful and their demands continue to increase.

- At the **bottom level** the customer is provided with the basic necessities to address fundamental requirements.
- **Second level**, the customer is provided with more helpful products and services that are a little more luxury based.
- **Third level**, the customer is provided with more enlightening products/services, with extra features and functionality specific to their requirements.
- **Fourth level** the customer is more empowered and provided with goods and services that enhance image, are competitively priced and appear superior to the Customer.
- **Top level** the customer is at the core of the businesses development process. Everything that the business does is instigated to address customer requirements. The customers dictate their own requirements.

3.2.5 Customer Relationship Management Categories

The three types of CRM are operational, analytical and collaborative:

Operational CRM includes any application that captures transactions or processes orders or enquiries. Automating core processes around customer activities enables business requirements to be focused on. These processes are typically anchored on productivity value via process effectiveness [Zornes *et al* 2001].

Analytical CRM refers to the analysis of transactional behaviour. The analysis is provided by businesses in the data warehousing and data mining areas. Analytical CRM capabilities include collecting, analysing, and applying customer data to provide personalised customer relationships. Originally, CRM focused heavily on the implementation of a process to solve an operational problem. The importance of analytical CRM has been realised, as the failure rate associated with CRM has been high. On examination, the underlying reasons for failed CRM implementations stem not from technology limitations but from business and organisational process issues [Young 2001]. CRM analytics may provide the basis for moving into several areas including personalisation as part of an over arching goal of one-to-one marketing. Companies concerned with appearing to do CRM rather than understanding it may still not accept analytical CRM [Cripps 2 2001].

Collaborative CRM is provided by applications that can embed the business processes within those of the customer, or vice versa [Lauchlan 2001]. Optimising internal and external customer interactions focuses customer collaboration as the engine for customer intimacy [Zornes *et al* 2001]. Business requirements should focus on customer contact points and internal/external interaction models.

3.2.6 Major Areas of Customer Relationship Management

There are three major areas of CRM. These are Service, Sales and Marketing:

Service

The area of service is probably the most crucial when it comes to customer relationship management. The customer service that an enterprise provides is key to its ability to maintain satisfied loyal customers [Dyche 2001]. The service that is expected today goes beyond the traditional methods, where customers either phoned the business or called in person to telephone call centers. Business customers have busy schedules and cannot afford to waste valuable time waiting on hold to get service. Many companies are evolving their contact points into an assortment of communication media. Telephone interaction must be coordinated with email, fax, web, and wireless, depending on the communication media that the customer prefers to use. Self-service is a fast growing requirement, as more customers are making their way to the web and want to look up their order status or make queries via their browser. Customer service clearly reaches beyond traditional procedures. The term "Customer Care" is being used today to broaden the company's' responsibility toward the customer. Proactive relations with the customer are an important part of what customer service is about. Customer service handles all types of customer queries, including product concerns, information needs, order requests, and fulfilment inquiries, as well as providing quality field service [Shulman *et al* 2000].

Sales

The system must empower sales professionals with a single, real time view of the customer and automated tools to manage all aspects of the sales function. The interaction of the sales force with the prospect, turning the prospect into a customer and then maintaining a loyal relationship, is a core business concern for the company's success. The sales process must be managed across many domains interfacing with other business units. Sales Force Automation is frequently expanded to include forecasting, contact and quote management, proposal generation, and win/loss analysis. Sales personnel are an essential source of information for the business and must have the tools both to access up-to-date field information and to provide this information to others.

Marketing

Marketing Automation includes lead generation, lead capture and management, campaign management, and telemarketing. Today, initial mass marketing activities are often used for the first contact, and are then followed up by more focused campaigns with specific target audiences in mind. Personalisation is quickly becoming the expected norm of interaction, where the customer's preferences and buying habits are taken into account. Content management and one-to-one marketing have emerged as trends with a mission of better addressing customers with the relevant information for their specific needs. Marketing activities have evolved from traditional telemarketing to web and e-mail campaigns. These web-based marketing activities give prospects a better customer experience, allowing the relevant information to be retrieved by the prospects on their own terms and in their own time. For maximum value, follow-up of these campaigns must be done in collaboration with the sales force to enable qualified leads and success/failure analysis. Management of marketing campaign costs as well as marketing events (trade shows and seminars) has significant value for future planning and Return On Investment (ROI) analysis.

3.2.7 The CRM Strategy: Process, People and Technology

Despite the acronyms' interpretation, CRM is not solely based on customers. It is increasingly being recognised that there are linkages between employees' satisfaction, employee retention, customer satisfaction, customer retention, sales and profitability [Payne 2000]. The starting point for introducing or further developing CRM must be determined from a strategic review of the organisation's current position. Companies need to address the following broad issues:

- What the core business process is and how it will evolve in the future
- How employees feel about the adoption of a CRM Strategy and what human resources principles are in the provision of customer value

- What form of CRM is appropriate for the business now and in the future

- What IT infrastructure is in place and what is needed to support the future needs of the organisation.

CRM requires a seamless integration of every aspect of the business that interacts with the customer. The process includes the business strategy, the people, and technology as shown in Figure 3.4.

Figure 3.3 CRM: A People, Process and Technology Integration [Fox *et al* 2001]

The business strategy process is the driver of the process that gives direction to the company. In turn, the strategic direction moves the two enablers, which are the people and technology. The interaction of these elements with business processes determines the success of customer relationship management [Fox *et al* 2001].

People

Difficulties may arise if the employees are resistant to change. Employees who have not understood the reason for change, who did not participate in the formulation of the change, who lack sufficient information about the change, or who did not get adequate training on the change will naturally be averse to that change [Goldenberg

2002]. Deploying CRM technology is no excuse for discriminatory employment practices, intentional or otherwise. Many firms do not understand the importance of employees in the creation of value. Customers inherently understand and appreciate the importance of people in service provision. They comment when employees are unhelpful, when there is insufficient staffing at busy times, or when employees are constrained by rules and regulations from spending time with customers [Barnes 2001]. Customer information is provided at the point where customers and the company interact. The people at this point should have the ability to communicate with customers in a manner that recognises them, remembers their contact history, understands the current customer issues, predicts anticipated behaviours and suggests appropriate responses, solutions or suggestion [Gordon 1998].

The Process

CRM requires that processes be engineered around the customer, which may require essential changes to existing processes [Gordon 1998]. Understanding the value of CRM requires a significant shift in mindset, learning to value qualitative rather than just quantitative benefits. To build the customer database, it is necessary to capture the information from the customer. Capturing customer information is the foundation of a CRM program. The capturing process is not always easy and must be accomplished with great customer care and understanding [Newell 2000]. Things that get in the way of value creation frustrate customers. Such frustrations include difficulties for customers to get through on the phone and inquires that are not addressed [Raphel *et al* 1995].

Technology

Some customer's perceive the introduction of technology into service provision as an interference with value creation. Many customers make dislike the fact that they resent having to interact with technology in order to access service. Many are averse to the impersonality of service provided by technology. Having the option to do one's banking through an ATM or by phone or Internet is perceived by some to be value-adding in that it creates both choice and convenience value; but for many others it diminishes value because it reduces relationship value. Therefore, it is critical that a business establishes that deploying a technology will address customer requirements, that the technology will be used by customers who benefit from its existence, and that the customers who are averse to using it are dealt with in the manner they prefer [Payne 2000].

3.2.8 CRM in Business-to-Business Environments

Business-to-business CRM adheres to the same concept as business-to-customer CRM. Likewise, it involves engaging individuals in interactive dialog to learn what they truly value and to learn their needs for solutions.

The only difference is that managing the customer relationship is a greater challenge in business-to-business programs than in consumer efforts because the relationship is more complex involving both an individual and a business. In business-to-business environments, the value of any individual is directly tied to the business application he or she manages. It is the individual acting on the business applications with the product that creates value for the customer [Maddox *et al* 1998]. Therefore, in dealing with business-to-business customers the focus must be placed on the individual and his or her requirements, rather than on the company he or she works for. In some cases, the most important individuals are those who do not actually buy anything but are the ones who most strongly influence the final purchasing decision. Many business products are purchased as parts for other business products, so the relationship in those cases is more like a partnership.

Despite the complexity there is also opportunity in business-to-business Web sites. The majority of businesses already have computer systems. Therefore, business customers are familiar with using technology. Additionally, they are generally highly motivated to save money, which means there is less reluctance to look online for savings.

3.2.9 Technology, the Web and Electronic CRM

While CRM is a familiar concept, electronic Customer Relationship Management (e-CRM) is a new means of using software to deploy CRM. E-CRM is the automation of CRM. It is not a specific technology, but has developed into the unified management of many technologies or systems to create a seamless view of customer and company information [Sanders *et al* 2002]. From an Information Technology (IT) perspective, the changes in CRM practice are being driven both by evolving customer demand and by developments in the enabling technologies [Ryals *et al* 2001]. In considering how CRM should be implemented, information technology plays a pivotal role in enabling companies to obtain more precise customer information. This involves leveraging relationships through the use of technology. Powerful new technological approaches involving the use of databases, data marts, data warehouses, data mining and one-to-one marketing are assisting organisations to increase customer value and their own profitability [Payne 2000]. Technology can greatly assist in managing the data required to understand customers so that appropriate CRM strategies can be adopted. In addition, the use of IT can enable the necessary data to be collected to determine the economics of customer acquisition, retention, identification of root causes of defection, service issues and corrective action to improve retention.

Technological Internet developments are continuing to create new and innovative connections between service organisations and customers through the development of a self-service environment [Shulman *et al* 2000]. The Internet gives people a tool that allows them to identify themselves to businesses they want to do business with. It is the most powerful means of communication ever developed [Newell 2000].

The World Wide Web (the web) is the most important part of the Internet and has brought E-Business into being. E-Business and CRM can move IT from the expense side of business to the revenue side [Breidenbach 2000]. The Web can be characterised as follows [Ryals *et al* 2001]:

- **Constant availability of information:** Information that is stored on the web can be retrieved at any time. As the information is electronic, not physical, it can be transferred to any country in the world in just seconds using the worldwide network of data lines.

- **Information can be addressed directly:** The Internet enables people to communicate directly and immediately regardless of their spatial or temporal distance.

- **Interactivity:** This term denotes related activities of several parties. The information users get depends on what they have entered before. For example, the Web allows fast browsing through a great variety of pieces of information that are interlinked. The user is provided with different data depending on which link he or she selects.

- **Individuality:** Real time interactivity enables individualisation of communication. The Web lets the user select information individually, providing specific, relevant, and up-to-date information. It also allows organisations individual design of products in accordance with the clients' conditions and preferences of consumption resulting in an optimum and customised adjustment of product quality.

- **Integration of communication and transaction:** The Web provides an opportunity to order products and services directly. There still are acceptance and security problems in the field of electronic cash transfer, so that this opportunity is used to a limited extent only.

- **Self-Service:** In the rush to embrace e-business, in most cases little consideration has been given to the implications of self-service as it relates to resolution of problems. Customer contact with human agents is typically cumbersome and inefficient. Currently self-service applications are often poorly designed. They can offer significant cost cuttings to the organisation, and should be built to add value for the customer in terms of ease of use, the provision of new and enhanced service, espically in terms of making best use of the customer's valuable time.

3.2.10 E-CRM Deployment Considerations

Information technology can only create a competitive advantage over competitors if it is used effectively. IT can be utilised to overcome market entry barriers, lower production costs, differentiate products and create novel distribution channels. However, there are many challenges in moving to a true electronic customer relationship management (e-CRM) environment, including [Frawley 2000]:

- **Consistency**

  E-CRM is not purely a strategy to cut costs. Internet and Web technologies must provide opportunities to support personal service based on an individual customer's needs and provide interactions with the company that are able to match or exceed a customer's expectations.

  The e-CRM application must meet the following essential conditions:

  - Provide a unified and consistent view of the customer every time it interacts with that customer.
  - Through the use of consistent customer data allow staff to perform their jobs more efficiently, thereby provide a better customer service.
  - Allow customers to have a holistic view of the organisation, regardless of how they chose to contact the organisation.

- **Technology**

  There are a number of key points that will impact on the successful use of technologies in the provision of e-CRM:

  - The willingness of different customers to use the technology
  - The performance versus customer expectations of the technology
  - The integration of new technologies with existing ones
  - The design and development of a technology foundation that enables deployment of the right technology
  - The maturity of technology and certainty or uncertainty of its success

- **Change Management**

  The implementation of technology must provide an IT infrastructure capable of supporting an integrated channel strategy underpinned by customer-centric thinking and action, which will be achieved only through effective management of the transition. This affects many key areas, including:

  - Organisation Design
  - People and Culture Changes
  - Business Processes
  - Management Processes
  - Training and Recruitment Requirements
  - Performance Measurements

- **Technology Adversity**

  The extravagant spending on failed online businesses such as boo.com have given the Web an impression of being expensive and wasteful. However, efficiency and effectiveness are more appropriate associations. Internet savings can be realised. Calculated risk has always been a part of doing business. The change that has come about as a result of the demise of many dot.com companies is that businesses now focus more intensely on the calculation as oppose to the risk. Technology issues should not outweigh the business issues. Information technology must adhere to the company's business logic, as that is why it is being adopted [Swift 2002]. How technology affects the business is of greater importance than how the technology works.

3.2.11 The role of E-CRM

Technology can serve multiple roles within a company and between a company and its customers, including:

External Communications

- Facilitating two-way interaction between individual customers and the company about every aspect of their requirements
- Providing a more rapid or informed communication than is possible with manual intervention
- Opening new approaches, such as the use of wireless communication, to communicate with customers and distribution channel intermediaries and using the Internet to communicate with customers, channel members and other partners
- Communicating with other stakeholders including investors, board of directors, employees, management, suppliers and distribution channel intermediaries

Internal Communications

- Removing disparate functionality from the many individual internal processes and technologies that face the customer, including call centers, Internet access, order, shipping, billing, field sales force, dealer sales, direct mail and mass advertising so that the customer relationship can receive clearer attention

- Uniting diverse communications systems, communications channels and databases so that the company becomes a more informed supplier with whom it is easier to do business

Computing

- The role of computing in CRM is to provide organisational memory for customer relationships, a predictive ability and current content needed by business to add value to the service provided

- Computing is used primarily to facilitate storage and retrieval of huge amounts of data that provides information of a number of factors important to the advancement of the customer relationship.

Content

Content includes customer information, customer context, customer behaviours and customer profitability. Customer information includes data describing customer demographics, locations, usage patterns, order frequency and preferences.

- Customer context captures information to describe the priorities the customer emphasises, the decision-making unit, criteria for buying and the purchase processes.
- Customer behaviours captures the information reflecting interactions before the sale, during and post sale; the number, nature and scale of orders; and other behavioural information.
- Customer profitability tracks the financial performance of the account with a costing methodology that recognises all the costs and time associated with selling to, servicing and financing a customer, not just the cost of goods sold.

Knowledge and Insight

- Technology must enable the Relationship Marketer to develop new knowledge and insight about the customer relationship and facilitate action on the information.
- Software, modelling and reporting tools can help add value to the underlying data and even predict what an individual customer will do, helping the marketer to be proactive in customer management.

3.2.12 Wireless E-CRM

Freedom from wired communication will change customers' actions, habits and behaviours [Newell *et al* 2001]. New technologies such as wireless technology give customers the freedom to broaden their choices. As mobile devices are inherently personal devices, it gives enterprises a new means of interacting with the customer on a one-to-one basis. Customers no longer have to be treated equally. Instead, they can be treated individually. This opens a new window of opportunity for businesses to enhance the experience of their customers. CRM is about providing customers with information that is relevant and pertinent to their requirements. In the same respect, given the limitations of current wireless technologies and devices, providing users with irrelevant data is wasteful of valuable resources. Therefore, deploying wireless solutions forces developers and companies to identify customer values, and adhere to the CRM concept of putting customers at the development point. The challenge for wireless CRM application development is to establish how to create and deliver customer value that goes beyond the product or service. Additionally, it may prove difficult to develop a real-time understanding of customers' needs and expectations, to ensure that the applications is perceived as valuable by the customer.

3.3 Small-to –Medium Size Enterprises (SMEs)

The term *Small and Medium-sized Enterprise* is regularly abbreviated to *SME*. It is a broad term used to distinguish a small business from a Large Scale Organisation (LSO). It proves difficult to establish a precise definition for SMEs.

3.3.1 Definition of an SME

'A general definition of SMEs is not possible. The concept varies from country to country and from sector to sector. As a general rule, however, the community accepts that an SME should not have a workforce exceeding 500, net fixed assets exceeding ECU 75 million or have more than one third of its capital held by a larger firm' [ECSC 1991].

SMEs are also summarised according to ownership, management, organisational structure and market shares as displayed in Table 3.1.

Ownership	• Normally owned by one or a few people • Owner or owners relatives own all or a large part of the company • It is independent of outside control
Management	• It is managed and operated by its owner or owners in a personalised way • Only a few people are involved in significant and critical decision making, and many day-to-day operations • It has a restricted range of products, technologies, services, expertise • It has limited resources and capability • Management systems are inadequate and informal
Organisational Structures	• Due to being managed and operated by one or a few people, the organisational structure is centralised and flat • As it has a small number of employees, it has a limited adequate segregation of functions.
Market Share	• It has a small share of the market or a share of a very small market

Table 3.1 Definition of a Small & Medium-Sized Enterprise [Chen 1995]

As shown in Table 3.1, SMEs differ from LSOs in the following respects:

SME Ownership: a significant factor in the progress of an SME lies in the career motivation and business growth expectations of individual SME managers.

Management: As there are a small number of employees it is achievable for the manager(s) to maintain a close working relationship with staff. However, SMEs tend to experience budget and resource constraints, and therefore have limited resources. The systems employed to manage information, accounts etc. tends to be basic and lacking in functionality.

Organisational Structure: Control of the business rests with only a few people. The manager is either the owner, and/or the company is managed by a very small number of people. Therefore less discussion is needed and there are less internal conflicts.

Market Share: Generally SMEs provide specific services or products. They are limited in what they can produce/provide by resources, budget, internal expertise and human resources.

3.3.2 Irish SMEs and Information Technology

Figure 3.4 outlines the state of play regarding Irish SMEs and technology.

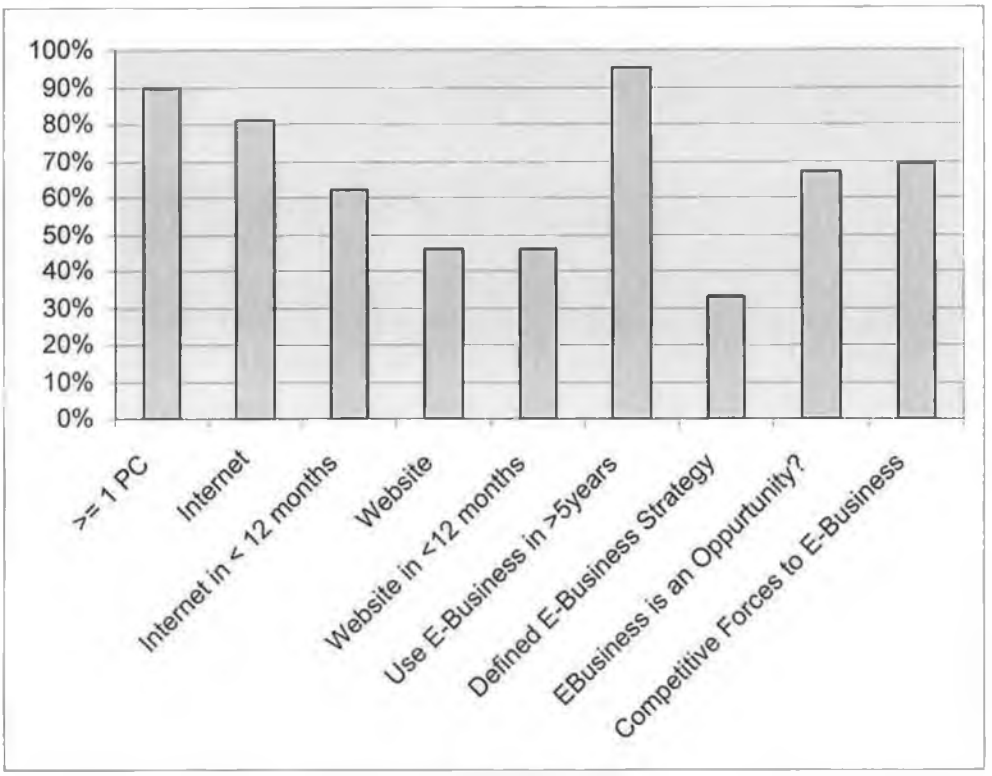


Figure 3.4 Irish SME Technology Data [Chamber of Commerce 2001]

As shown in Figure 3.4:

- **>= 1 PC:** 90% of Irish SMEs have at least one computer
- **Internet:** 81% have Internet access
- **Internet in < 12 months:** Of the companies that do not have Internet access 62% were likely to have access within the next 12 months
- **Website:** 46% have there own website
- **Website in <12 months:** 46% with Internet access but without a web site were likely to have a web within the next 12 months
- **Use E-Business in >5years:** 95% expect their use of Internet and e-Business to increase over the next 5 years
- **Defined E-Business Strategy:** 33% had defined an e-Business strategy.
- **E-Business is an Opportunity:** 67% believe that e-Business will offer new opportunity to their business
- **Competitive Forces to E-Business:** 69% believe that competitive forces are pushing them to get involved in e-Business

3.3.3 Irish SMEs and their adversity to eBusiness

In April 2000 technology stocks dropped alarmingly and the NASDAQ recorded it's second worst drop in history [Konrad *et al* 2000]. These events lead to a global down turn for the technology sector and brought about the demise of many dot com companies. The impression that many are left with is that the eBusiness revolution has not only failed, but has played a major part in causing the present economic turndown.

The pace of adoption of eBusiness by Irish SMEs has been slow relative to other European SMEs [Campbell *et al* 2001]. Irish SMEs have, for the most part, been spectators seeing the huge demise in the dot com sector followed by a huge down turn in the global economy, along with declining share values and growing job losses in the high-technology sector.

The reasons that there is reluctance among the SME community to tackle fundamental eBusiness Strategies include the following [Campbell *et al* 2001]:

- E-Business has failed to deliver on its promises
- Technology is expensive
- Technology lacks interoperability
- Technology determines business processes rather than follows them

An additional significant factor is that Irish society in general resists using e-Business channels: according to a 2001 Amarach report[1], 47% of Irish people say they will never use the Internet, and only 15% of Irish internet users use e-commerce services [Amarach 2001].

[1] "Eir-Commerce 2001 Ireland's Consumer Internet Economy: Gloom or Boom?"

A major obstacle for SMEs may still be psychological. Attempting to bring a revolutionary eBusiness system to replace or more efficiently manage an existing system is a difficult task. This is because, although it may be slow and inefficient, the old system has worked well for years and the employees are familiar with it. Employees may fear that the technology may be too advanced for their level of skills or that the technology may be capable of making them redundant, and therefore will resist embracing it.

Contrary to the Irish situation, there is a still a strong underlying commitment to eBusiness from businesses in Europe, the United States and Japan. According to a 2001 Accenture[2] report, fifty per cent more European executives expect to increase their eBusiness spending by fifteen per cent next year, and forty nine per cent plan to pursue mCommerce within the next three years [Accenture 2001]. While this report was not carried out exclusively on SME companies, it does point out that, as a main priority, Irish SMEs must adopt positive steps to ensure they realise the benefits of e-commerce in order to remain competitive and sustain an overall national competitiveness. 90% of Irish businesses are SMEs [Campbell *et al* 2001]. The longer these businesses are offline the more likely the chances are that they will demise in the face of international competition.

The collapse of many technology companies has had one positive effect: the hyped publicity and propaganda that surrounded eBusiness is now dispersed.
The single largest enabler for eBusiness will be improvements in technology that provides solutions that can deliver on a long-standing promise that technology can revolutionise. Technology providers must develop products and services that recognise the limited financial and IT resources where IT is not a core business function.

[2] "The Unexpected eEurope", an eCommerce report commissioned by Accenture Corporation.

3.4 CRM and SMEs

SMEs have an advantage over Large Scale Organisations, in that a more intimate knowledge of the customer base is achievable. Many SMEs, particularly in the retail sector, are higher priced than their larger competitors. Customers are often prepared to overlook the higher price and to keep going back. The reason for this is because value is delivered in different ways. Value is measured by the level of service, the expertise of the employees, how the customer is treated, and the way the customer feels in dealing with a small firm [Barnes 2001]. SMEs can customise their level of service, if not their products, to satisfy the needs and desires of individual customers. SMEs have several advantages that make it possible for them to deliver better service and greater value than larger companies. They are more innovative mainly because they are not held back by rigid company policies and procedures. Generally, in SMEs internal decision-making is flexible, owing to a lack of bureaucracy in the organisation. Decision-making also provides faster response time in dealing with customer issues and complaints. There is often an open door policy in a small firm, whether formally or informally, where both employees and customers feel they are able to communicate directly with the managers or owners of the organisation when issues arise.

The most important element is communication, which, in the process of building and maintaining relationships, comes naturally to SMEs as they conduct business. As customers and staff have more opportunities to interact, their conversations become more meaningful and a deeper understanding of each other develops. As a result, the parties feel closer and relationships form. In turn, employees and owners often know what customers want, even before they ask [Barnes 2001].

However, as a company's customer base extends, competitive pressures become more threatening and ever-increasing customer expectations grow, maintaining customer intimacy and relationships becomes more complex. In addition, new e-business and m-business applications make transacting with competitors an easier, faster and more effective option. SMEs need to maintain their customer relationships, as it is this that gives them an advantage over LSOs.

3.4.1 The Deterrents to Implementing an ECRM system in an SME

Customer relationship management (CRM) solutions have been very successfully used to deliver benefits to large organisations worldwide, but most small and SMEs have yet to realise the full advantages of CRM.
SMEs lack the financial resources of LSOs. Customer Relationship Management software from vendor such as Siebel and Onyx has historically been out of reach for SMEs. It is prohibitively expensive [Yankee Group 2000]. Additionally such software requires technical expertise to implement and maintain [Lee 2002].

There are three interrelated reasons that SMEs resist the adoption of CRM solutions: They are commonly perceived as too complex to implement, too expensive, and too risky.

- **Complexity**
  SME managers often believe that CRM solutions are suited only for enterprises with unlimited development resources and budgets. Aware that a CRM deployment may take several weeks and may require in-house IT specialists and training professionals, SME managers anticipate that such an implementation will be time consuming, and resource intensive.

- **Expense**
  CRM vendor solutions are expensive [Lee 2002]. The cost of software is a major investment. Add to this the related expenses of implementation, customisation, training, maintenance, and administration, and CRM quickly becomes more than most SMEs can commit to.

- **Risk**
  There are no guarantees that the system will deliver the benefits required. For many SME managers considering sizable investments, that is an unacceptable level of risk.

3.4.2 The Approach to CRM Implementations for SMEs

Starting simple

In a well-managed CRM deployment, simplicity, not complexity is best. The focus should be on the number one tactical need and add features in a modular fashion as business needs develop.

Controlling the budget

Being small and growing modularly means that the SME can utilise resources effectively. This keeps the IT budget under control by reducing software, customisation, implementation, and administration costs.

Reducing risk

In a well-managed deployment, risk is minimised, and selecting the right solution protects investments. It is critically important for SMEs to leverage the best implementation practices.

3.4.3 Reasons to Implement e-CRM

The key rule for SMEs is to understand what customers will value prior to adopting any technology to provide a solution. Many customers understand their own requirements but do not necessarily know what fulfilling those requirements is worth to them. To business, this lack of understanding may be an opportunity to demonstrate persuasively the value of what they provide and to help customers make good purchasing decisions.

In many Irish SMEs who do not utilise technology, CRM is a manual, paper-driven procedure, comprising of spreadsheets, notebooks, and sticky notes. There is a growing awareness that these processes are inefficient and impossible to control and that they hinder efforts to improve customer experiences.

Deploying solutions by building or purchasing separate applications that store customer information in disconnected data storages is futile, because these data silos do not communicate to each other, there is no means of achieve a single view of customers. These disconnected applications can result in the following:

- **Lost opportunities**
  In a disorganised system, the tracking of opportunities becomes hit or miss, with little consistency of practice or control over activities. Managers cannot create accurate and reliable forecasts. Business is routinely lost, and no one in the company has the information needed to regain it.

- **Higher costs**
  In a disorganised system, everyone works at less than optimal productivity. So much time is spent on administrative tasks; such as re-keying customer information from one application to another, that attention to building customer value inevitably suffers. Many people in the organisation, highly trained and highly paid, spend most of their valuable time performing these tasks.

- **Competitive disadvantage**
  In this competitive world, where fast moving corporations compete with slow ones and customer service is absolutely critical to maintaining customer loyalty, companies that are slow to focus on service and leverage technology are falling behind. Unable to respond to customer demands, they are already at a competitive disadvantage with an IT gap. As their competitors enhance their systems, that gap will widen.

The main drivers for SMEs to adopt customer relationship management services include:

- They need to effectively monitor, manage and personalise the sales life cycle from lead generation to sale
- The importance of real-time automation and linkage of sales prospects, customers, and company employees for better management and control of information
- The importance of data mining customer information for additional sales opportunities and improvement in customer service and support
- The growing customer expectation of quality 24 hours, 7 days per week customer support.

3.4.4 CRM Solutions for SMEs

CRM Software Vendors

There are several vendors providing CRM software solutions on the market including: Siebel, Onyx and Oracle. These solutions are usually expensive. Therefore, serious analysis of the advantages and expenditure should be exercised prior to purchasing. Slogans like "Our software will support you regardless of your needs" or "You should buy software first and reconfigure around it" are not credible and vendors who claim these slogans are best avoided [Lee 2002].

To optimise the benefits of a CRM solution, SMEs must select solutions that are not only comprehensive, but are also specifically tailored to the special requirements of the SME. The issues of complexity, cost, and risk must be managed and minimised. The following factors need to be considered during the selection:

- Rapid deployment
- Ease of enhancement
- Lifetime support for upgrades
- Low total cost of ownership
- Provider reliability

Web-Based CRM Applications

Web-based CRM applications may provide a more financially and technically viable alternative to monitor, manage, and personalise customer interactions. Additionally, Web-based applications will enable a company to partake in e-Business services that adhere to CRM. From an SME perspective, the advantages of Web-based CRM applications as opposed to vendor solutions are as follows [Yankee Group 2000]:

- Less technical expertise is required to use and maintain a web-based system
- Real-time automation of information system
- Open communication with customers
- Easy analysis of data

Wireless CRM Capabilities

Adding wireless capabilities to a CRM service portfolio will be a priority for many companies in the next few years [Young 2001] [Accenture 2001]. Wireless services provide a valued added component to CRM strategies.

3.5 Conclusion

This chapter has discussed CRM, SMEs and outlined the options that SMEs encounter in the deployment of applications that adhere to the CRM concept. The aim of this chapter has been to highlight the importance of CRM considerations in the development of both e-business and m-business technological solutions. It is of critical importance that the technologies discussed in Chapter 2 are deployed in a manner that addresses individual customer needs. Customer Relationship Management is not a new concept, however the use of technology to automate CRM efforts is. The adoption of CRM is being fuelled by recognition that long-tern relationships with customers are one of the most important assets of an organisation. Successful customer relationships will create a competitive advantage and resulting in improved customer retention and profitability for the company. The main challenge for SMEs seeking to adopt a CRM strategy will be in transforming their business from product to customer centricity.

Web-based CRM applications offer SMEs access to sophisticated solutions. Unlike larger companies, most SMEs do not have the IT resources and money to implement and manage enterprise-class CRM applications. Web-based CRM applications are an effective alternative for smaller companies.

Chapter 4

Electronics Technology Company, AMT Ireland

4.1 Introduction

The previous chapter discussed the role of CRM and in particular its role in an SME environment. For the purposes of applying this research, a single SME company is selected.

This chapter will present an overview of the company. It will provide general background information about the company. Next, a detailed examination of an area within the company will be discussed, as this is the area for which the applications will be built. The current business process and information structure and CRM system within the company will be analysed. Finally, the issues that occur within the current system will be identified.

4.2 Overview of Electronics Technology Company

The Electronics Company is part of AMT Ireland, and is located in Holland Road, County Limerick. It was founded in 1988 and is a leading supplier of advanced Manufacturing Management and Technology Consulting Services to Irish Industry. AMT Ireland provides a wide variety of services. This thesis concentratrates on the Electronics Technology Company, and primarily on the Material Services within the Electronics Technology. Any reference to the "company" for the remainder of this thesis refers to the Electronics Technology company of AMT.
The electronics industry within Ireland constitutes a significant part of the company's customer base.

4.2.1 Services Provided by Electronics Technology Company

The company has a total of six employees. The Services offered by the Electronics include the following:

- **Research and Development**

  The research in the areas of manufacturing engineering and reliability testing of electronic components is carried out in order to apply the latest technology to redesign products and recapture competitive advantage for its customers.

- **Training**

  Training is carried out with accreditation from the Institute for Printed Circuit board (IPC). It is provided for companies who wish to train or enhance the knowledge of their workforce. Training is provided in the following areas: The essentials of Surface Mount Technology (SMT), Hand Soldering for SMT, Hand Soldering for Plated/Pin Through Hole (PTH) Technology, Pad and Track, Induction to Electronics Manufacturing, SMT Inspection, Rework and Workmanship Standards, Optimising Wave Soldering, and The Essentials of Ball Grid Array (BGA) Technology.

- **Manufacturing Engineering Services**

All of the work in manufacturing services is conducted in accordance with the Institute for Printed Circuit boards (IPC) and with ISO 9000 accredited system. The services include the following:

  - **PCB Prototyping**
    The PCB prototyping service offers a quick turnaround prototyping service on SMT, PTH and thick-film assembly with process capabilities for BGA, micro Ball Grid Array (mBGA), flip-chip and fine pitch technology.
  - **Low Volume PCB Assembly**
    It has an advanced manufacturing facility for low volume PCB assembly. It delivers fully populated printed circuits from conventional through hole to high density double sided SMD/BGA.
  - **PCB Rework and Repair**
    Advanced rework and repair of PCBs includes services such as: Pad and Track repair.

- **Materials Reliability Analysis Services**

The company can assist in improving process quality for its customers through its Materials Testing Analysis Service. It provides a range of tests, which give its customers the assurance of high quality in their process.
This part of the company is the area for which the applications will be developed and will be dealt with in greater detail in section 4.3.

Purchase requisitions and invoices for the Electronics Technology company are processed by the AMT central office. However the company is run autonomously in every other sense. It is a stand-alone company. Its employees are each responsible for the output and profitability of their section within the company. For this reason the Electronics Technology company will be analysed in the same regard as an SME for the purpose of this thesis.

4.2.2 Electronics Technology company organisation

Figure 4.1 outlines the various subdivisions within the company and the activities that take place in these areas.

Figure 4.1 Overview of Electronics Technology Company Structure

Currently there is one manager who is responsible for overseeing all areas within the company and in addition is responsible for carrying out research and development. For each of the services there is at least one dedicated expert assigned to a service. The customer base differs for each subdivision of the company. Therefore, in each area within the company the dedicated expert is responsible for dealing with their specific customers, as there is no single employee dedicated to customer-service. They are also responsible for the preparation of annual budgets and targets. Additionally, they must manage costs and marketing campaigns for their particular section.

Figure 4.2 outlines the hierarchical structure of the employees at the Electronics Technology Company.

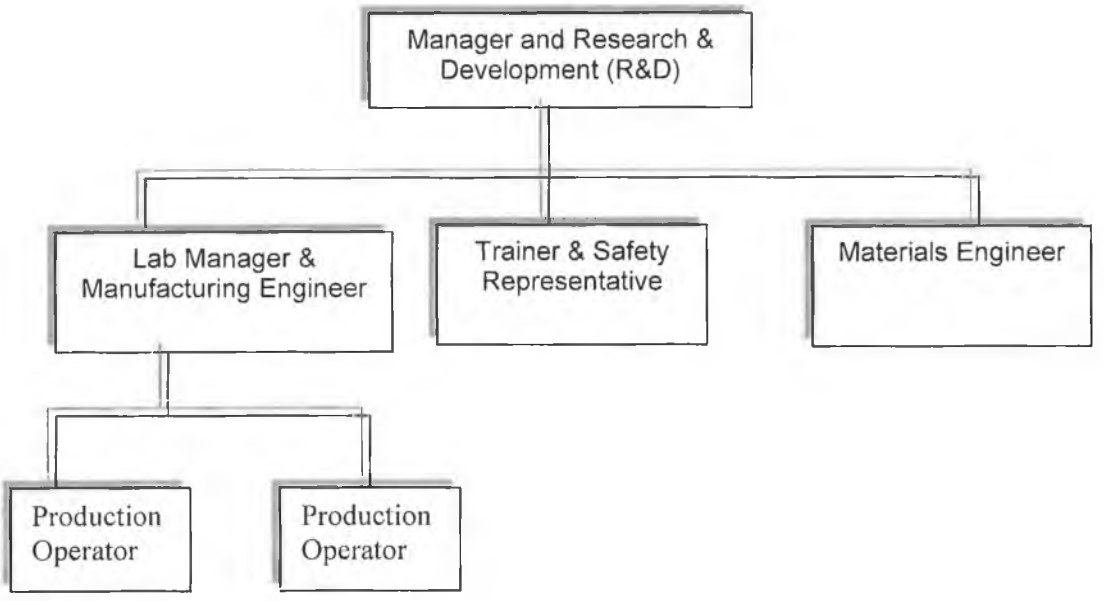


Figure 4.2 Electronics Technology Employee Hierarchical Structure

Figure 4.2 explains the roles of the six employees. It is also evident from the figure that each employee has a very distinct role within the company. The employees predominantly work in their area of expertise. Only in the event of absence do they additionally adopt the role of another employee. The manager is experienced in all sections of the plant and therefore, can adopt any role necessary.

4.2.3 Quality Procedures

The Electronics Technology company adheres to ISO 9001. This is an International Standard for Quality Systems. The standard specifies the requirements and recommendations for the design and assessment of a management system, the purpose of which is to ensure that the suppliers provide products and services that satisfy specified requirements. The company is committed to best practice and continuous improvement, by providing consistently reliable products and services to meet their customer's expectations.

There are ISO 9000 procedures drawn up by AMT for all procedures that take place within the company. Examples include: safety, maintenance, design control, process control, product identification and trace ability, inspection and testing, control of

non-conforming products, procedures for testing, procedures for the handling, storage, packaging and delivery of products, meetings, and document writing.
There is an annual audit carried out by the CVA (Client Value Assured), which is an Internationally Accredited Certification Body or Registrar. The audit is carried out to ensure that the employees are adhering to the procedures and that the procedures in place are beneficial and sufficient. The manager also carries out quarterly internal audits to examine the above. ISO 9001 gives customers confidence when dealing with the company. Having the procedures in place also maintains the workflow in an organised and manageable manner.

4.2.4 Finance and Cost

Customers are invoiced at the end of each month. A sales requisition is completed by the engineers for their section in the company (i.e. materials engineer draws up the sales requisition for reliability analysis). The total incomes made from projects for that month are totalled to establish the monthly income for each section. For the materials laboratory the estimated income for the end of this year is €80,000.
Each of the services generate different amounts of income. The cost is determined by the amount of time spent executing the tests and the amount of manual work expended. The majority of costs are established according to the amount of hours it takes to complete the project and then an hourly rate is applied. All costs are monitored and all purchases are documented. The total number of projects for the year is recorded, and the most frequently requested services are recorded. The total costs, such as phone and equipment expenditure, and the engineers salaries are subtracted from the income. All of this detail is added to the performance review, which is drawn up at the end of the year.

This section provided an overview of the Electronics Technology Company of AMT Ireland. From the next section, 4.3, onwards the thesis will discuss the Materials Service area of this company. It is for this area that the Web and Wireless CRM applications will be developed and implemented.

4.3 Material Services

The operations of the material service laboratory are managed and controlled exclusively by the Materials Engineer. This involves assembly reliability analysis. Additional work involves participating in research activities in the areas of materials and optics, the drawing up of proposals for grants, and the management of projects that are received. All of the administrative requirements for the laboratory, along with the purchase of new equipment, and adherence to ISO requirements are also included in the materials engineer's job function.

4.3.1 Services Provided

The services provided to customers who deal with the materials laboratory are concerned with assembly reliability analysis. This involves the testing of electronics, mainly printed circuit boards (PCBs). Customers may request any of the tests provided by the material laboratory to be carried out. The engineer executes the required tests to establish a conclusion regarding the quality of the part(s) tested. These tests may include any of the following shown in Table 4.1:

Test Name	Duration
Scanning Electron Microscope (SEM) Analysis	Approximately 2-5 Days
Energy Dispersive X-ray (EDAX) Analysis	Approximately 2 Days
Ionic Contamination	15 minutes per sample.
Micro-sectional Analysis	Samples 1 hour - 2 days to prepare, set, polish and photograph.
Solder-ability Tests	Approximately 10 minutes per sample
Tensile Tests	Approximately 5 minutes
X-Ray	Approximately 10 minutes per Sample

Table 4.1 Analysis Tests and Durations[1]

[1] See Appendix A

4.3.2 Process Flow of Materials Laboratory

The normal process involved from the customers' request for services to the final outcome is demonstrated in Figure 4.6.

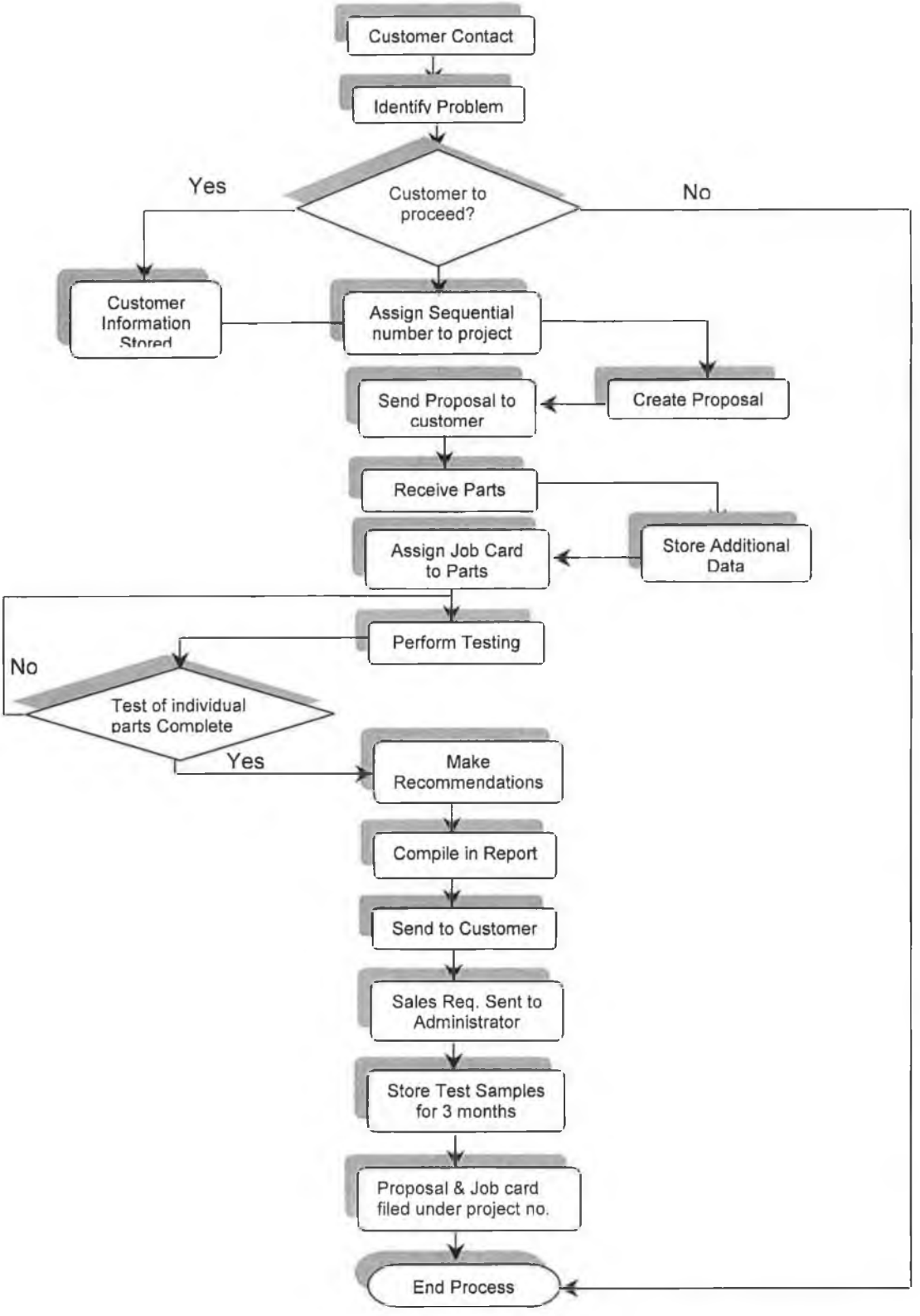


Figure 4.3 Process Flow of Materials Laboratory

Figure 4.3 illustrates the procedure that is used from the beginning to the end of a given assignment. This is the normal code of practice for the vast majority of assignments:

- The process is initiated when a customer contacts the laboratory to request a service. The materials engineer responds to the customer contacts individually. Currently the customer contacts the company via phone, email post or by calling in person to the company.

- The materials engineer identifies the problem they need to resolve, for example, a customer may wish to test a newly created Printed Circuit Board (PCB) to ensure that it is up to the necessary standard. The customer is informed as to what tests need to be executed, approximately how long it will take to complete testing and an estimate of how much it will cost.

- If the customer agrees to avail of the service the details for that customer are noted in the engineers diary. The customer is asked to send the parts that are to be tested.

- The engineer then enters the details from the diary into an Excel Spreadsheet. The spreadsheet generates a sequential number to uniquely identify the project as an order. This number is known as the project number.

- The next progression is for the engineer to draw up a proposal, which contains the details of they type of testing that will be performed and the costs. The proposal is given a Request for Quotation (RFQ) number. A unique RFQ is used for each proposal that is sent. This proposal is sent to the customer. In the mean time, the customer sends the parts to the company (i.e. the parts which need testing).

- When the parts are received the project details are logged into the material projects book. This book contains the following details: company name, contacts name, job description, invoice total and the customers purchase

order number. The engineer must also return to the excel spreadsheet and activate the order.

- The parts are then given a job card, which identifies which tests are to be performed and is used to keep track of the work being done. When the project is complete the job card is closed. The job cards are used in accordance with ISO 9000. They can readily identify at what stage of testing a part is at any given time.

- The tests are then performed. The tests can include any of the tests mentioned in section 4.3.1. The time spent executing tests can vary. Some projects such as micro-sectioning take up to 2 days, due to the fact that the samples consume considerable time to prepare and take a lot of manual work to complete. Other projects, for example the Tensile testing, take about five minutes.

- After the tests have been carried out a report is drawn up, outlining the test procedures, the test results, conclusions, discussions and appendices, which contain graphs and photographs.

- The report is sent to the customer. If the testing has been straightforward, then the customer is informed in the report. If however the testing conclusions determine that the parts have defects, or could be improved, it may be necessary to contact the customer to discuss the findings and suggest alternatives and solutions.

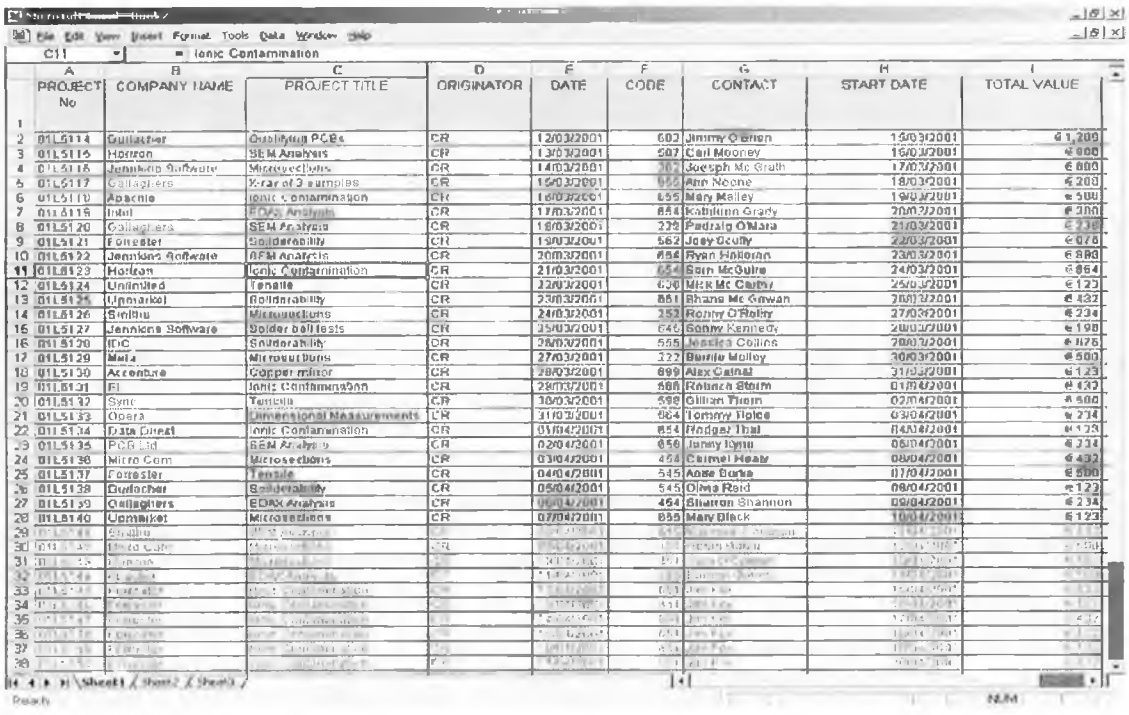
- The cost for the entire testing is calculated and a Sales Requisition is drawn up and sent to the administrator, who will send and invoice the customer at the end of the month. When the sales requisition has been sent, the engineer returns to the excel spreadsheet to close the order.

- The parts that have been tested are stored for three months.

- The proposal and job card are put in a folder and stored in a filing cabinet indexed by the project number.

4.3.3 Information System of Material Laboratory

The information system of the materials laboratory consists of mainly a paper based driven procedure with a diary for holding customer contact details, and a hardback notebook, referred to as the materials laboratory book, used to store customer and project data. An Excel spreadsheet application, which is referred to as *Name Source*, is the only technology employed, it is used to track project numbers and the status of projects. Figure 4.4 is a screen shot view of Name Source.



	A PROJECT No	B COMPANY NAME	C PROJECT TITLE	D ORIGINATOR	E DATE	F CODE	G CONTACT	H START DATE	I TOTAL VALUE
1									
2	01L5114	Guilcher	Qualifying PCBs	CR	12/03/2001	602	Jimmy O'Brien	16/03/2001	€ 1,200
3	01L5115	Horizon	SEM Analysis	CR	13/03/2001	507	Carl Mooney	16/03/2001	€ 800
4	01L5116	Jenkins Software	Microsections	CR	14/03/2001	707	Joseph Mc Grath	17/03/2001	€ 800
5	01L5117	Gallaghers	X-ray of 3 samples	CR	15/03/2001	655	Ann Neene	18/03/2001	€ 200
6	01L5118	Apacnic	Ionic Contamination	CR	16/03/2001	655	Mary Malley	19/03/2001	€ 500
7	01L5119	Intel	EDAX Analysis	CR	17/03/2001	884	Kathlinn Grady	20/03/2001	€ 200
8	01L5120	Gallagher's	SEM Analysis	CR	18/03/2001	228	Padraig O'Mara	21/03/2001	€ 238
9	01L5121	Forester	Solderability	CR	19/03/2001	562	Joey Scully	22/03/2001	€ 076
10	01L5122	Jenkins Software	SEM Analysis	CR	20/03/2001	884	Ryan Holloran	23/03/2001	€ 880
11	01L5123	Horizon	Ionic Contamination	CR	21/03/2001	654	Sam McGuire	24/03/2001	€ 864
12	01L5124	Unlimited	Tensile	CR	22/03/2001	630	Mick Mc Carthy	25/03/2001	€ 123
13	01L5125	Upmarket	Solderability	CR	23/03/2001	851	Rhana Mc Gowan	26/03/2001	€ 432
14	01L5126	Smiths	Microsections	CR	24/03/2001	352	Ronny O'Reilly	27/03/2001	€ 234
15	01L5127	Jenkins Software	Solder ball tests	CR	25/03/2001	645	Sonny Kennedy	28/03/2001	€ 198
16	01L5128	IDC	Solderability	CR	26/03/2001	555	Wesley Collins	29/03/2001	€ 876
17	01L5129	Mata	Microsections	CR	27/03/2001	222	Bernie Molloy	30/03/2001	€ 500
18	01L5130	Accenture	Copper mirror	CR	28/03/2001	899	Alex Cairns	31/03/2001	€ 123
19	01L5131	BI	Ionic Contamination	CR	29/03/2001	686	Rebecca Storm	01/04/2001	€ 432
20	01L5132	Sync	Tensile	CR	30/03/2001	598	Gillian Thorn	02/04/2001	€ 500
21	01L5133	Opera	Dimensional Measurements	CR	31/03/2001	864	Tommy Noice	03/04/2001	€ 234
22	01L5134	Data Direct	Ionic Contamination	CR	01/04/2001	854	Rodger Thal	04/04/2001	€ 123
23	01L5135	PCB Ltd	SEM Analysis	CR	02/04/2001	656	Jenny Lynn	05/04/2001	€ 234
24	01L5136	Micro Com	Microsections	CR	03/04/2001	464	Carmel Healy	06/04/2001	€ 432
25	01L5137	Forester	Tensile	CR	04/04/2001	545	Anne Burke	07/04/2001	€ 500
26	01L5138	Guilcher	Solderability	CR	05/04/2001	545	Olivia Reid	08/04/2001	€ 123
27	01L5139	Gallaghers	EDAX Analysis	CR	06/04/2001	464	Sharron Shannon	09/04/2001	€ 234
28	01L5140	Upmarket	Microsections	CR	07/04/2001	885	Mary Black	10/04/2001	€ 123
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									

Figure 4.4 Name Source

As shown in Figure 4.4, Name Source is an Excel Spreadsheet that is used to store customer and project data. It uses colour codes to determine whether they are at proposal stage, acceptance stage or invoiced stage.

Figure 4.5 outlines the flow of the information system.

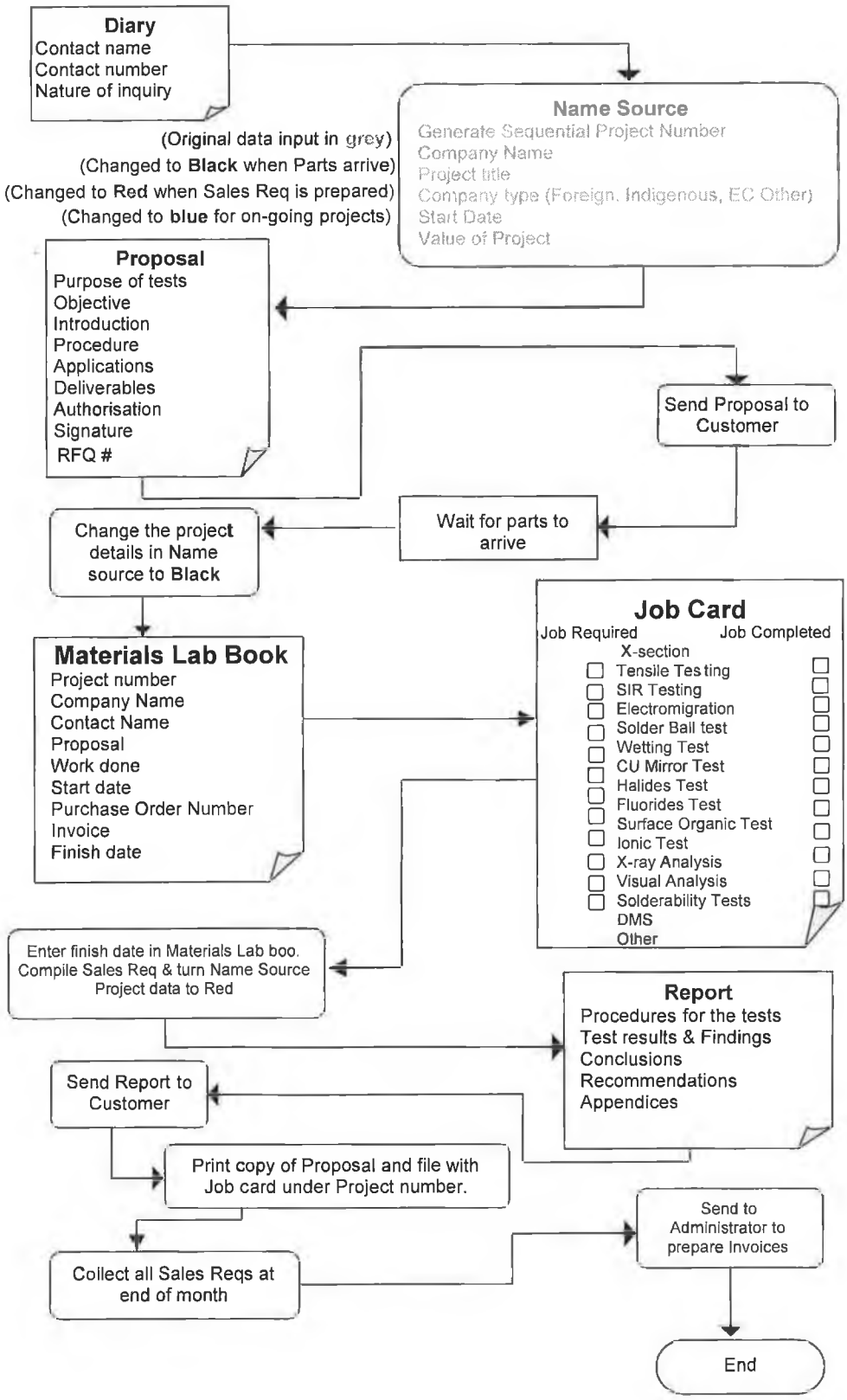


Figure 4.5 Information System of Materials Laboratory

As shown in Figure 4.5 the first entry of customer information is into the engineer's diary. The customers contact details such as their name, company, address, phone number and Purchase Order (PO) number, along with the details of the testing they wish to have carried out.

If the customer requests tests to be carried out the engineer opens an Excel Spreadsheet, which is referred to as Name Source.

It generates new project numbers sequentially, so that individual projects are uniquely identified. Information such as company name, project title of tests to be performed, the date the customer contacted, the type of company i.e. indigenous, multinational or foreign and the value of the project. The initial inputs into the Name Source spreadsheet are highlighted in grey text to differentiate them from projects that are initiated, complete or ongoing.

After the data is entered in Name Source the engineer draws up a proposal. In order to keep track of proposals a Request for Quotation number is assigned to each proposal. The proposal is usually three pages in volume. The first page is a letter to the customer informing them of their project number and that the test will proceed. The second page contains details including: the purpose of the tests, a description of what procedures will be conducted, what the objectives of the tests are, the benefits of doing the test, the deliverables and the costs. The engineer then signs the proposal and the manager signs an authorisation signature. Finally the terms and conditions are printed on the final page. The proposal is then sent via post to the customer.

The customer sends the parts they wish to test to the company. When the parts arrive the engineer re-opens Name Source and initiates the project by turning the grey text to black, the black text identifies the project as an active project. Additionally, the start date of the project is entered into the appropriate cell.

Then the engineer refers to the Material Laboratory book. This is a hard back notebook which is ruled into rows and columns in order to enter the following data under their appropriate headings: the project number, the customer name and contact

details, the work done, the start date, the purchase order number, the finish date and a tick box to be filled when the customer is invoiced at the end of the project.
The testing then begins and a materials job card is assigned to the parts and used throughout the testing. The job cards are sequentially numbered and have the unique project number written on them, they also have tick boxes identifying the tests that need to be executed and parallel tick boxes, which are ticked as each test is completed. The cards also have a start and finish date.

When all the testing has been completed the engineer returns to the Materials Laboratory book and enters the finish date of the tests. Name Source is re-opened and the finish date is also entered. The engineer uses Name Source to generate a Sales Requisition. When this has been done the text detailing the project data is turned to Red to indicate that the project is complete.

A report detailing all the findings of the tests is then compiled. The report provides in depth explanations of the procedures used to examine the samples, the findings from the tests, the test conclusions, recommendations, and appendices containing graphs and photographs of the analysed samples. This report is then sent to the customer.

Copies of the proposal and report related to a specific project are printed and along with the job card are filled away and indexed using the project number.

At the end of each month all of the Sales requisitions for each project are gathered and brought to the administrator at the AMT main branch, who sends the invoices to the customer.

4.4 Customer Relationship Management

The company is a successful small business, the manager and the staff work hard to provide personal, high-quality service and have built its customer base over time without the assistance of technology. The company has an advantage over larger companies in that the employees are in direct contact with the customer, they offer friendly advice and are close to the selling process. However, the majority of important customer data regarding preferences and the general behaviour of an individual customer is not stored, other than in the brains of the employees that deal directly with that customer. Important CRM data such as who purchased recently, who purchased frequently and who has spent the most money in total is stored in the disconnected information system. Acquiring such data requires a manual, painstaking and time-consuming process, which is avoided and, again, the employees tend to rely solely on their memory for such data.

4.4.1 The CRM Strategy: People, Processes and Technology

The People

The people involved with the company's process are customers and employees.

Customers

At present the materials laboratory has a customer base of approximately one hundred customers. The company works in a business-to-business environment, therefore, the customer base consists of individuals who request services on behalf of the company they work for. Many of these customers are from Large Scale Organisations (LSOs), such as Dell and Intel. These customers are busy individuals who generally have urgent requirements regarding the services they are seeking.

Company Employees:

The manager and employees are young, dynamic individuals, all of whom have third level qualifications and some experience with the usage of technology. They are eager that the company should grow and become more profitable. While they are capable of remembering some customer data at

present, as the customer base grows it will become impossible for them to remember data pertinent to single customers.

The Process

The Company adheres to a transactional driven rather than relationship oriented philosophy. The process has been discussed in Section 3.4.2. The current process involves the duplication of many administrative tasks, which detracts from both the testing analysis and customer service time.

The Technology

As seen in Figure 4.5, the majority of customer information is stored in separate paper-based books. A Microsoft excel spreadsheet is the technology currently used to store customer data, which is manually altered as additional customer data is added to the paper-based system. Therefore, there is no means of achieving a single, unified view of customers. The current system is devoid of any method to aggregate and examine all of the information it stores. In fact, the current system is limiting growth at present as it hinders efforts to improve customer experience with more time being spent going back and forth between disparate storage methods, which wastes time, impedes responsiveness and impacts negatively on the customers. Email is used as a contact point, where customers can email requests and enquiries to the materials engineer. Microsoft word is used to prepare the proposals.

4.4.2 Access to Customer Service

The points of contact for which a customer can interact with the materials engineer are presently via phone, email, the postal system and calling in person to the company. The percentages of usage of each point of contact are shown in Figure 4.8.

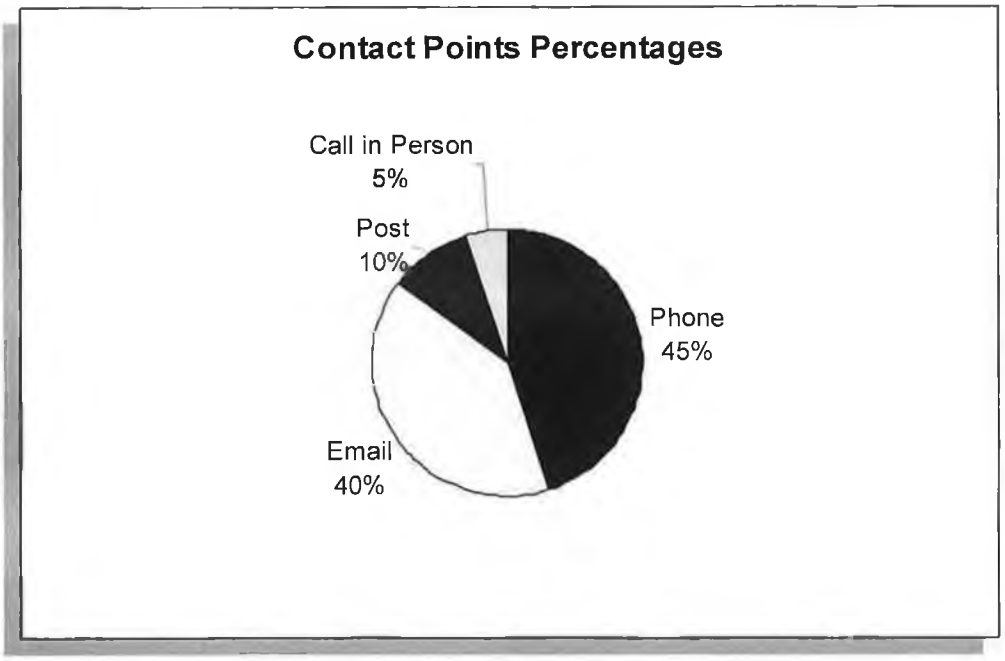


Figure 4.6 Customer Points of contact Percentages

As shown in Figure 4.6, phone calls are the main contact method used by customers; approximately 45% of all customer contact is currently via phone. The second, almost as utilised as the phone, is email with approximately 40% of customers. 10% of customers use the postal systems, they send the parts that they require to be tested and enclose their contact details and requirements and wait for a response when the testing has been completed. Lastly, 5% of customers call in person to the company, these customers are in close geographical proximity to the company.

The customer is limited in all of these methods of contact, in that they have to wait for the company to respond. The issue here is that none of these contact points support customer self-service, and therefore do not adhere to the concept of CRM, i.e. the customer has very limited control. However, when customers phone or call in person to the company they speak directly with the materials engineer, which is a personalised service in that they are known and can express their issues candidly with a person who is qualified to deal with their specific issues, unfortunately the engineer may have more pressing issues at a given time and may not be in a position to spend the necessary time with an individual customer.

4.4.3 Current system employed to deal with customers

From the Materials engineers' perspective dealing and responding to customer contact is a time consuming process. From the customer's perspective each method of contact to the company involve waiting to gain access to the company. This situation is outlined in Figure 4.7.

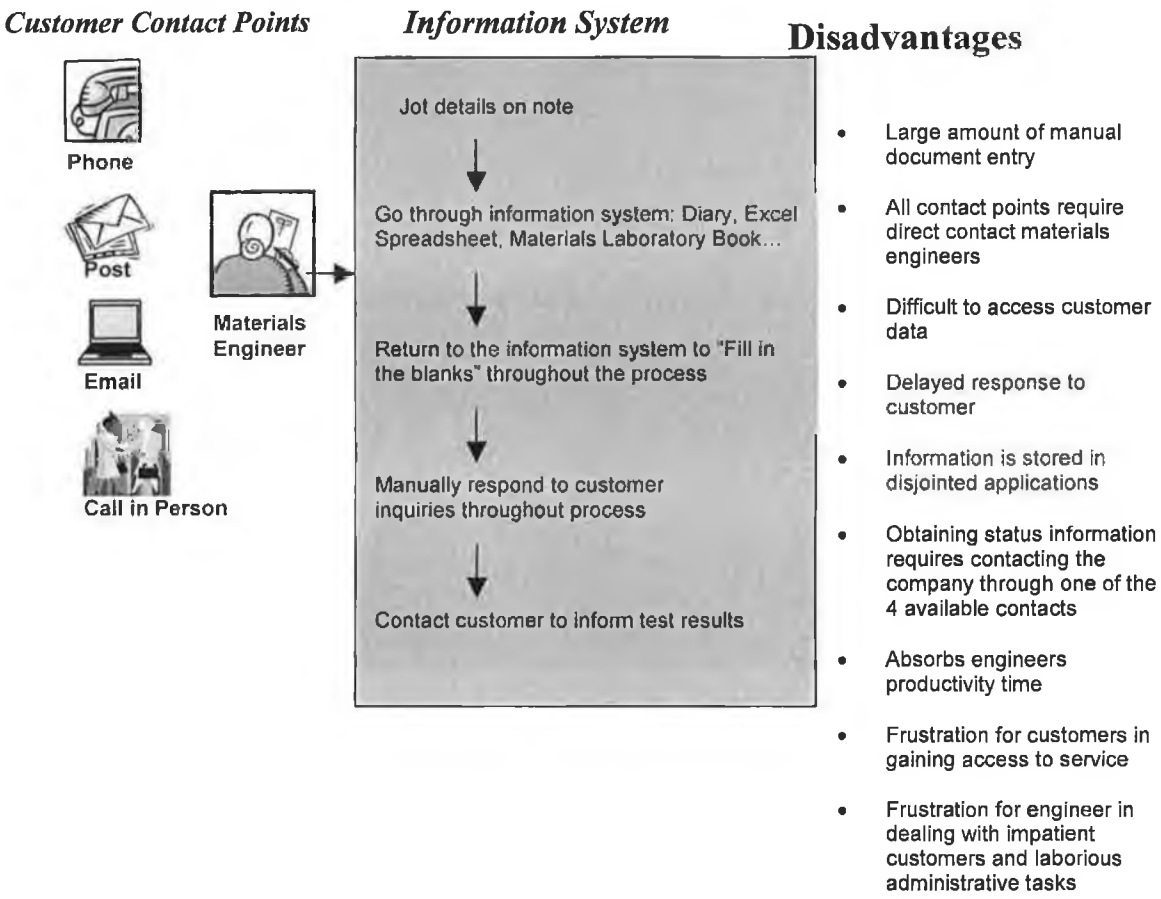


Figure 4.7 The Current System Employed to Deal with Customers

As shown in figure 4.7, when the customer contacts the company the materials engineer has to go through a series of procedures. The contact information has to be documented in the current information system in several places. While the current system works and is familiar to the engineer, it is extremely time consuming. Additionally, the customer is left without any information of the status until the end

of testing. The only way the customer can gain access to status information is to use one of the available contact points and wait for a response.
Additionally, the method in which the customer data is currently stored is very dispersed.

4.5 Disadvantages of current system

The current system Lacks efficiency and effectiveness due to the amount of paper work, which makes it difficult to find customer data.

4.5.1 Disadvantages from Customers Perspective

- **Points of Contact**
  In order for a customer to request a service they must contact the company either by phone, email or calling in person. Both phoning and calling in person may be costly and time consuming. Emailing involves waiting for a response. Generally customers contact the company via phone.

- **Customer Service**
  If customers require information regarding the status of their project, price enquiries, the types of tests available or the results of tests, they must either phone or email the materials engineer and rely on the availability of the materials engineer.

- **Hours of Business**
  The company works from 9am until 5pm. Therefore, a customer who works night hours may have difficulty requesting a service and making further enquires.

- **Interruptions**

  The company works in a business-to-business environment. Hence, customers calling on the phone are in their working environments. Either party (i.e. the materials service engineer or the customer) may become disengaged from the call due to a more urgent requirement from their employment.

- **Lack of data transparency and Self-Service facility**

  Such covert systems where the customers cannot view their own data can lead to customer frustration. Many customers would prefer self service access to data that is delivered immediately.

4.5.2 Disadvantages from Materials Engineers' Perspective

Capturing information through manual or paper-based processes is: slow, error-prone and expensive, and it forces people to accommodate the needs of the system.

Administrative work

There is an enormous amount of administration work involved in all of the processes throughout the company.

- Projects are documented when they enter the procedures, while they go though each point of the procedure, and when it is completed.
- Reports need to be drawn up, detailing the outcome of tests carried out.
- A daily record is kept outlining the time spent on each individual task.
- Earnings per day, per week, per month and per year are documented. Currently this information is stored in a diary. On a busy day it may not be possible to document all the detail, and details may be forgotten at a later stage, leading to inaccurate forecasts.
- Duplication of Data. Due to the fact that project details are held in different paper based locations, for example, a diary, a project logbook, customer supplied specifications and datasheets for the equipment; the data entered in these books may overlap with the data stored in other books and Namesource.
- ISO procedures must be drawn up for new tasks. The documentation regarding ISO procedures must be current for review by the auditor.

Obtaining new Customers

When new customers want to send a project to materials services, it may prove difficult in obtaining all the contact information required. For example, the potential customer may have voiced interest at a seminar, and it is necessary to manually note their personal details. Potential customers who phone the company may have to end a call prematurely, as they are phoning from their working environment, and crucial contact details may not be documented.

Customer Interruptions

Often a customer may call simply requesting an update on their projects status, however they consume time discussing other irrelevant matters. This consumes valuable time that could be profitable spent on testing or with potential customers. Customers regularly phone to seek expert advice, which they can apply to projects separate from those sent to materials services. This cost-free advice is both time-consuming and non-profitable.

4.6 Conclusion

This chapter provided an over view of the Electronics company and an analysis of the Materials laboratory within the company. One person operates the materials laboratory, the materials engineer. The materials engineer has a primary role in delivering the service of testing analysis to customers. However, this role is being undermined, as the time spent on administrative tasks is absorbing time that would be better utilised in the primary role of customer care. The customer relationship management concept is not supported in the current working environment, however customers do receive a personalised service in that they deal directly with the person who is qualified to solve their service requirements. The next chapter will introduce a solution to address the issues that have been highlighted in this chapter.

Chapter 5

The Web and Wireless CRM Solution

5.1 Introduction

Chapter four stated the issues regarding the current process flow in the materials laboratory. This chapter will introduce a technological solution to overcome these issues, and introduce a more efficient and customer friendly method of delivering customer service. This chapter examines several issues facing the development involved in setting up both the web and wireless services. It also presents details of a cost-effective WAP service that sends order status information to WAP enabled mobile devices.

From the company's perspective, the solution will enable the company to part take in e-Business, m-Business and electronic Customer Relationship Management (e-CRM) for the first time. Additionally, the system provides a centralised resource where all customer details are held electronically in a database, as opposed to paper-based notebooks and an excel spreadsheet. It will enhance the company's business processes and customer care.

The solution will centralise the information system and have the capabilities to access, view, sort, query and modify the data, as opposed to containing data into different, disconnected paper-based books and the excel spreadsheet. It will also provide customers with an additional contact point with the company, where they can engage in self-service activities to get faster responses. The wireless application will provide customers with a value-added service, where they can see the status of their orders at anytime and at any location.

5.2 Objectives for Technological Solution

As discussed in Chapter 3, Small-to-medium size enterprises (SMEs) have a significant advantage over Large Scale organisations in that they have a smaller customer base and can therefore establish a closer relationship with their customers. However, as the customer-base extends it becomes more difficult to give the necessary time and personal attention to individual customers.
As discussed in Chapter 4, there is no dedicated customer-service individual employed in the company, the materials engineer deals directly with customers. Presently at the materials laboratory CRM remains a manual, paper-driven procedure, comprising of spreadsheets, paper-based notebooks such as a diary, a project logbook, customer supplied specifications, and sticky notes. The system is made up of separate applications that store customer information in disconnected data storages. Additionally, unnecessary time is consumed on administrative tasks, such as re-entering customer information from one application to another. These administrative tasks are time consuming, and attention to building customer value inevitably suffers. There is a growing awareness that these processes are inefficient and impossible to control.

This solution should ultimately provide a means to better serve customers by enhancing the current system to operate more efficiently by reducing manual operational tasks, thereby liberating employees to devote more time to customer service and care. The system should provide value added services to customers by opening new points of contact and a transparent view of their data. The customers

should have the ability to engage in self-service at anytime and at any place convenient to them.

5.3 Requirements

A software requirements definition is an abstract definition of the services that the system should provide and the constraints under which the system should operate [Wiegers1999].

5.3.1 Functional Requirements

The solution will have to encompass the following:

- The ability to store data in a central repository. Customer data, project data and process data should be stored in a related manner. This will:
    - Make it easier to locate, and amend customer data
    - Eliminate redundant administrative tasks
    - Provide the ability to perform data analysis on customers and their preferences

- The ability to extract different elements of the data. A means of having search criteria, which sorts the data in order to view only the data requested. This will also provide a mechanism to analyse customer data easily

- Methods to electronically view this data

- The provision of secure administrative access to all data, where it may be altered and amended by the materials engineer

- The provision of customer access to the data that only relates to the individual. The system should be secure to allow the customer to view only

his/her data. The customer should also have the facility to make requests and amendments to their data.

- New points of customer contact should be provided that will enhance customer experience and provide them with "self-service" options

5.3.2 Non-Functional Requirements

Additionally, there are some non-function specific requirements that must be adhered to for the development to be feasible. It must be:

- Low in implementation costs. The company is not financially prepared to invest their resources in technological expenditure, as technology is not a core element of the services provided

- Easy to learn. The level of IT usage within the organisation thus far has been limited to the use of email and Excel. Therefore, the employees do not wish to engage in a step learning curve to use the system. Additionally, it is necessary that usage of the system does not absorb time that erodes into the time constraints in dealing with the day-to-day operation of the company

- Easy to use. From the customer perspectives it is essential that they can operate the system with little effort, as the success of the solution is dependant on the customers usage of the system and the provision of easy access to services

- User Friendly. The technology must be easy to use and lack ambiguity. The user interface must be easy to use and navigate. Ease of access to the required data is essential for both the company and the customer.

- Easy to Maintenance. As there is no employee in the company equipped with the skills set required to produce a professional web site and due to the fact that the development team are temporarily involved with the company, it is of critical importance that the applications are easy to maintain.

5.4 The Solution Proposed

The requirements outlined by the company were derived from the functionality that the current system lacks. These have been discussed in Chapter four. Additionally, the company is eager to adopt the practice of e-Business and m-Business in order to stay on par with competitors, as in the case of e-Business, and to gain advantage over competitors as in the case of m-Business. The development of web and wireless applications will better serve the current customer base, thereby providing customer care and a personalised service to customers. Given the functional and non-functional requirement, the delineated solution is as follows:

- The development of a centralised resource for data storage to contain all customers, project and process information in a related manner.

- The ability to have different views of this related data.
  Different interfaces to access the database are necessary to achieve this. The interfaces will be developed in accordance with the types of users the system will have.
  To provide the user with the access most appropriate to the type of user the interfaces will be as follows:
  An Administrative Web site view. The administrative web site will enable the database administrator to view the entire database via the Internet. This interface will be designed to hide the complexity of the underlying database, and thereby provide the administrator with a user friendly and efficient method of modifying and maintaining all data contained in the database.
  The Administrator web site will have the following functions:

Requests for Quotation (RFQ): The Administrator will be able to view all the submitted requests for price quotations that have been submitted by customers. The administrator will therefore, be easily able to view the customers for whom a proposal must be drawn up and sent to.

Orders: The customers that have placed orders will be displayed in this web page. All customer orders, including those received through other points of entry such as the phone will be on display here. Details pertaining to the orders, including the status of each order will be shown here.

Add an Order: The administrator can enter data received by non-web users here, for example, a customer who requests an order over the phone or via email. The administrator will use this web page to enter the details so that they are written to and stored in the database.

Administrator User: This web page will include all the details the company has about the customers, such as their contact details, usernames and passwords. The administrator can remove, add and update customers' information as required.

- In order to sort the data, the website pages of the Administrator's Interfaces will have links that allow sorting of the data by simply clicking on the link. For example the administrator will be able to sort the data by Order ID, User ID, Project number, Purchase Order (PO) Number, RFQ Submission Date, PO submission date in the Orders web page and by User ID, User Name, Full Name, Company and City in the Administrative web page.

A Customer Website view. The decision to use the Web to interface with the database enables the opening of a new contact point for customers. This will provide the customer with self-service access to the company 24 hours per day, 7 days per week. The customer website interface will allow the customer to have a transparent view of the data pertaining to him/her. The customer will be provided with the following functions:

Online customer account creation: The customer must be able to set up a secure account online. The customer will enter details and create a username and password, which will authenticate him/her in future when accessing the system

Submit a Request for Quotation (RFQ): Here the customers will be able to request a price quotation for parts that require testing analysis

Check the Status of their projects: When customers have parts being tested they will be able to check the status of their projects online.

Activate an Order: When the customer has received a price quotation and is satisfied that the testing should proceed he/she will be able to activate the order to inform the administrator to proceed with the testing.

Change Account Settings: This will enable the customers to change and update the data in their profile. It will also be possible to change their username and password.

A Wireless Customer View. This interface will enable customers to access the database and retrieve the status information of their projects at anytime and anywhere, using a WAP enabled mobile device. Given the limitations of some wireless devices in terms of speed, bandwidth and screen size, Order Status is chosen as the most appropriate data that customers will receive via a wireless device. Customers who have placed samples for testing with the company most frequently phone to enquire about how the testing is progressing. Therefore, enabling the customers to check the status of their orders via a wireless device will provide a value added service to them. Extra functionality will also be available, comprising of an Information page, a Settings page, and a Help Page. However, the Order Status functionality will be the most significant feature.

5.4.1 Outline of the Solution

Figure 5.1 gives a basic overview of how the system will be structured.

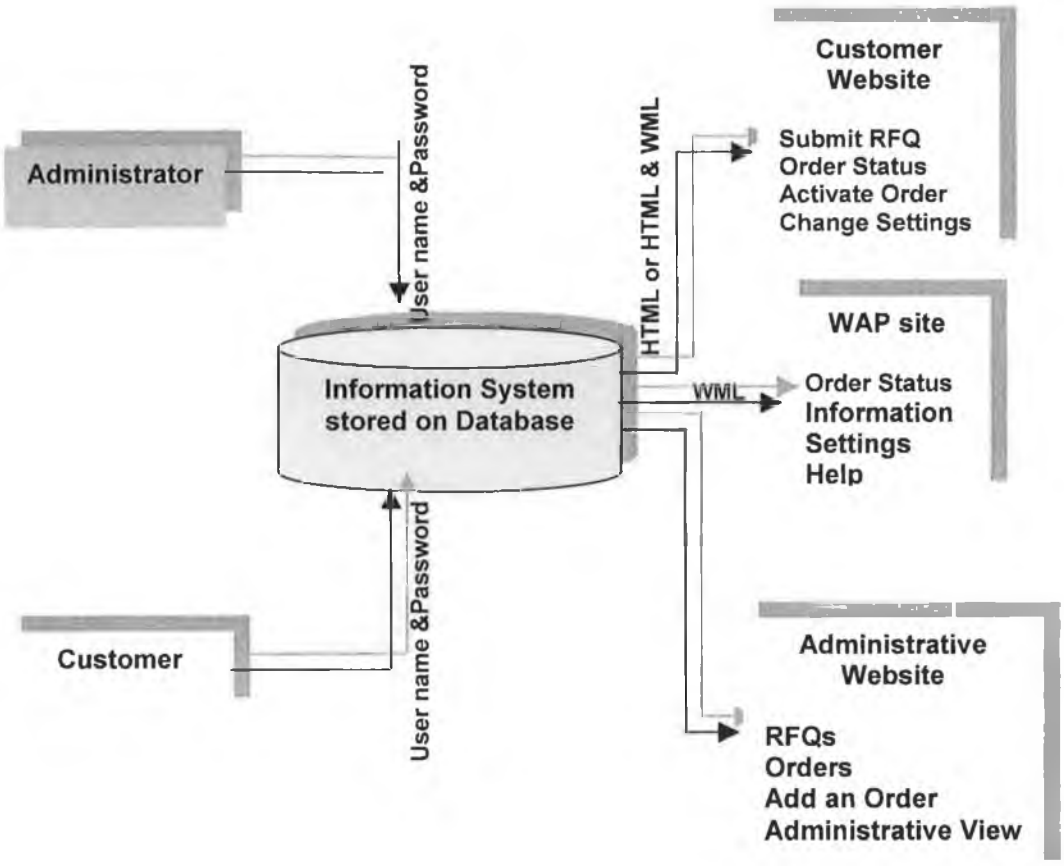


Figure 5.1 Concept of the system.

As shown in Figure 5.1, the username and password submitted will be checked against those stored in the database for authenticity. The administrator will be directed to the Administrators view, which contains all the data in the database. The customer will be directed to the Customers View where they will access the data from the database that is only relevant specifically to them. Additionally, depending on what content type is sent by the client (i.e. HTML or WML), the server will direct the customer appropriately to either the web or WAP application. Issues including content-based re-direction are not discussed in detail here, but are available in other work related to the MOTTO project. See [Radulescu 2002] for further details. Figure 5.2 outlines how the user will be directed to either the Customer or Administrator View

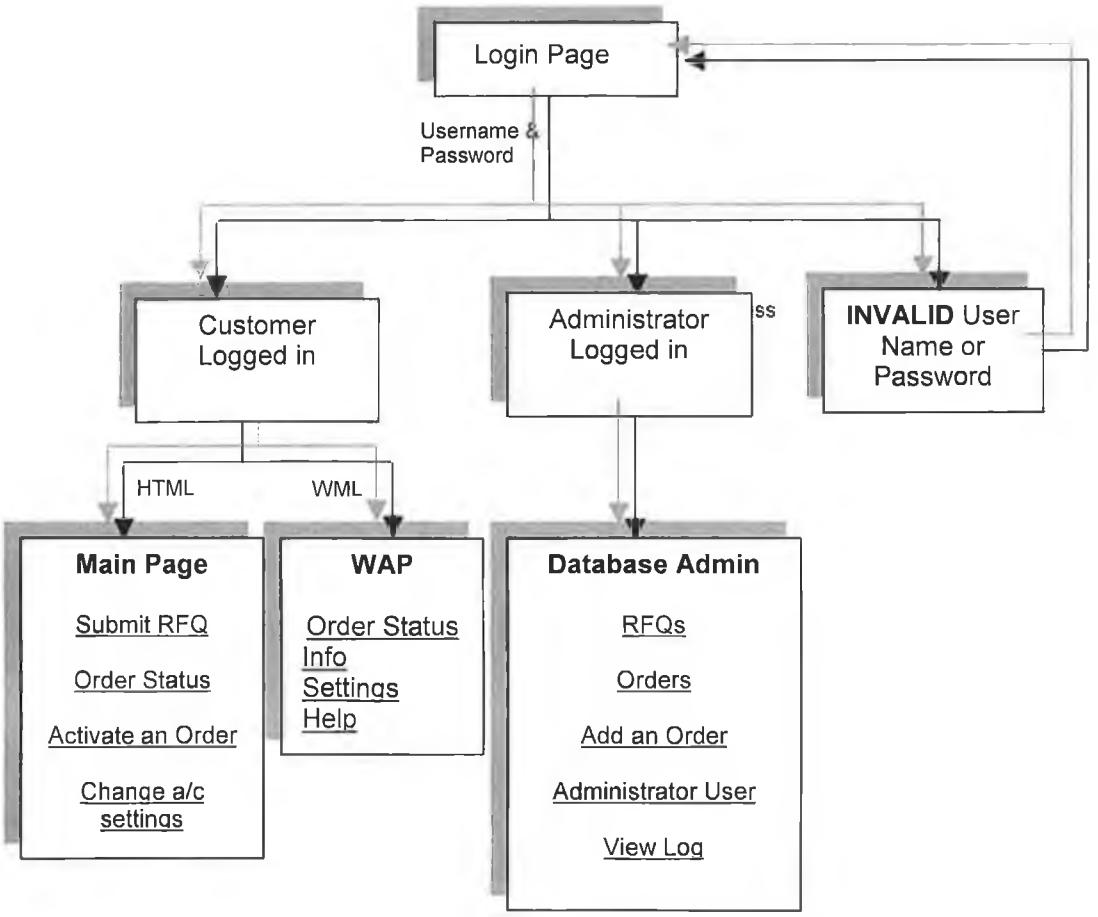


Figure 5.2 User Authentication and User Privileges

As outlined in Figure 5.2 and previously in this chapter, the Administrator and customers are distinguished by the use of their usernames and passwords. The users login details are submitted and compared with those stored in the database. If the user is a customer the database will ascertain that the user does not have administrative rights and direct the user to the customer Main Page. Alternatively, if the details submitted are those of an administrative user, namely the materials engineer, the database will acknowledge that the user is an administrator and the Administrative website view is called up.

5.4.2 The Systems Interfaces

As stated in the non-functional requirements, the User Interfaces must be designed to ensure the system is usable and navigable by individuals who lack technical expertise. It is critical to the applications success that the Interfaces are designed to be easy-to use and that the critical information that the customer and administrator require can be accessed simply and without ambiguity.

The systems interfaces that will be used for the customers view are displayed in Figure 5.3.

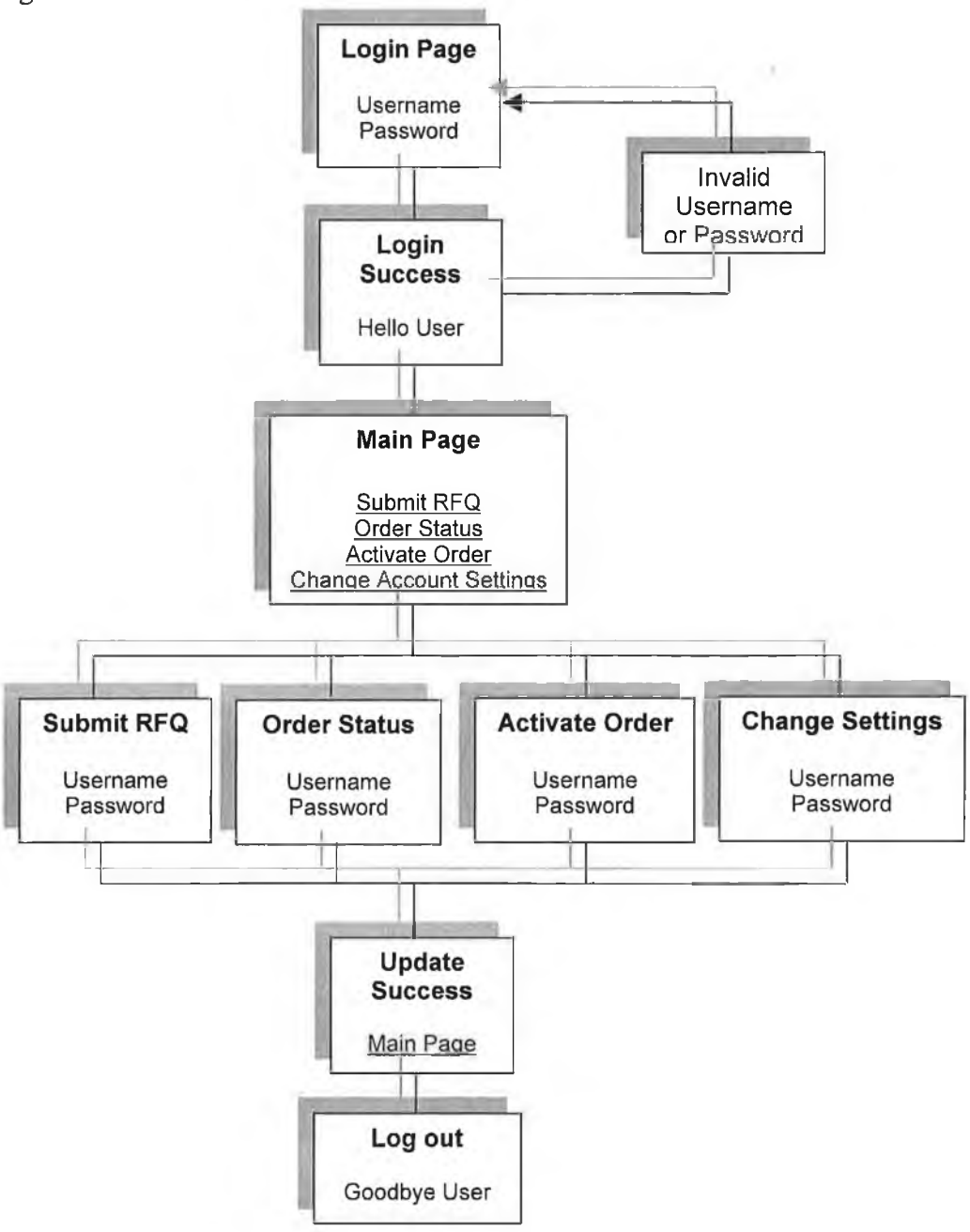


Figure 5.3 The Customer User Interface

Figure 5.4 shows the Interfaces that will be used for Administrator Users.

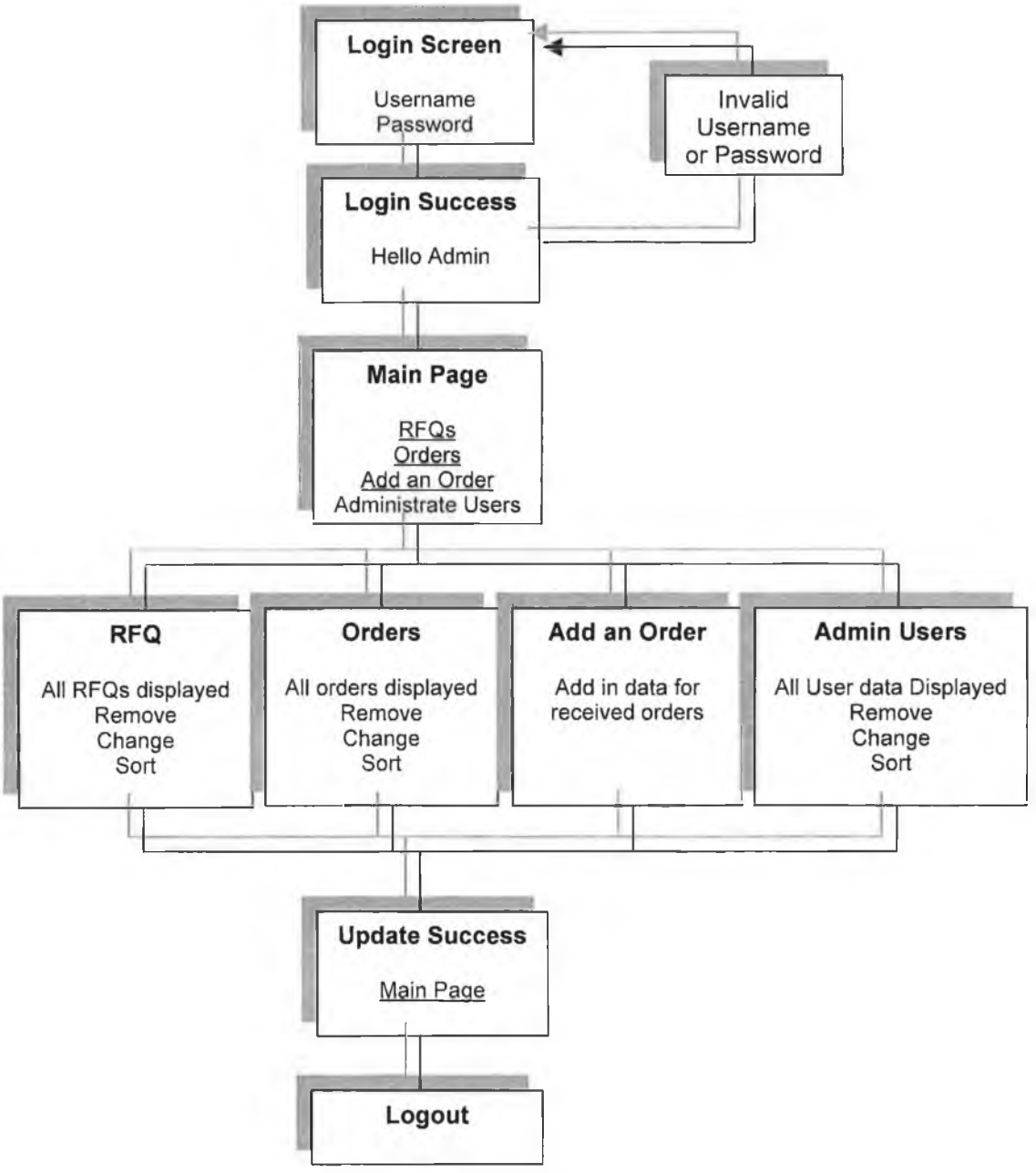


Figure 5.4 Administrator User Interface

Figure 5.5 shows the Interfaces that will be used for the WAP application

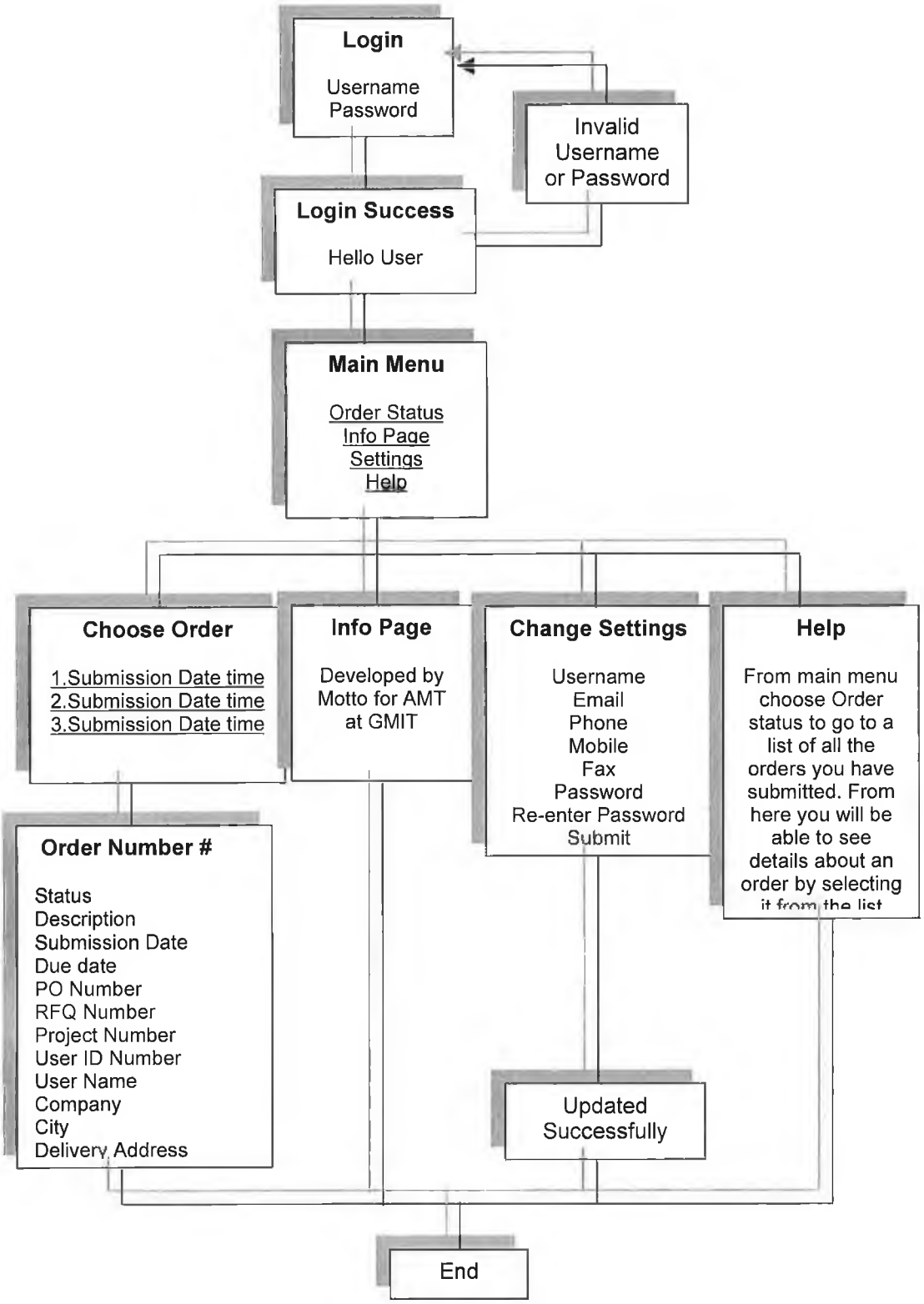


Figure 5.5 The WAP User interface.

5.5 Design of the Solution

In order to develop the solution certain technologies must be employed and integrated to produce a system that meets the requirements. This section give an overview of how the solution is developed.

5.5.1 Database-centric Web/Wireless Applications

Most web applications that offer interactive services are generally database-centric. This means that a database, containing most or all of the data content, is located at the center of the system architecture. A database provides a means of storing all the valuable data in a central repository. The Internet provides a global means of accessing that data. By centralising the source of data, synchronisation of data is simplified, if a customer changes a detail of their information it only needs to be changed once as oppose to several different areas. With centralised data it is feasible to apply several interfaces to the data and thereby allow various levels of access to the data. The most significant advantage to adopting a database-centric system is that the users interactive experience is enhanced. Databases are optimised for quick retrieval of information.

5.5.2 The Technologies used to create the Applications

The technologies deployed to develop the solution are as follows:

Microsoft Windows NT Version 4 Operating System.

The Microsoft platform is the one most familiar to the company, as they have worked with Windows applications in the Microsoft office suite. Therefore, the server hosting the application will have a Windows NT version 4 operating system. Windows NT is a Microsoft Windows personal computer operating system designed for users who need advanced capability. The Server is designed for business machines that need to provide services for network-attached computers. The Server is required, together with an Internet server such as Microsoft's Internet Information Server (IIS), for a Windows system that serves Web pages.

Microsoft Internet Information Server (IIS) Version 4.

Windows NT includes the IIS (Internet Information Server), which comes as standard with Option Pack 4. IIS is a group of Internet servers (including a Web or Hypertext Transfer Protocol server and a File Transfer Protocol server) with additional capabilities for Microsoft's Windows NT and Windows 2000 Server operating systems. It is designed to deliver high-speed web content, while also serving as a platform for testing and development. With IIS, there is a set of programs included for building and administering Web sites, a search engine, and support for writing Web-based applications that access databases.

MS Access 2000 Database Management System (DBMS)

A Database Management System is a software system that facilitates the creation, modification and maintenance of a database or databases, and the execution of computer programs using the database.

The DBMS manages user requests so that users and other programs are free from having to understand where the data is physically located on storage media. In handling user requests, the DBMS ensures the security and integrity of the data. The most typical DBMS is a relational database management system (RDBMS). A standard user and program interface is the Structured Query Language (SQL). Microsoft Access 2000 was the chosen database management system. Access package contains the following elements:

- A relational database system that supports Structured Query Language (SQL)
- A full-featured procedural programming language, essentially a subset of Visual Basic
- A rapid application development environment complete with visual form and report development tools
- Various wizards and builders to make development easier

All of the data from the present information system will be stored in the Access Database. The data will be stored in tables. The tables in an Access Database comprise of field names, which are in columns, fields, which are the specific spaces in which the data is entered, and records, which are in rows. The data types stored in the fields must be identified, i.e. the data is numerical, alphanumerical etc. Related data is stored in different tables of the database, for example user data is stored in

one table and order details are stored in another. Each record in the table is assigned a unique identifier, or primary key, which helps to connect the data in different tables. Queries are used to organise, filter and manipulate the data in the tables.
In addition to tables, an Access database file contains several different types of database objects:

- Saved queries for organising data,
- Forms for interacting with the data on screen,
- Reports for printing results

Structured Query Language (SQL)

SQL is an ANSI standard language for accessing databases. SQL statements are used to retrieve and update data in a database. SQL works with database programs like Access, Oracle, Sybase, and many others (however, most of them also have their own proprietary extensions to the language). With SQL, it is possible to query a database and have a result returned in a tabular form.

Hyper Text Markup Language (HTML)

HTML (Hypertext Markup Language) is the set of markup symbols or codes inserted in an editor, such as EditPlus or Notepad, intended for display on a World Wide Web browser page. The file is saved with the .html extension. The markup is used so that the Web browser can display a Web page's words and images. Each individual markup code is referred to as an element or tag. Some tags come in pairs that indicate when some display effect is to begin and when it is to end.
HTML is generally compliant with major browsers, such as Microsoft's Internet Explorer and Netscape's Navigator. However, both Internet Explorer and Netscape implement some features differently and provide non-standard extensions. The current version of HTML is HTML 4.0. When using the more advanced features of HTML 4 it may be necessary to design pages for both browsers and send out the appropriate version to a user. Significant features in HTML 4 are sometimes described in general as dynamic HTML.

Wireless Markup Language (WML)

Wireless Markup Language is derived from eXtensible Markup Language (XML) and Hand held Device Markup language (HDML) [Bennett 2001]. When WML emerged, HDML formed the basis for the language, but it was modified to conform to the XML specifications. WML is a language that allows the text portions of Web pages to be presented on mobile WAP enabled devices, via wireless access. WML is part of the Wireless Application Protocol (WAP), which has been discussed in chapter two. The Wireless Application Protocol works on top of standard data link protocols, such as Global System for Mobile communication, and provides a complete set of network communication programs comparable to and supportive of the Internet set of protocols. WML is like HTML in that it supports layout, input and navigation as well as inclusion of images and scripting. Unlike HTML, it addresses the limitations of wireless devices. In particular it is useful when dealing with small displays, low processing power, and slow connections.

Wireless Markup Language Scripting Language (WML Script)

WML Script is a client side scripting language that extends the basic functionality of WML. It provides the capability for client-side validation, user interaction, and client device access. WML Script functions reside on the server and are referenced by two-part URLs. The first part describes the compilation unit (a file) containing the WML Script function. The second part identifies the function and lists associated parameters.

WML Script is an extended subset of ECMA Script (formerly JavaScript). WML Script is not embedded in WML. WML Script executes only on the client side and is encoded into byte-codes before transmission to the client.

Visual Basic Scripting Language (VBScript)

VBScript is a scripting language. A scripting language is a lightweight programming language. VBScript is a light version of Microsoft's programming language Visual Basic. It is fast and portable, making it suitable for use in World Wide Web browsers and other applications that use Microsoft ActiveX (ADO) Controls, Automation servers, and Java applets. When a VBScript is inserted into a HTML/WML document, the Internet browser will read the HTML/WML and interpret the VBScript.

Java Scripting Language (JavaScript)

JavaScript is a scripting language. It comprises of lines of executable computer code. JavaScript can be inserted into a HTML/WML page and interpreted by the browser (or client). JavaScript can also be run at the server as in Microsoft's Active Server Pages before the page is sent to the requestor. JavaScript is an open scripting language that anyone can use without purchasing a license and it is supported by all major browsers like Netscape and Internet Explorer. In general, script languages are easier and faster to code in than the more structured and compiled languages such as C and C++. Script languages generally take longer to process than compiled languages, but are very useful for shorter programs.

JavaScript is generally used in Web site development to automatically change a formatted date on a Web page, to cause a linked-to page to appear in a popup window, and to enable text or a graphic image to change as the mouse moves over them.

Active Server Pages

Active Server Pages (ASP) is a Microsoft Technology. It is a compile-free application environment in which HTML, WML, scripts, and reusable Active X (ADO) server components can be combined to create dynamic Web and WAP-based solutions. Using ASP technology means that applications, including ActiveX controls, can be imbedded in Web pages that modify the content sent back to users. Developers can also write programs that filter requests and get the correct Web pages for different users by using the Internet Server Application Program Interface (ISAPI) interface. ASP and ISAPI programs run more efficiently than common gateway interface (CGI) and server-side include (SSI) programs.

ActiveX Data Objects (ADO) database connectivity

ActiveX Data Objects (ADO) is a Microsoft technology that has become the basis of Internet database access for Microsoft users. ADO is the programming interface used for gaining access to a database through a Web page.

Microsoft ActiveX Data Objects (ADO) is an object-oriented database access technology. It is automatically installed with Microsoft IIS. ADO can be accessed from within the Active Server Pages.

EditPlus 2000

EditPlus is the text editor used for writing the code. It supports syntax highlighting for codes including HTM, ASP, Java and VBScript. It is superior to Microsoft Notepad in that it has more functionality, as it can preview HTML documents inside the editor. It also has a ruler, which shows the current column position.

Nokia Mobile Internet Tool Kit

The Nokia Mobile Internet Toolkit provides a development environment to provide Internet services and content for mobile devices. It can be downloaded free of charge at the Nokia website. The tool kit includes an emulator that gives a realistic, PC based testing and simulation environment to develop WAP and other mobile Internet applications. The 3.1 version of the toolkit is compliant with WAP 2.0. In addition, a range of Nokia handset simulators are available to download separately. These simulators are based on commercially available Nokia devices and enable the previewing of different applications. Applications can be stored and queried directly from the PC file system. Other toolkits are available and are from providers including Phone.com, Ericsson and Motorola.

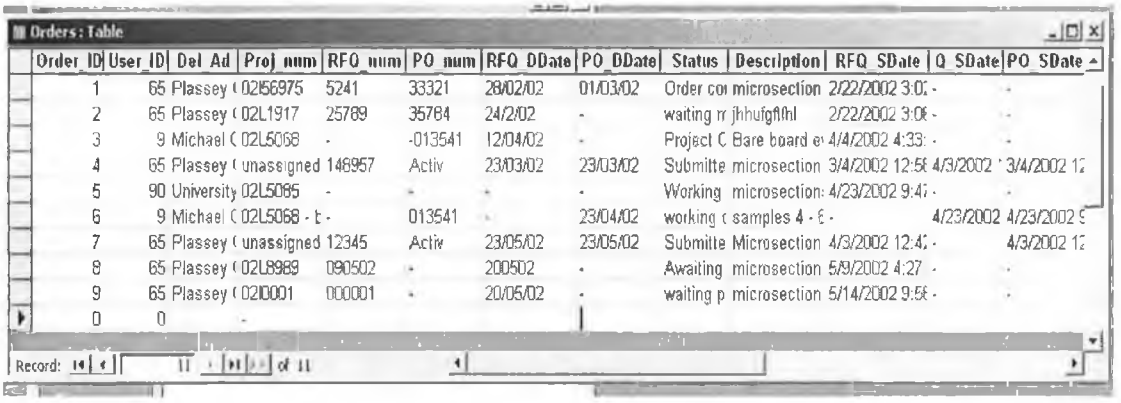
5.6 System Development

This previous section has described the technologies that will be deployed to develop the Web and Wireless CRM system. This section will discuss how these technologies are used to develop the applications.

5.6.1 Database Design

The materials laboratory requires a centralised repository for storing information. The first concern, therefore, is to develop a means of achieving this objective. The information that is storded in the database comes from the paper- based system and NAME SOURCE, the excel spreadsheet program, which are currently used to store data. The data stored is related to the orders that have been placed with the materials laboratory and the customers who placed those orders.

The database is created with two different tables. One table stores all the data related to the orders that are placed, this is called the ORDERS table. The other table stores all the customer information and is named the USERS table.
Figure 5.6 shows the ORDERS Table.


Orders : Table

Order_ID	User_ID	Del_Ad	Proj_num	RFQ_num	PO_num	RFQ_DDate	PO_DDate	Status	Description	RFQ_SDate	Q_SDate	PO_SDate
1	65	Plassey (	02I56975	5241	33321	28/02/02	01/03/02	Order co	microsection	2/22/2002 3:0	-	-
2	65	Plassey (	02L1917	25789	35784	24/2/02	-	waiting m	jhhufgfffhl	2/22/2002 3:0	-	-
3	9	Michael (	02L5068	-	-013541	12/04/02	-	Project C	Bare board e	4/4/2002 4:33:	-	-
4	65	Plassey (	unassigned	146957	Activ	23/03/02	23/03/02	Submitte	microsection	3/4/2002 12:5	4/3/2002	3/4/2002 1
5	90	University	02L5085	-	-	-	-	Working	microsection	4/23/2002 9:4	-	-
6	9	Michael (	02L5068 - b	-	013541	-	23/04/02	working (	samples 4 - 6	-	4/23/2002	4/23/2002 9
7	65	Plassey (	unassigned	12345	Activ	23/05/02	23/05/02	Submitte	Microsection	4/3/2002 12:4	-	4/3/2002 1
8	65	Plassey (	02L8989	090502	-	200502	-	Awaiting	microsection	5/9/2002 4:27	-	-
9	65	Plassey (	02I0001	000001	-	20/05/02	-	waiting p	microsection	5/14/2002 9:5	-	-
0	0											

Record: 11 of 11

Figure 5.6 The ORDERS Table

The orders table has been designed to store all the information relating to the orders from customer for testing analysis. As shown in Figure 5.6, the data is stored in columns and rows. The columns are given headings that identify what the data stored in the columns is. The rows hold the records of individual customers data. The details stored in the ORDERS table include:

- **Order_ID:** The order ID is the primary key of the ORDERS Table, it is a system-generated number used to uniquely identify each individual record
- **User_ID:** Is the primary key of the other table in the database, it is referred to as a foreign key in this table. This is used to enable the data held in the ORDERS table to be linked with the data stored in the USERS table
- **Del_Ad:** This is used to store the delivery address data to identify where the results should be sent to after testing
- **Proj_Num:** The materials engineer assigns a project number to the samples that are to be tested. This is done at the onset of the samples testing. Therefore, once a project number has been assigned the order can be considered active by the application. If a project number has not been assigned then the data in the field will contain the word "unassigned" or a dash
- **RFQ_Num:** The engineer also assigns The Request for Quotation (RFQ) number. It is a number that is assigned for each quotation that is sent to a customer
- **PO_Num:** The customer provides the Purchase Order (PO) number. It is used in the invoice that is sent after the testing is complete to receive payment for the testing service. If the PO number has not been submitted the field will contain a dash. When the materials engineer assigns a project number to the parts or when the customer submits the PO number the order is considered active (i.e. about to undergo testing). Also the customer will be given the authority to activate and order. Where the customer has activated an order the word "activ" is contained in the field. This is to alert the engineer that a customer has self activated an order
- **Status:** The Status of the individual projects. The status states are:
    - Request for Quotation: the customers has submitted an RFQ, the RFQ status remains until a project number is present and/or a PO number is submitted
    - Order Received: customer has accepted the proposal and the project is to proceed.
    - Waiting Material: the company is awaiting the samples to arrive

- In Production: the testing is being carried out
- Job Complete: some samples are finished testing
- Project Complete: all testing complete and results have been sent

- **Description:** The user will submit details on their projects when they place an order
- **RFQ_Sdate:** RFQ submission date. The date that the customer submitted a request for a price quotation is held here
- **Q_Sdate:** Quotation submission date. The date that the materials engineer sent a quotation to the customer is stored in this field
- **PO_Sdate:** PO submission date. The date that the customer submitted the PO number is held here

The second table in the database is the USERS table. This table is used to store the data that relates to the individual customers. Figure 5.7 illustrates the USERS Table.

Figure 5.7 The USERS Table

The USERS table has been designed to store all the information relating to the customer of the company. As shown in Figure 5.7, the details stored in the USERS table include:

User_ID: The User_ID is the primary key of the Users Table

Username: The customer's name for accessing the applications

Fullname: The customer's Name(s) and Surname

Company: the company for whom the customer works

Inv_Ad: The address to where the invoice should be sent

Del_Ad: The address to where the customer wants to receive proposals and results

City: The city name of the company customer works for

County: The County name of the company customer works for

Email: The email address of the customer

Phone: Phone number of the customer

Mobile: Mobile phone number of the customer

Fax: Fax number of the customer

Admin: If the user has administrative privileges, Yes/No

Password: The customer's password, which he/she uses to access the system

5.6.2 Database Connectivity to Generate Dynamic Web and WAP content

A database connection is established in order to receive requests from both the Web and WAP browsers. ASP and ActiveX Data Objects (ADO) are deployed to perform the database access. ASP is a program that runs inside IIS, it enables server side scripting for IIS with native support for both VBScript and Java Script. An ASP file can contain text, HTML, WML, XML, and scripts. Scripts in an ASP file are executed on the server. The file extension used is .asp. When a browser requests a HTML/WML file, the server returns the file. When a browser requests an ASP file, IIS passes the request to the ASP engine. The ASP engine reads the ASP file, line by line, and executes the scripts in the file. Finally, the ASP file is returned to the browser as plain HTML/WML. Using ASP it is possible to dynamically change or add any content of a WAP/Web page, respond to user queries or data submitted from HTML forms, access any data or databases and return the results to a browser, and customise a Web page to make it more useful for individual users. It provides security since the ASP code cannot be viewed from the browser.

An ASP file normally contains HTML and/or WML tags, just as a standard HTML or WML file. In addition, an ASP file can contain server scripts, surrounded by the delimiters <% and %>. Server scripts are executed on the server, and can contain

any expressions, statements, procedures, or operators that are valid for the scripting language used. In ASP it is possible to use different scripting languages. The default language in ASP is VBScript.

The use of ADO components along, with ASP provides the mechanism that makes the applications available through the Internet.

The fist step in deploying ADO is to create an object that will manage all aspects of connecting to the database. Next, the object must be provided with the information that is needed to connect to the database. Finally, the commands to create the connection must be invoked. ADO creates some of the objects implicitly. However, there may be some part of the connection that need to be controlled, and these objects will need to be created. The three main objects are:

The "connection" object, which manages the connection to the database. This object can execute SQL commands and automatically create recordset objects to contain the results.

The "command" object: used to execute commands. It is used, for example, to access pre-written queries that are used to access specific user data.

The "recordset" object: contains the data that is extracted from the database when a query is executed.

Both the Web and WAP interfaces will access the same database. This will be achieved by converting the Web and WAP pages to ASP files.

5.6.3 Creation of Web pages

The web interfaces are created by using Hyper Text Markup Language. The tool used to write the web page code content is Edit Plus. HTML documents are text files made up of HTML elements. HTML elements are defined using HTML tags, which are used to markup HTML elements. Two characters surround tags "<" and ">". A HTML document begins with <HTML> and ends with </HTML>. HTML is not case sensitive. In order to ensure that the Web interfaces are able to access, read from and write to the database the HTML files must be converted to ASP. This is achieved simply by placing an .asp, as opposed to a .htm extension on the files as they are saved. In addition to the use of HTML, Java Script and VB script is used in the coding to provide additional functionality to the website.

The web site is accessible at the URL: http://amt.ul.ie/motto/
The first web page is the login.asp file[1]. The user enters their login details and submits the data. Depending on the login details submitted, the user is established as either a customer or an administrative user. Figure 5.8 shows the Login interface.

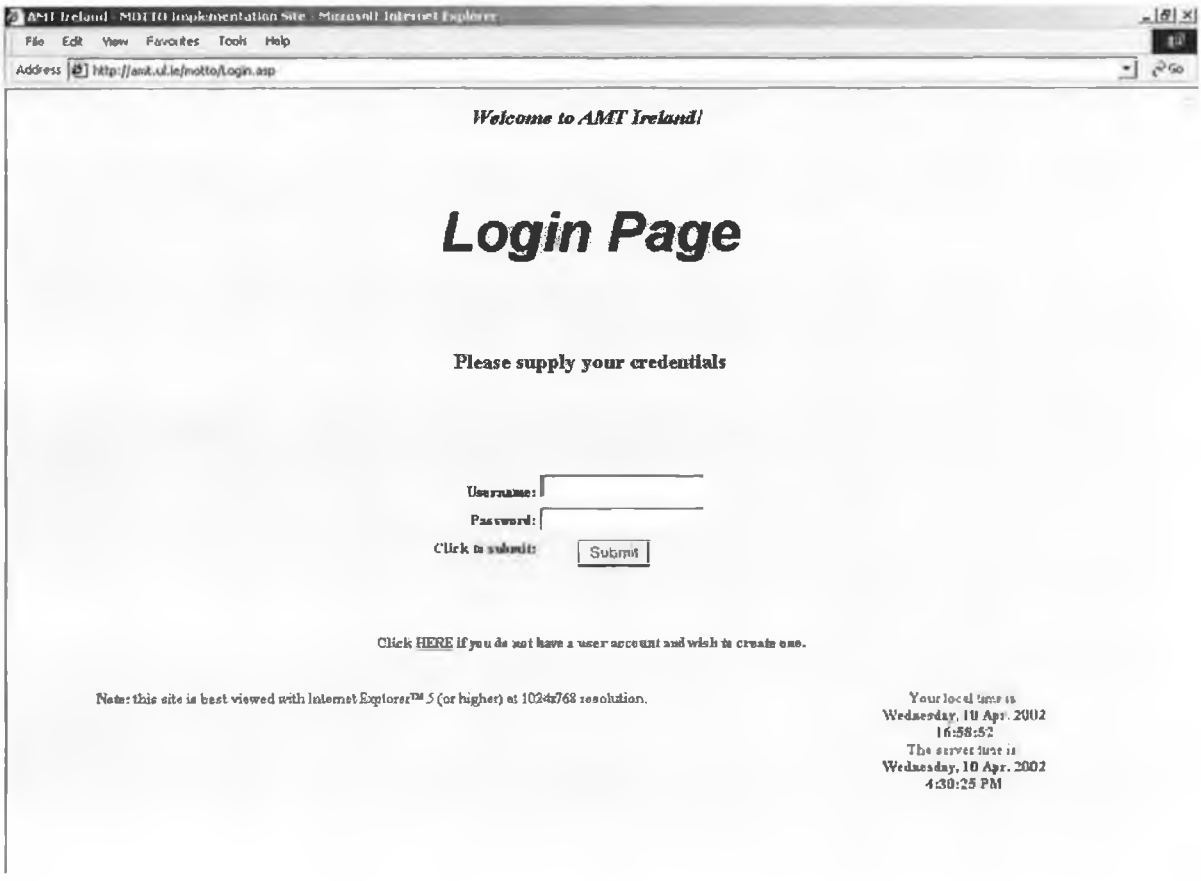


Figure 5.8 Login Web Page

As shown in Figure 5.8, users are given a welcome greeting and asked to enter their login credentials, these being a unique user name and password. Unlike the username, the password is case sensitive. There is a link on the page, which allows new users to create an account. On the bottom right-hand corner the date and time are shown for both the users' local time and the servers' time.

[1] See Appendix B for login.asp code file

A new customer who requires an account may click on the *HERE* link of the LOGIN page, this will direct the user to the INPUT DETAILS FOR THE NEW USER ACCOUNT page, illustrated in Figure 5.9.

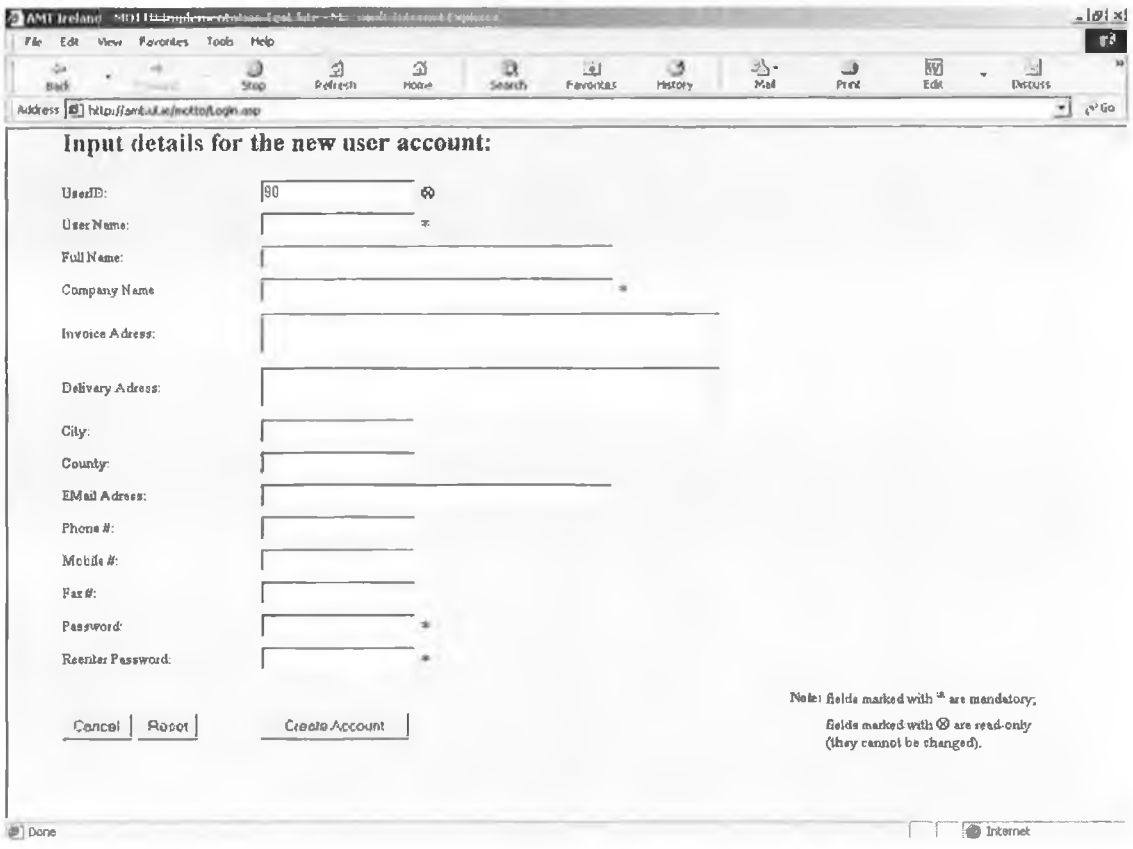


Figure 5.9 Create New User Account Web Page

The User ID is generated by the database and is present once the user activates the page. The customer may manually enter the remaining details, these are:

- User Name
- Full Name
- Company Name
- Invoice Address
- Delivery Address
- City
- County
- Email Address

- Phone Number
- Fax Number
- Password
- Re-enter Password

User Name, Company Name, Password and Re-enter Password are fields that compel the customer to enter data.

- The user ID entered must be four characters or greater. Should the user enter less than four characters or avoid inputting data into the User ID field, a message alert will appear stating: "The user name must be at least four characters. Please adjust".
- The same applies to the password field. There is a condition applied where four or more characters must be entered, if the user fails to enter data or enters data of less than four characters long a message alert will appear on screen stating "The password must be at least 4 characters long. Please adjust". If the data entered in the Password field fails to match the data entered in the Re-enter Password field then the message alert will state, "The passwords do not match. Please re-type password".
- If a data is not entered into the Company Name field or if the data is under three characters a message alert with the following text will appear on screen: "You must enter a company name (at least 3 characters)".

Data entries to the other fields are at the customers' discretion.

When the user has entered and submitted their personal details and the compulsorily fields adhere to the conditions, the new user account is created as illustrated in figure 5.10.

Figure 5.10 New User Account Created Web Page

In Figure 5.10, a tick box with a correct sign is shown to indicate to the user that the new user account has been successfully created. The link MAIN PAGE underneath the tick box allows the user to go directly to the main customer page.

When login details are submitted the verify.asp file sends a query to the database to authenticate the user. This is achieved by comparing the data entered by the user and the corresponding data stored in the database. Additionally, the administrative authentication is checked to determine if the data submitted by the user is that of an administrator or a user. If the users record is devoid of administrative privileges then they are directed to the user website view. Otherwise, if the user does have administrator privileges he/se is directed to the Administrator view. The code that achieves this is as follows:

```
<%Session.Timeout=15
Dim User, Pass, URecord, SQLquery, Status, UserID, Details
User = Request.Form("User")
Pass = Request.Form("Pass")
Session("UName") = User
        If Session("Admin") <> nul Then
        Session("Admin") = nul
        End If

SQLquery = "SELECT Users.UserID, Users.UserName, Users.FullName, Users.Password,
Users.Admin FROM Users WHERE UserName = '" & User & "'"
Set URecord = conn.Execute(SQLquery)

        If URecord.EOF then
        Status = "Failed"
        UserID = 0
        Details = "Invalid UserName (does not exist in the database)"
%>
```

5.6.4 The Customer Web Site View

All users who access the website first encounter the Login Page, which is shown in Figure 5.8. The customer will enter their username and password here and, providing that the entered data corresponds to the data stored in the database, the user is admitted to the website. Figure 5.11 shows the web page that the user sees on screen.

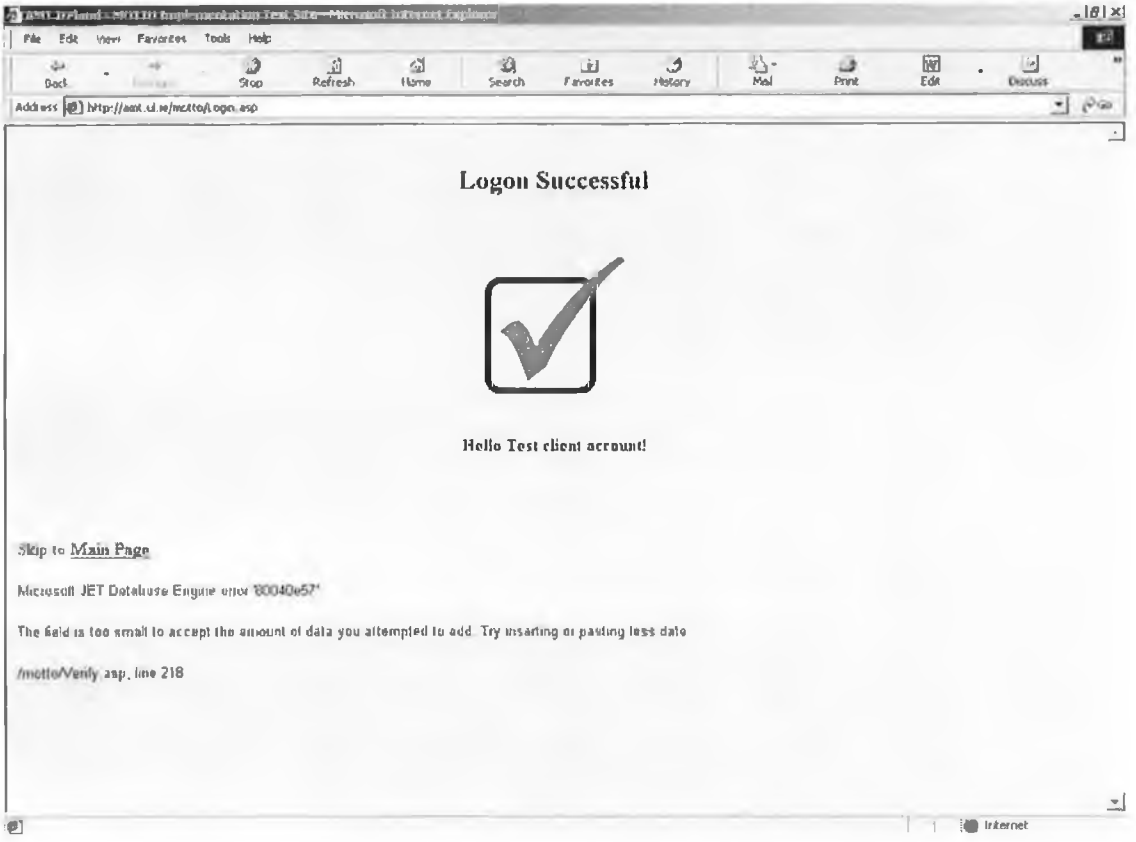


Figure 5.11 Login Successful Web Page

This page informs the customer that the data entered is valid, and greets the customer by their name. The page stays on screen for a few seconds and then skips to the Main Page shown in Figure 5.12.

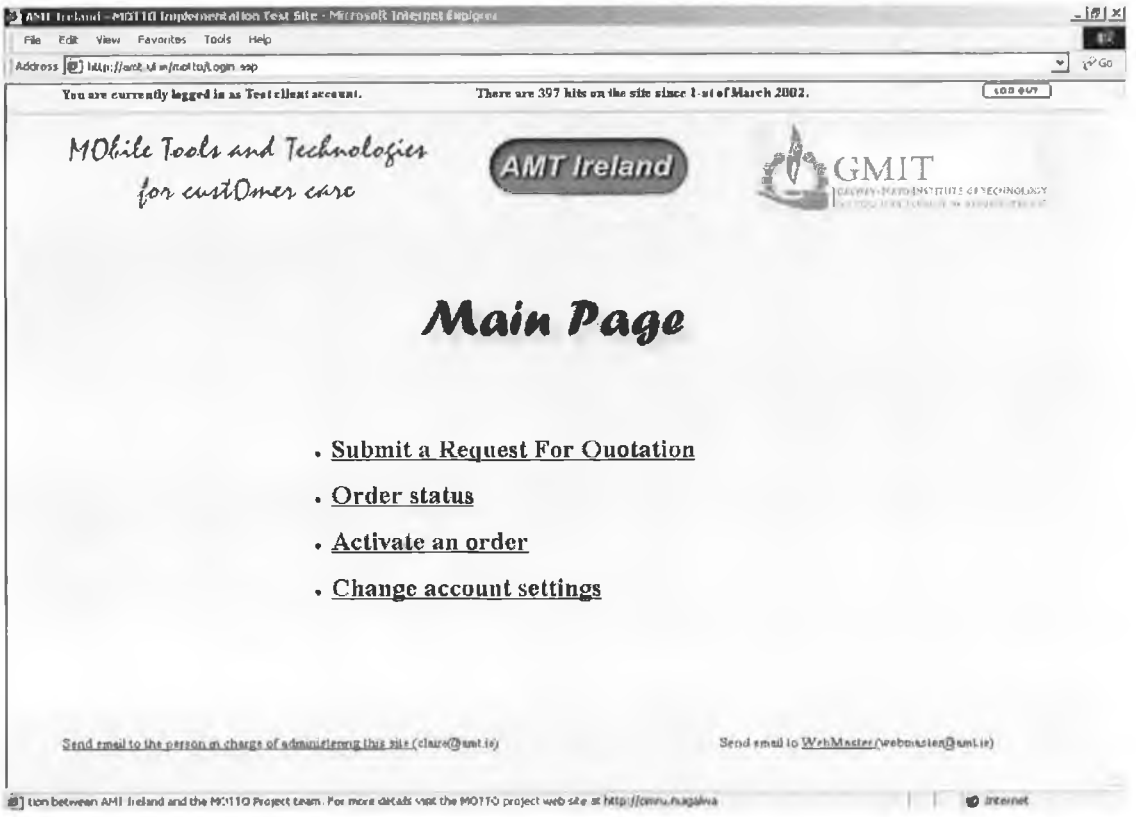


Figure 5.12 Customer View: Main Page

The Customer Main Page offers the user the following options:

- Submit a Request for Quotation (RFQ): This link will direct the customer to the Submit Request for Quotation web page. The customer can use this option if they wish to receive a price quotation to have certain tests performed. The customer types information into the required fields. When the user clicks the submit button, the information entered is written to the database.

- Order status: This link will take the customer to the Order Status web page. On this web page the customer is supplied with information regarding the status of the project and the associated details of the project. Details of the orders are available on this page and the status of these orders is displayed. This information is retrieved (read) from the database and displayed on the web interface.

- Activate an order: This link will take the customer to a list of the RFQs submitted and the customer can either manually enter a PO number or ticks a tick box stating that the job order should go ahead. When this option is

selected the database reads from the RFQ data and outputs the data on the screen. The data submitted by the user is written back to the database.

- Change account settings: This link goes to the account data of the user. The customer can change any personal details, which were submitted on the previously. The database retrieves the data that pertains to the customer from and displays it. The customer can then amend the data and submit it back to the database, which overwrites the previous data.

When the customer selects the Submit a Request for Quotation hyperlink the screen illustrated in Figure 5.13 is the web page the user views.

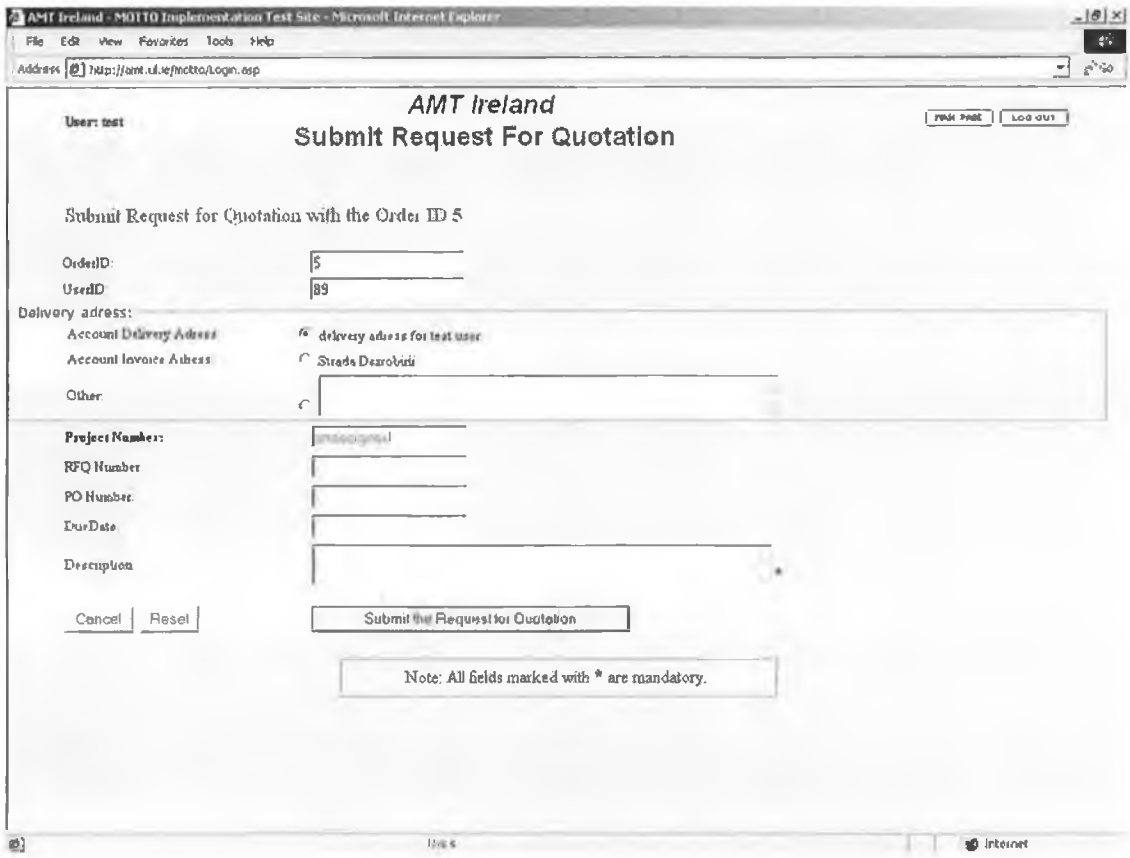


Figure 5.13 Submit Request For Quotation Web Page

5.6.5 The Administrative Website View

As previously discussed, the database establishes the authority users have over the database by recognising them as either administrative users or not. The administrative view enables its users to manipulate the entire database in a user friendly and easy to use manner. It is a far superior method of database maintenance than accessing the Access database directly and manually maintaining the data from there. Figure 5.14 illustrates the screen shown upon login identification of an administrative user.

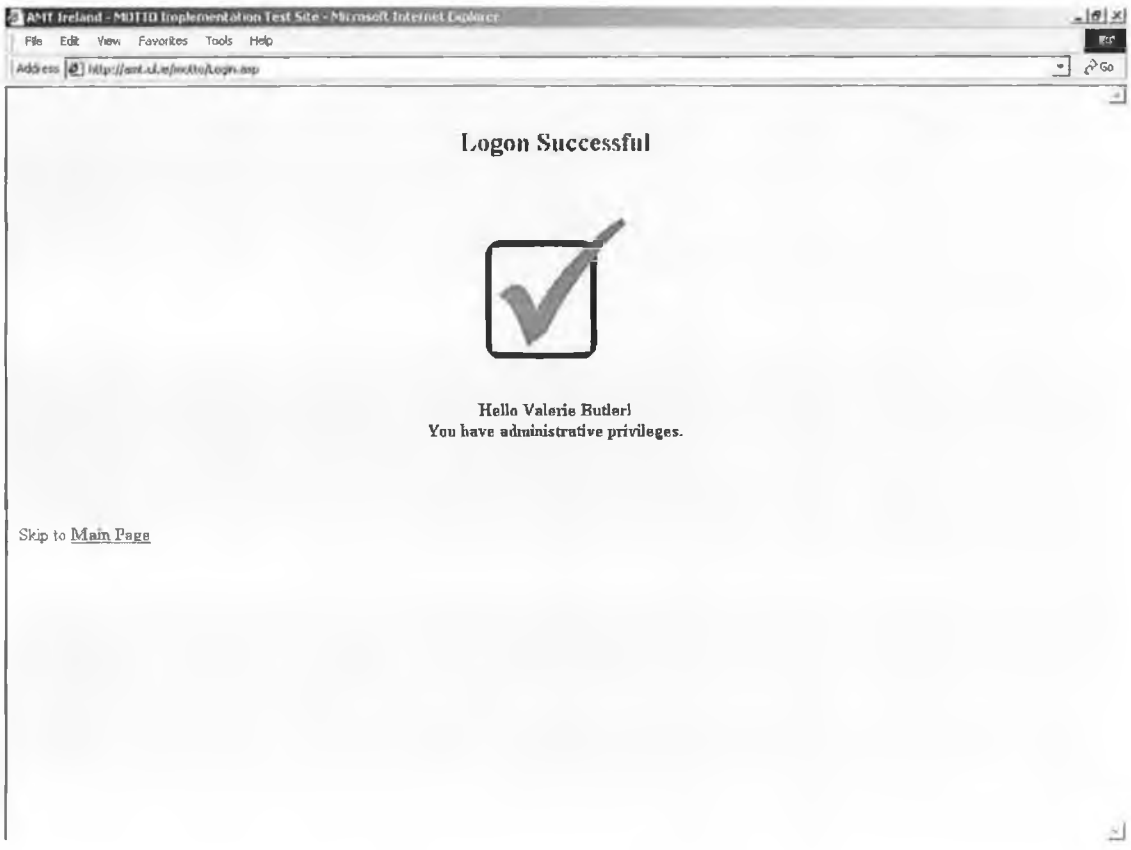


Figure 5.14 Administrative Login Acknowledgement

The administrator of this database will be the materials engineer. The Login acknowledgement is similar to what the customer receives on login. However the database sends data to inform the system that this user has administrative access.

When the administrator is authenticated the Login Acknowledgement Screen has a link which will go directly to the main page, otherwise the system will automatically direct the user to the main page. Figure 5.15 illustrates the main page.

Figure 5.15 Administrative View: Main Page

The main page consists of four operational links these are:

Requests for Quotation: This links to the Request for Quotations Web page. All of the RFQs submitted by customers using the system and their relevant data are retrieved from the database and are displayed here.

Orders: This link directs the administrator to the Order Web page. Data regarding orders that have been placed by customers that have accepted the quotation price and wish to proceed with testing are retrieved from the database and displayed here.

Add an Order: This link goes to the Add an Order page. The administrator can add orders to the database here. This is necessary to store data relating to customers who do not use the system.

Administer Users: This link goes to the Administer Users Web page. All customer data in the database is retrieved and displayed here. The administrator can view, analyse and maintain customer data.

The final link, View log, is not presently operational: it will store data in relation to customer interactions with the website. The objective of this is to provide analytical data to the administrator regarding customer interactions with the system.

Figures 5.16 and 5.17 show two of the administrative web pages already discussed.

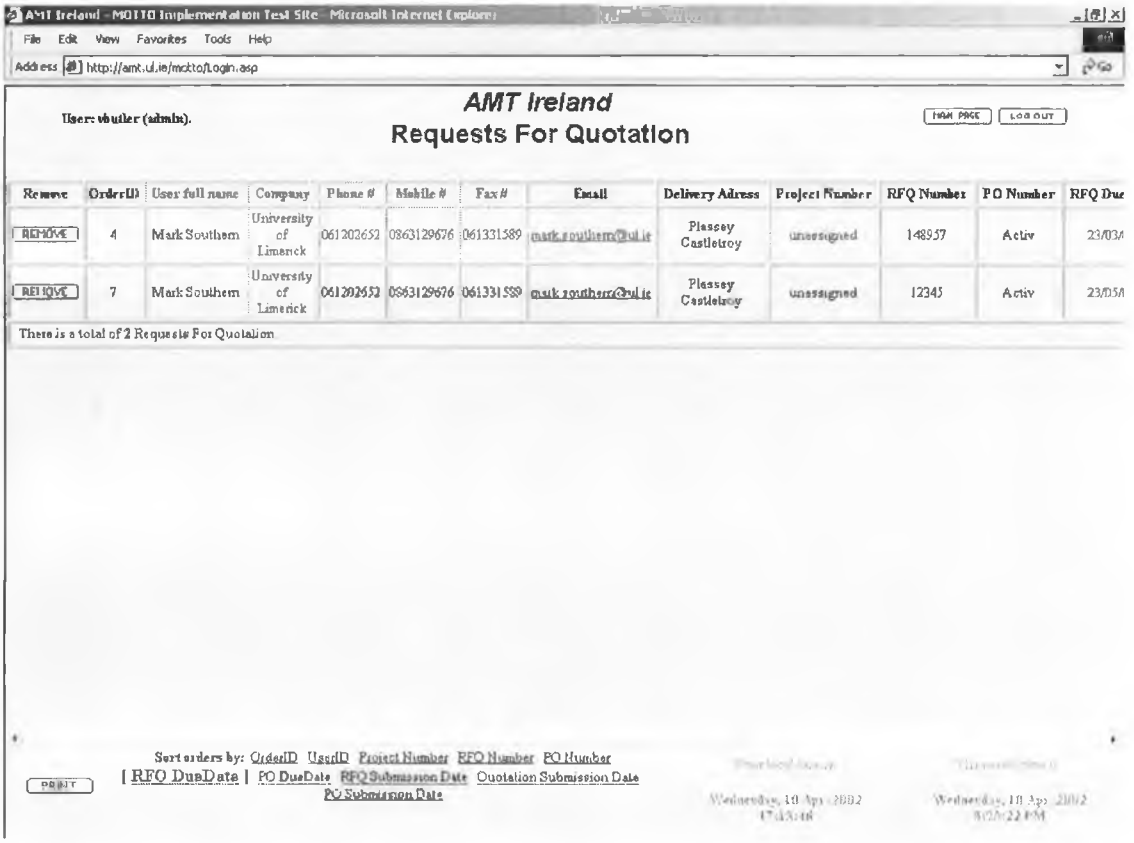


Figure 5.16 The Administrative Request for Quotations Web page

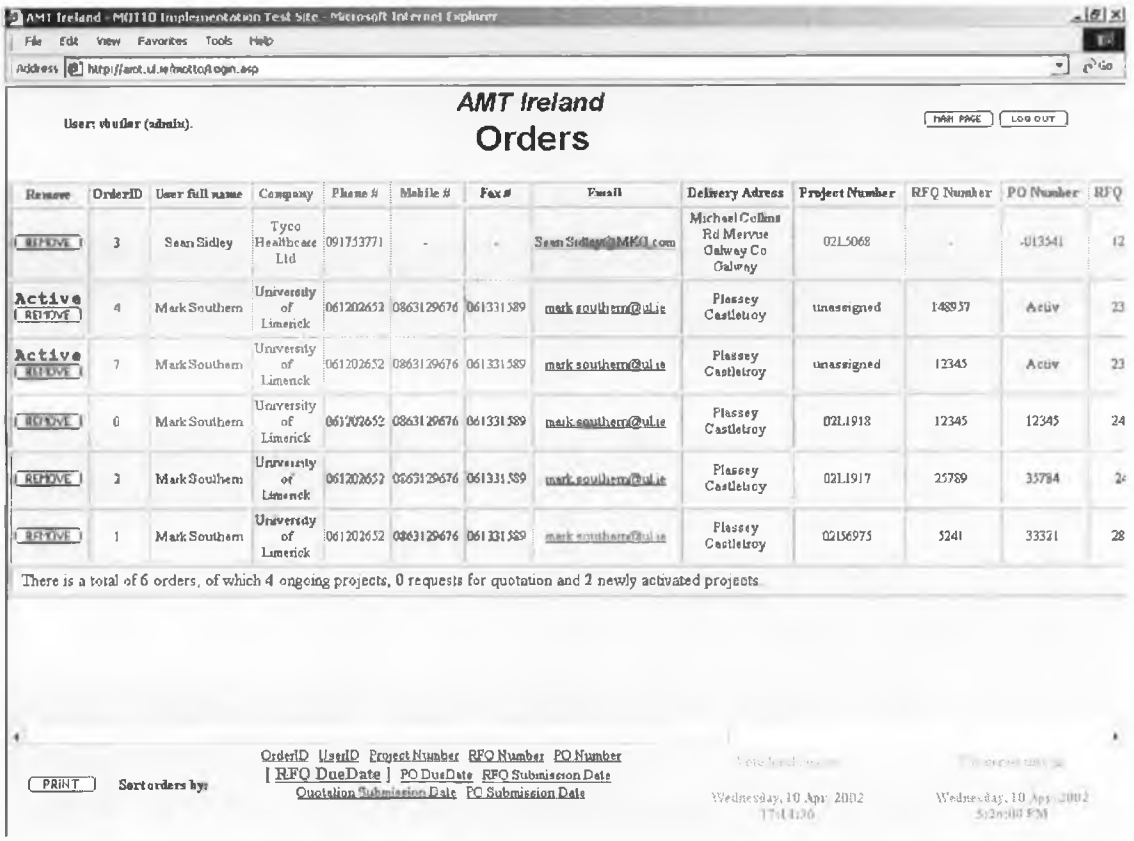


Figure 5.17 The Administrative Orders Web page

5.6.6 Creation of WML pages

This section will provide an overview of WAP coding. Section 5.6.7, describes the WAP application created for the system.

WML and WML Script are used to create the WAP interface. The tools used to write the WML code content is Edit Plus. The Nokia tool kit is use to view the content. As with the HTML files, the WML files also have to be converted to ASP. However, to convert the WML files, along with changing the extension of the files, the server needs to be configured to use the MIME type for WML. By default the IIS will forward the content of an ASP file to the browser using the MIME type for HTML, which is not accepted by a WAP device.

Most the activity in WAP development is at the markup language used to create the WAP application. WML is to a wireless browser what HTML is to a web browser.

WML was created to address the display, bandwidth, and memory limitations of mobile and wireless devices. As WAP devices have special user interface requirements and restrictions, the use of HTML is not an option.
WML markup requirements are much more strict that those of HTML development. Attention to case (e.g., <deck> is not the same as <DECK>), correct pairing of tags, and use of an XML prologue are required. Wireless devices will not display incorrect WML code.

Deck of Cards

WML uses a deck and card model for content display and navigation. Wireless users receive a WML deck (i.e. on the screen) consisting of one or more cards. Each deck is a self-contained unit, allowing a user to work offline between deck requests. A card is intended to represent a single physical display screen. To define a deck, a pair of <wml>: </wml> tag set is used that contains one or more cards enclosed by <card></card>.

The first two lines that precede the <wml> tag are as follows:

Line1: <?xml version="1.1"?>

Line 2: <!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN" "http://www.wapforum.org/DTD/wml_1_1.dtd">

These lines are found in all WML decks and must be the first text in the deck. The first line is required because WML is an XML language. The second line references the WML document type definition (DTD). This DTD defines all the allowable elements and attributes in WML. They are required in order for the WML to be valid.

Layout and Presentation

WML provides several alternatives for card layout. The tags define a standard paragraph, with attributes providing options for word wrap (mode="wrap" or "nowrap") and paragraph alignment (align="left," "right," or "center"). The default text alignment is left, and default word wrap is that of the previous paragraph. Within a paragraph text, line breaks, text emphasis (e.g., bold and italic), tables, images, and various navigation tags are allowed.

Text may be any character data except XML-reserved characters, such as angle brackets and ampersands.

Emphasis of Text

Text can be highlighted by using emphasis tags and line breaks. Line breaks are inserted into text using the
 tag. Emphasis tags enable changes in the appearance of text. These tags are similar to those available in HTML and include for emphasis, <I> for italics, and so on. The WML specification recommends the use of and elements because these are likely to be supported on most devices.

Navigation

WML provides a few ways to navigate within and between decks of cards. Navigation is generally enabled using two related WML elements: the event and the task. Basically, events trigger tasks. Events may be user generated, such as a key pressed input or the selection of a hyper link; the wireless device itself may also generate events, such as when a countdown timer expires. A task represents the execution of a piece of code in response to an event. Tasks typically are used to control navigation either within a deck or when loading an entirely new deck. Events and tasks lead to the <do> element for navigation. The <do> element provides a way for the user to act upon the currently displayed card. The <do> element must be paired with a task element, such as <go>. in order to perform an action. The <go> task element is used for both inter-card navigation and for making server requests.

Input (WAP data entry)

The options for user input is both text entry and/or selecting items from lists. WML text input is limited to normal text and password entry via the <input> tag, which associates data with a name. The <select> tag for lists supports either single or multiple <option> items to be chosen.

WML provides options for constraining user input. The maxlength attribute limits the number of characters that may be entered in a field. The format attribute

provides a way to implement a format, constraining user entry to a specific set of characters and/or numbers.

Other input attributes include value, which is used to specify a default value for input, and type, which may be either text (the default) or password when the input should be hidden. The size attribute specifies the width of the entry area (in characters). Input uses the tabindex attribute to specify display order within the selectable elements on the current card.

Select lists enable a user to choose one or more items from a list. Each item in the list is specified by an option element.

Variables, Parameters, and Context

Variables, parameters, and context are used to maintaining state within WML. Variables hold data values within the client and are maintained by the WML browser context. Parameters send this client state to the server.

Variables allow information to be passed from card to card, both in and between decks. Variables are automatically defined and set when a value is entered in an input field or an item is selected from a select list. Variables must begin with a letter or underscore and may contain underscores, letters, and numbers. In WML, variables may be referenced anywhere character data is between tags and also within certain attributes.

Variables reside locally in the WML client, accessible from both WML cards and WML Script programs. To make client data available to the server programs, it is necessary to understand parameters.

Parameters pass information between the mobile device and a server during a URL request. The postfield element is used to define and set parameters, and it can be used inside go tasks.

WML Attributes

Due to the fact that attributes are useful when describing elements, some attributes appear with most WML elements. The id attribute is used to give a unique identifier to any element, allowing reference to the element from another element. The class attribute can be used to associate an element with a class or classes to which the element belongs. Using the xml:lang attribute a natural or formal language in which text has been written can be specified. Although it is not found with all elements, the

title attribute is commonly used to provide a short name that can be used when a WML browser displays the element.

Events, Tasks, and History

Two types of events exist: explicit (user-initiated) events and intrinsic events. Built-in events occur as an indirect result of a user action or as a result of a countdown timer expiring.

The types of events that a user directly initiates are: depressing a key, selecting a link, entering a text URL, and selecting an option in a list. The events that occur indirectly or without user intervention are: transition into a card and timer expiration. It has previously been addressed that the go task may be used to navigate to specified URLs both within and between decks. In addition to go, three other tasks can be used to handle events specified by the <do> and <onevent> elements:

prev (go to the previous page in the history context)

refresh (update the variable context)

noop (do nothing)

Deck Declarations

In addition to cards, WML decks can contain optional header and template elements. These elements contain information of relevance to the deck as a whole.

Access Control

WML allows control over the URLs that may request a deck. This control is provided by the access element. The access element is specified inside the optional head element, which, if used, must be the first element in a deck following the <wml> tag. The head element must contain access elements, meta elements, or a combination of the two. A simple form of access control is provided by the access element's two attributes: domain and path. The domain attribute determines the URLs allowed to request a deck, while the path attribute is used to limit access to resources that are found under a specified directory within the selected domain. Either or both of attributes may be used to limit access.

WML Scripting

Like WML, WML Script is case-sensitive. Semicolons are used to end statements such as expressions, variable declarations, and return statements. WML Script supports a number of data types but does not require that variables be declared or contain a specific type. Types supported are:

Integer: These are 32-bit signed values (-2^{31} to 2^{31}).

Float: These are 32-bit single precision (1.17549435E-38 to 3.40282347E+38).

String: These may be defined using single ('...') or double ("...") quotes.

Boolean: These are initialised to true or false and contain the result of a logical test.

Invalid: This is a special type useful when denoting an invalid value.

A number of reserved words (language key words such as name, var, and agent), literals (such as true and false) exist. Comments are supported such as blocks (/*...*/) and single-line (//) comments.

Values can be assigned to variables using operators. It is also possible to compare values, test truth, and perform arithmetic.

The normal set sof statements supported in any procedural language can be used in WML Script. These include the following: if statements, for and while loops, block statements, break, continue, and return, and empty statements

To make use of WML Script, statements are organised by function, and functions are declared within compilation units. A WML Script function is simply a named collection of WML Script statements that returns a value. When a function is called, it must be passed exactly the same number of parameters as are in its declaration.

The WAP standards provide a rich set of standard libraries as well as libraries to provide application-level security and access to telephony functions. To use the library functions, it is necessary to download the "WMLScript Standard Libraries Specification" and optionally the "WMLScript Crypto Library" and "Wireless Telephony Application Interface Specification," available from the WAP Forum's Web site.

WML Script does not provide an exception, handling mechanism like that found in Java and other languages. Care must be taken when testing WML Script programs to exercise all the branches of the scripts during testing.

Common coding mistakes that can lead to errors include these: using invalid variables in calculations, dividing by zero, using integers where floating numbers are expected, and vice versa, nesting functions too deeply (the stack memory is very limited on many handsets).
VBScript is also used in the WML and used by the server to enable the WML pages to operate on the web server.

Images

WAP supports Wireless Bitmaps (WBMP), which provide basic monochrome image display. Images can be inserted into paragraphs, or links using the `<img>` tag. Attributes specify image location, layout options, and what text to display if images are not supported. The alternate attribute (e.g., `alt="gmit"`) must be provided both for user agents that do not support images and to provide backup in case there is an error in retrieving an image.

5.6.4.1 The WAP Application

The WAP application is developed to provide the following services to customers via a WAP enabled device:

- Order status information about what stage a particular project is at, and the details of the selected order
- Information about the WAP site
- Settings to change customer profiles
- Help in using the application

5.6.7 The WAP application

The WAP application offers far less functionality than the website. This is due to the limitations of the devices. In the case of this company, order status information is the most useful information to provide the mobile customers with. It provides a value added service, by eliminating the need for the customer to contact the company to gain information as to what stage their projects are at. Additionally, it is easy to use as it is not over burdening the customer with a lot of data to navigate through on these small devices, and it is not costing them extra for the retrieval of large data

amounts. Instead, it is addressing a status inquiry that is easy to use, to the point, not overly costly and can be accessed at anytime and anywhere.

The user accesses the application at the same URL as for the Web application (i.e. http://amt.ul.ie/motto/). The server establishes by the mime types provided that the client is requesting WML content. When the customer accesses the site the application begins initiation. When the application is ready for use the "AMT Ireland WAP site" deck appears and the page flicks back and forth between the "Motto Project" deck. Figure 5.18 shows the screen that the user sees.

Figure 5.18 WAP Application Initiation and First Screen

The code that achieves the screen flicking in the first screens is as follows:

```
<wml>
  <card id="flip1" title="  Welcome to the " newcontext="true">
        <onevent type="onenterforward">
              <refresh>
                    <setvar name="retry" value="0"/>
              </refresh>
        </onevent>

        <onevent type="ontimer">
    <go href="#flip2"/>
   </onevent>
   <timer value="50"/>
   <do type="options" label="Login">
    <go href="#Login"/>
   </do>
   <p align="center">
     <img src="images/AMT-WAPsmall.wbmp" alt="AMT Ireland" />
     <br/>
              WAP site.
        </p>
  </card>
 <card id="flip2" title="  Built by the ">
```

```
        <onevent type="ontimer">
    <go href="#flip1"/>
  </onevent>
  <timer value="30"/>
  <do type="options" label="Login">
    <go href="#Login"/>
  </do>
  <p align="center">
     <img src="images/motto.wbmp" alt="MOTTO" />
     <br/>
          <big>
     PROJECT
     </big>
  </p>
 </card>
```

When the application has been initiated, the user presses the enter button the Login Screen is displayed, as shown in Figure 5.19

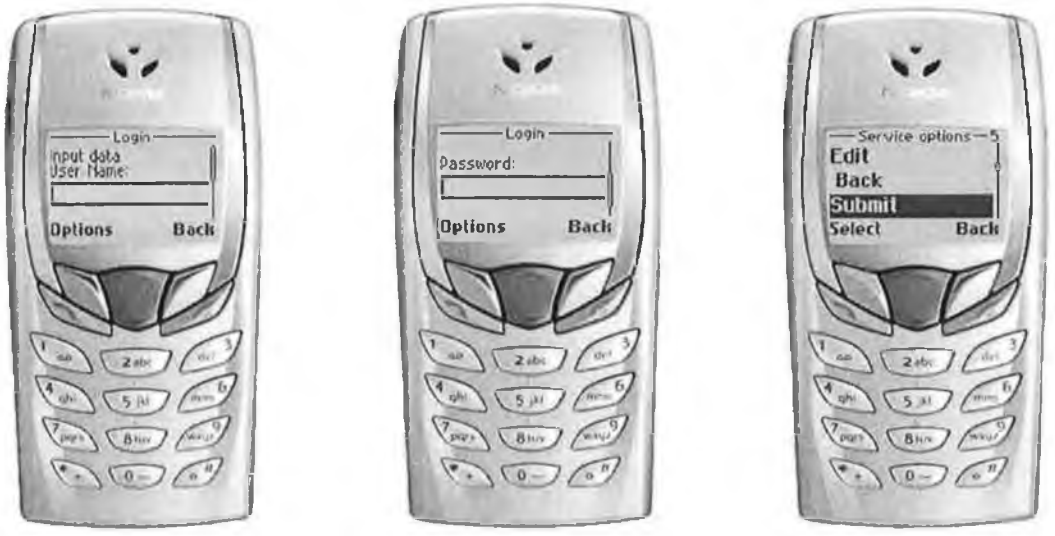


Figure 5.19 The WAP Login Screen

As shown in Figure 5.19, the user accesses the database by providing a user name and password. The user first enters the username then presses the enter/ok/select button (depending on the device) and then enters the password and presses the enter/ok/select button again. Depending on the device the user may have to press the enter/ok/select again to submit the data, as in the above example on the Nokia 65 10 phone. The submitted username and password are compared with the values for user name and password stored in the database. Providing that they match, the user is then greeted by name and directed to the main page as shown in Figure 5.20.

Figure 5.20 Successful Login and Main Page

The main page contains an image for AMT Ireland. As the user scrolls down the screen a list is displayed giving the user the option to chose one. These options are: Order status, Info page, Settings and Help. Figure 5.21 shows the order status selection.

Figure 5.21 Order Status via WAP

The orders WML page provides a further list containing specific orders that have been submitted by the user. The user can chose one of these by selecting it. The submitted selection retrieves details on that specific order from the database and displays it on the client device. These details include:

- Order Number
- Status
- Description
- Submission Date
- Due date
- PO Number
- RFQ Number
- Project Number
- User ID Number
- User Name
- Company
- City
- Delivery Address

The remaining options: Information about the WAP site, Settings to change customer profiles and Help in using the application, are accessed in the some manner as the Order Status option.

5.7 The New System

Figure 5.22 diagrammatically outlines the new system

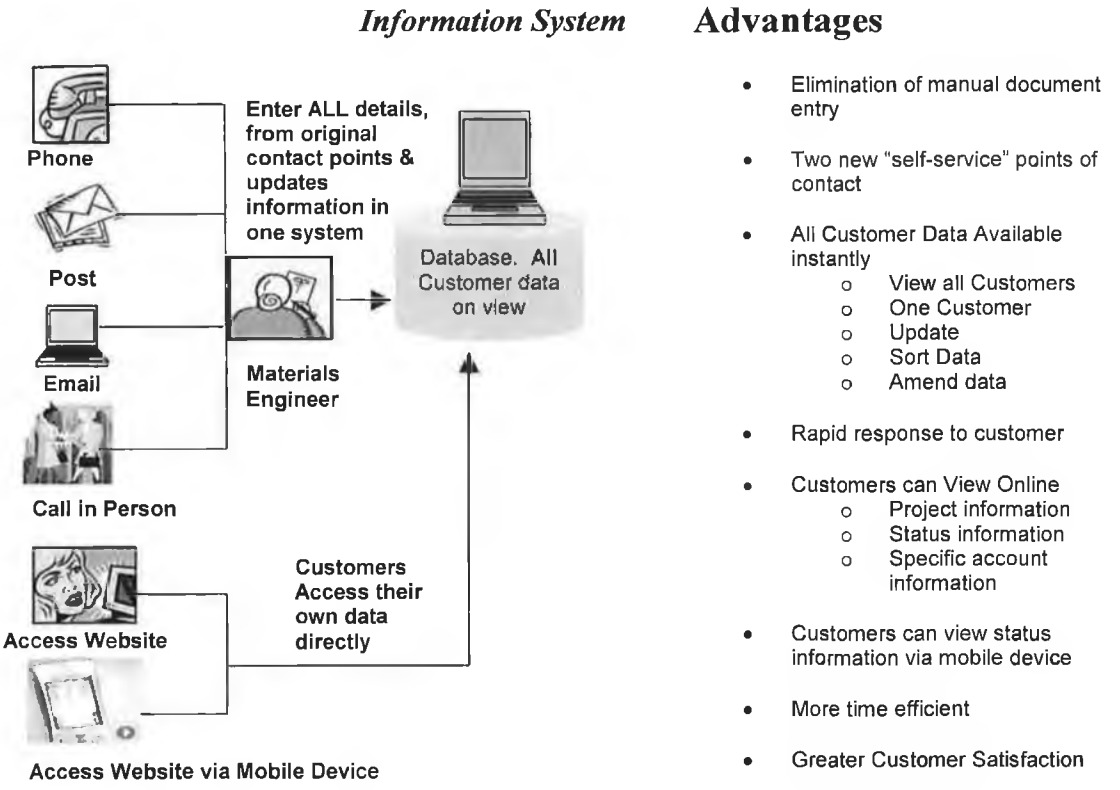


Figure 5.22 The New System

5.7.1 Original System versus New System

While the original system worked, it was inefficient in responding to customers. Each of the contact points in the original system required the customer to wait for the materials engineer to respond to the customer's inquiry. In business-to-business environments customers generally are contacting the company from their own working environments. Having to wait for a response erodes their valuable and limited time, and may have negative repercussions in their decision to deal with the company.

For the company employees who operated this system, in particular the materials engineer, the amount of time absorbed in dealing with customers: responding to phone calls, email, letter etc. and searching through the pages of various notebooks and the spreadsheet to locate relevant data, was both inefficient and frustrating.

As shown in Figure 5.22, the new system is equipped to better serve customers regardless of which contact point they chose to use. If customers choose the same contact points as in the original system they can still do so. They will still deal directly with the materials engineer. However, all of the old paper and excel data is now available on the engineers Administrative web view. This enables the engineer to input and retrieve data instantly, eliminating the laborious administrative tasks. For customers who wish to view the data without interaction with the engineer, it is now possible to do so by using the "self-service" options of using either the Web or Wireless applications.

5.7.2 Advantages of the Web and Wireless CRM System

Advantages of the Website Application for the company

- **Customer Contact data are stored centrally**
  All of the customer contact details are held in a centralised database. This provides ease of access in obtaining customers' details, contrary to the original system, which involved searching through books.

- **Customer contact details are more accurate and up-to-date**
  It proves easier to obtain the customers details, as customers may now enter their personal contact details online. Instead of taking the details manually over the phone, it is now be possible for the materials engineer to suggest that the customer create their account on line.

- **All of the projects will be more transparent**
  All of the project, at anytime in the process, can be readily identified. For example, it is easy to identify a request for a project from a project in

progress; therefore, at a glance, the materials engineer knows how many jobs are waiting to proceed.

- **Customer interruptions reduced**
  Customers can check the status of their orders and make amendments to the orders. This eliminates many customer enquiries, which frees some of the engineers time to use more productively.

- **Paper work will be reduced**
  It cuts down on paperwork in that some customers now enter their details electronically. The engineer also enters and updates data electronically using the administrative website.

- **Reduced Costs of communication**
  When a customer phones and the engineer is unavailable to receive the call. It is necessary to return the call to the customer. Less phone calls have to be returned to the customers, as more users adapt to using the Web.

- **Obtaining new customers**
  It helps in gaining new customers. The web site can be advertised and marketed to potential customers to enable the company to extend its market reach to the following:
    - **Overseas customers:** businesses in other countries can now avail of the testing analysis services by submitting quotations and orders online.
    - **Customers working during non-open business hours:** for example individuals who work on night shifts, can now submit a request for quotation and it can be delivered to them the following day. As the company opens at nine and closes at five, this was previously unachievable.

Advantages of the Website Application for the Customer

- **24 hour 7 days a week service**
  Customers have the ability to submit a request for quotation regardless of the time they wish to do it. Previously, they were confined to the 9am-5pm opening hours of the company, and the availability of the materials engineer.

- **Customer is an integral part of the business**
  Customers can view and control their own data. The data is delivered in a personalised manner. Therefore, the customer has a transparent view of their data that is contained by the company. This will assist in customer retention and customer loyalty.

- **Instantaneous updates regarding Orders in Production**
  It is possible to receive status updates over the web, as oppose to having to phone or email the company. This saves time for the customer.

- **Placing orders is be more time efficient**
  As stated earlier, the company works in a b-to-b environment. Some customers are very busy and use the Web application as a self-service option.

Advantages of the Wireless Internet application for the Company

- **Fewer Interruptions from customer enquiries**
  The WAP site enables the users to check their status form any location, using their mobile device. This is of great benefit in that there are fewer enquiries in relation to status.

- **Greater Customer Service**
  It enhances customer satisfaction. Customers who have the require access to status data while away from their desks appreciate that this is now achievable

via a mobile device. These customers are being provided with a value added service that addresses their requirements.

- **Company Image**
  Wireless applications are relatively new; therefore it enhances the company image to have such an application functional. It also encourages new customers to avail of the company's services.

Advantages of the Wireless Internet application for the Customer

- **Anytime, Anywhere access**
  The customer can check the status of their project, using their mobile device, regardless of where they are.

5.8 Conclusion

This chapter has provided details of the development of a feasible, practical and cost effective solution that has been designed bearing the limited resources of SMEs in mind. The chapter has discussed the requirements defined by the company, from which the functionality and user interfaces of the system have been proposed.
The advantages of deploying database centric Web and WAP applications have been explored, along with the technological tools that have been used to develop this solution. The Solution development has been discussed using diagrammatic representations of interfaces for the Web and WAP applications. Finally, the chapter has discussed the advantages that the solution has delivered.
Throughout the development of this system many issues were encountered and lessons were learnt. The next chapter will provide a description of the development process and the issues that were encountered.

Chapter 6

Review of Development Process

6.1 Introduction

The previous chapter has discussed the system that has been developed for the materials laboratory. This Chapter will review the development process from beginning to end. It will highlight the experiences and issues encountered during the development. The chapter concludes with an outline of the lessons learnt from this development and presents guidelines for small companies planning to adopt a similar CRM development.

The purpose of this chapter is to highlight the experiences and issues that were encountered throughout the process of realising this system.

6.2 Analysis of the original system and business processes

In order to establish an in-depth understanding of the current system and business environment of the materials laboratory it was necessary to establish an overall view of the company, its processes, its current technology and its employees. To achieve this, questionnaires, interviews and regular visits to the company were carried out. These served the purpose of providing a familiarity with the business and, more significantly, the employees. A working relationship was established between the employees and the developers.

6.2.1 Company Visits

The initial introduction to the company comprised of a guided tour of the plant. The engineers in control of different services introduced themselves and gave an overview of what their jobs entailed. Subsequent to the first introduction, several more site visits were made in order to gain a familiarity with the business and to pose additional questions to the engineers. It was decided that technological development should focus within the materials laboratory of the company, as it is currently under the sole control of one engineer. The technological solution could assist the engineer, by providing a more efficient system, a reduction in administrative tasks and provide a new CRM approach to customer relations. The system would only have one administrator, the materials engineer. Therefore only one person would require training and be accountable for the system.

6.2.2 Questionnaires

The initial "*getting to know each other*" phase was addressed by the company visits. The next progression was to get a more detailed comprehension of the company's processes. The core focus was on the materials laboratory, as was for this part the technological solution was to be developed. Questionnaires were compiled and completed by the employees of the company. The questionnaires completed by the materials engineer provided a good basis for understanding the operations of the materials laboratory[1]. The questions asked were in relation to customer interactions and the process flow.

[1] See Appendix C

6.2.3 Interviews

The questionnaires were reviewed and a series of interviews were conducted in order to establish clarity of responses to the questionnaires and to pose new questions that arose as a result. The interviews were conducted at the company site.

6.2.4 Examination of the current working environment

The visits to the company provided the opportunity to examine the working area of the materials laboratory. It was possible to view processes in operation, the documentation in use and the methods used to store data. Additionally it became clear that the laboratory and the entire company made very little use of information technology, Microsoft Excel and email were the only information technology applications in use.

6.3 The Requirements Elicitation Process

The information gathering techniques provided an analysis of the current operation of the materials laboratory including the process and the information system used. This was discussed in Chapter four. Prior to information gathering, the initial idea, from the developers' point of view, was to develop a wireless CRM application with sophisticated functionality. It had been assumed that the company would have a database and transaction website functional. However, after analysis of the company, it became clear that a wireless application as envisaged by the developer would be impractical and inoperable for this company.

The aim of a CRM application is that the customers are the focus point of the development. For this reason the adoption of the solution decided upon was deployed in the following manner:

- Prior to the development of a Website or a WAP application the most critical issue was to tidy the data in the original information system into a form where the data was concise, accurate and easy to access. The organisation of customer and order data was very dispersed and lacked any method of viewing

individual customers and their preferences. It was also necessary to store the data in a centralised resource for the concept of CRM is to be adhered to.

- As the company did not have a website it was imperative that one should be developed. A transactional web site was a practical and useful solution for allowing both the customers and administrator to access the database.
- The development of the wireless application provided a value-added service to customer, which enabled access to order status information in a convenient and easy manner.
- The individuals within the company had to be introduced firstly to the concept of CRM, to identify how customers were dealt with and how this could be improved upon. Then they had to be made aware of the impact and advantages of e-Business before they could embark on m-Business.

6.3.1 Establishing Requirements and System Functionality

The requirements gathering phase provided an understanding of how the original system operated and highlighted the issues with the original system. However, the question of how technology could resolve these issues was unclear for the company employees. The lack of technology usage within the company contributed to this. Additionally, even with its issues, the original information system in place was reasonably adequate and was well understood. For these reasons the individuals found it difficult to state clearly exactly what technical functionality the solution needed to have. Therefore, the developer had to establish what the solution should do and verify with the employees that it was the right approach.

The proposed functional and non-functional requirements, discussed in Chapter five, came about as a result of the requirements outlined by the company and the decisions made on technical feasibility and scope by the developer. The solution was developed primarily to address the requirements of the materials laboratory. In line with the requirements of SMEs in general, the solution was developed at minimum cost.

The solution was built using technologies that are familiar to most individuals. Given Microsoft's popularity, market share and the widespread usage of Microsoft Office

applications, it was appropriate to use this technology for the development platform and database. Additionally, the company already had and were using Microsoft Office applications.

6.3.2 Approach to Implementation

Through an in-depth understanding of the company, its people and processes, it became apparent that the individuals were happy to embrace the technology. However they feared that the impact of a new system might require technical skills that they lacked. Therefore, a gradual implementation was regarded as the best approach. This approach is as follows:

- Only one area of the company, the materials laboratory, was technologically impacted upon. The materials laboratory has only one person in control of its operation. Therefore, only that person needed to be trained to use, administrate and maintain the system.
- The Development was gradual, the database and website were developed and implemented at first and the wireless application at a later stage. The database comprises the information in the paper-based system and the Excel application. The website provides a user-friendly interface to this data.
- The engineer used the application for several weeks before introducing it to customers. This provided the engineer with the opportunity to experiment and use the application in order to state any issues that arose in using the system.
- The Technological solution initially ran concurrently with the existing system. Although this involves using the traditional system, along with adding the same data to the database and maintaining the database. The materials engineer can become accustomed to using the application before abandoning the old information system. This also proves useful in assisting the engineer to fully understand the advantages of centralised data storage.

6.4 Development of Technological Solution

The technology used and the system developed has been discussed in chapter five. This section explains how the development of the system evolved and the issues encountered.

6.4.1 Development of the Solution. Phase One

After the questions such as "what the system should do" and "what technologies are to be employed in its development" had been addressed, the next progression was to develop the solution. Figure 6.1 outlines the development steps of the first phase of development:

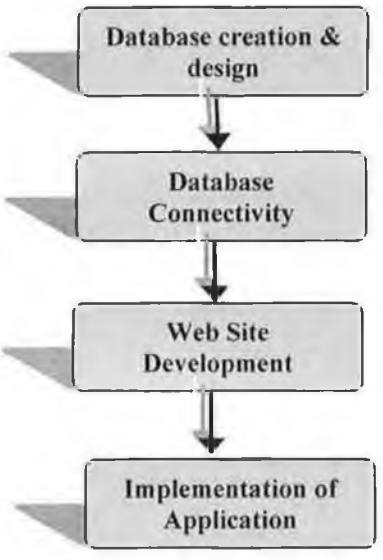


Figure 6.1 Phase One of Development

As shown in Figure 6.1, the first issue addressed was that of the dispersed data within the original system. All the data was transferred to the database and stored in tables that related either to the Order data or the Customer data. After the database had been developed the connection between the database and the server was created. The next part was the development of the Web pages, which are the customer and administrative interfaces to the database. Finally the application was implemented in the company.

The initial implementation was measured against the requirements that had been previously stated. All of the stated requirements that had been agreed upon between the developer and the company were met. However, upon using the application the materials engineer immediately noticed previously unconsidered functionality lacking in the development. These issues were as follows:

- During the analysis of the company the materials engineer stated that, in accordance with procedures, all customers submit the Purchase Order (PO) number before any testing job can proceed. The database had been designed to adhere to this condition (i.e. if there was no PO number submitted by the customer then that order could not proceed). However, in reality testing services do proceed without a PO number in cases where the customer is longstanding and credit worthy.

- The administrator needed to have customer notification capabilities in the system. This was necessary to enable customers, who accept the quotation price, and want to avail of the testing analysis service to, notify the administrator. It is therefore necessary to have a function where the customer can activate his/her orders. The developer had relied on the PO submission by the customer to provide this notification.

- The administrator must be able to create new user accounts for those customers that do not use the system (i.e. they use the phone, post or email). The developer had assumed that the customers would create their own user accounts online.

- For the customers that do create their own accounts online it is essential that the administrator be informed of these new system users. This is necessary so that the data entered by the customer can be validated. This is necessary to reduce redundant data. For example, if a customer misspells the company name and the administrator searched by the company name, that customer will not be listed.

Although this functionality had not been stated in the requirements it was essential that new functionality be added, as the system would otherwise be ineffective. This required the developer to return back to a second development phase to address these issues.

6.4.2 Development of the Solution: Phase Two

Many requirements that had not previously been stated by the materials engineer and were not obvious to the developer began to emerge. It became apparent that the lack of clear communication between the company and the developer on a more frequent basis had caused the first implementations lack of required functionality. The analysis of the company had served to provide a good understanding of how the company operates. However, what the company said they required and what they actually required in reality varied.
Additionally there was a considerable geographical distance between the company and the developer, which made frequent face-to-face communication less feasible. To address the issue of infrequent communication it was decided that Yahoo messenger should be installed on both the engineer and developer's personal computers. Yahoo messenger is free to download from the Internet. It provides two way interactive communications, enabling users to "chat" interactively either by typing or using voice via a microphone. It is also possible to send files through Yahoo messenger. This proved to be much more effective than the use of email.

The initial implementation remained in the company and the materials engineer used it to experiment with. Also the engineer used the time to populate the database with real customer data, as it was dummy data that had been used for customer data by the developer. The developer returned to the coding to add the new functionality.

Throughout phase two, and the remainder of the development time Yahoo messenger was used to communicate during the interim periods where the developer and the engineer were not meeting in person. The developer had the ability to clarify requirements, get the engineers opinion of various functionalities and ensure that the

next implementation would produce a mutually satisfactory outcome. The engineer could pose questions to the developer regarding system usage.

Figure 6.2 outlines the steps involved in the second phase of development:

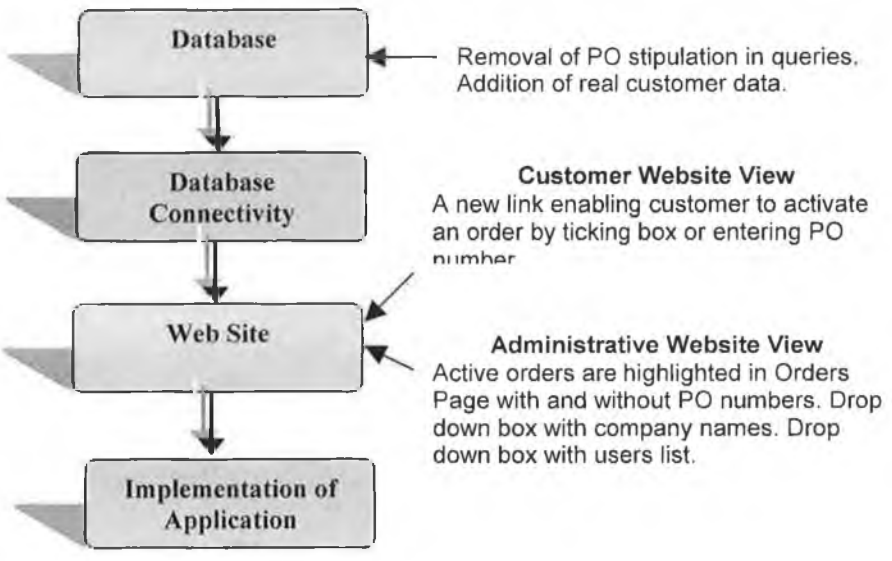


Figure 6.2 Phase Two of Development

As shown in Figure 6.2, the second phase involved addressing the functionality issues that were devoid in the first phase. These issues were overcome by the removal of the PO constraint that was present in the first installation. A new link was added to the customer view that enabled the customer to view their submitted Requests for Quotations (RFQs). By double clicking on a RFQ the customer can either manually enter a PO number or tick a box to activate the order, this function is used so that the customer can inform the engineer to proceed with the testing.

When customers activate an order, the Orders page of the Administrators website view highlights this Active orders by having a red flashing icon next to the customers order information to alert the administrator.

Additionally, in the Administrators view, a new drop down box containing all the companies in the database was developed. This enables the administrator to select a specific company and view individual customers from that company.

After the new requirements were accommodated in the system the implementation of the final version came about. Due to the fact that the engineer had been

communicating with the developer throughout the second phase, the system was designed with all of the required functionally and was exactly in line with what the engineer had expected.

6.4.3 Development of the Solution: Phase Three

After the second phase the engineer then worked with the new and final system both from the engineers administrative view and the customer view. The reason for this was to envisage scenarios to see if the system dealt appropriately. This was important to ensure the system would adequately serve both the customers and the engineer as its administrator before the system was made available to real customers. The engineer posed any queries regarding system usage to the developer via Yahoo messenger.

Simultaneously the developer set about the creation of the Wireless Application, which would provide customers with order status information relating to their orders. The reasons for developing the Wireless Application last are twofold. Firstly, the company required the website more urgently, as it provides greater functionality to both the customers and administrator, it is impossible to administrate a database on a tiny screen with limited input ability. Secondly, the developer was awaiting GPRS capabilities, as it provides "always-on" connectivity and could result in greater customer usage of a wireless application. GPRS was advertised as being on the market in January of 2001, however the GPRS handsets were still not available on the Irish market a year later.

Figure 6.3 shows the steps in the development of the Wireless Application (Phase Three):

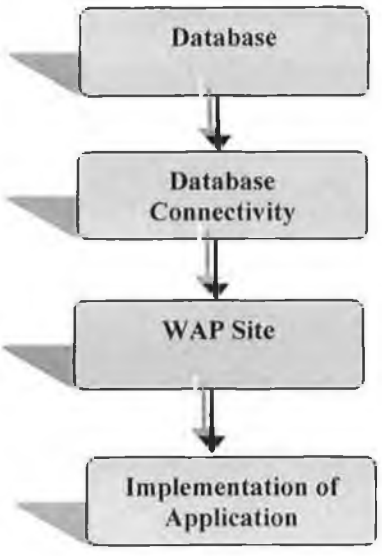


Figure 6.3 Phase Three of Development

The existing database was used, and the interface was created using WML and WML scripting language. The server was configured to identify whether the requesting client (Web or WAP browser) is using WML or HTML. If it is using HTML or HTML and WML (e.g. PDA) then it will be directed to the Web site. If the client is only using WML then it will be directed to the WAP site.

The WAP application was implemented on the server. It had been decided at the onset of the system development that this application would provide order status information to customers, which it has successfully achieved. Therefore no issues regarding lack of functionality were encountered.

6.5 Testing and Validation

Testing was carried out throughout the development phases. Testing was performed on the code of the both the administrative and customer web interfaces, the wireless interfaces, the database, the database connectivity, and the interoperation of these components in the overall system. All errors and bugs identified were eliminated during this testing phase.

Testing was carried out in the areas of functionality, usability, reliability, and speed to ensure the system was robust enough to operate under various constraints.

Additionally the materials engineers and other employees of the company operated the system in house, prior to informing customers of the system availability and relayed any issues encountered. The developer addressed these.

6.6 Monitoring of System and System Training Support

The engineer became accustomed to using the system subsequent to the first installation. Additionally, while the Wireless application was being developed, the engineer used and examined the system from both the customers' perspective and the system administrator's perspective. This made training on how to use much easier for the developer. The system was designed to address customer's requirements of a self-service contact point to the company. Therefore the system was developed to make customer interactions as user-friendly as possible. Training on the maintenance of the system was also carried out to ensure that the engineer is confident in using the system.

6.7 System Development time

The development of this system spanned over a period of 8 months. The development of the system from a development perspective is graphical represented in Figure 6.4.

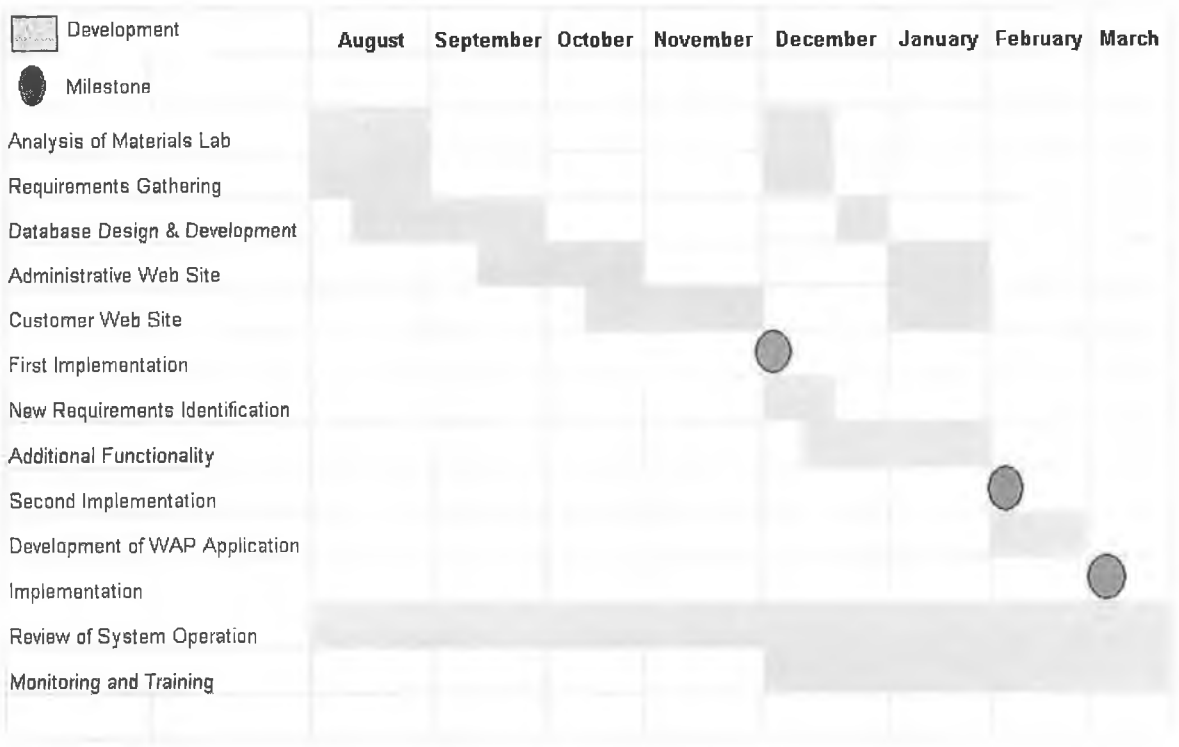


Figure 6.4 System Development Time

Figure 6.4 highlights the major development areas, and the stages at which they were developed. Research in the area of wireless application development and CRM had been carried out prior to the development of the system, which also assisted in the process of development.

The development also required the developer to overcome some learning curves to develop the system. The use of ASP, ADO, JavaScript, Visual Basic Script, WML and WML Script all had to be learned and utilised by the developer.

6.8 A Critique of a Development Model Used

The development of the solution for Phase 1 followed the classic Waterfall Life Cycle Strategy. The information gathered was for the purpose of establishing the current system characteristics, the problems in current operations and to establish how to create improvements. This approach was advantageous in that it is a well understood, tried and tested method of establishing requirements. The disadvantages were that it was time consuming. Also, the end users had very little involvement in the

development. At the beginning they were asked numerous questions and both the developer and the users decided what they needed and what was technically viable. Then the development of the system began. The users did not see the system until it was ready for implementation. There were many issues encountered in adopting the waterfall model. Figure 6.5 outlines the problem in eliminating the users during the development phase.

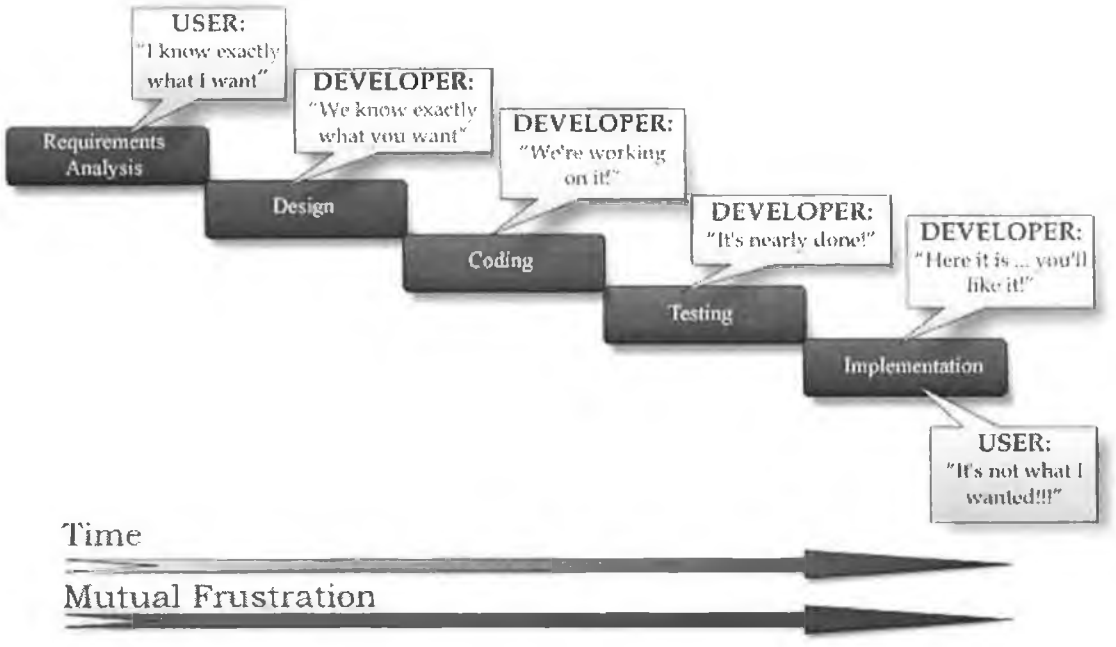


Figure 6.5 Issues with using the Waterfall Model [Lang 2001]

As shown in Figure 6.5, the waterfall model separates requirements from development, however it is impossible to define a requirement without some idea of how that requirement will be implemented. As a system is being developed requirements that have not been previously stated will inevitably emerge. Therefore it is highly desirable that the channels of communication between the users and developer/software designer remain open throughout all stages of the systems development.

The justification for using the waterfall approach at the onset of this development was the lack of technical knowledge on the user side. The first implementation provided the users with the requirements they had initially stated. It was only when the users saw the system up and running that they became alerted to the additional required functionality. However, after the first implementation it became clear that the users

had to be involved throughout the remainder of the development. Therefore yahoo messenger was used on a day-to-day basis for communication between the developer and the materials engineer.

The first model (i.e. the waterfall model) of software development deployed proved ineffective in the delivery of a final robust solution. The development process then followed the incremental model for software development to overcome the shortcomings of the waterfall model. The first system developed became the first increment or phase, as opposed to the final version of the system. The incremental model combines elements of the linear sequential model with the iterative philosophy of prototyping. Each linear sequence produces a deliverable "increment" of software. When an incremental model is used, the first increment is often a core product. That is the basic requirements are addressed, but many supplementary features remain undelivered. The incremental process model is like prototyping in that it is iterative in nature. However, unlike prototyping, it focuses on the delivery of an operational product with each increment [Pressman 1997].

The incremental model used in the phases of development is described in Figure 6.6.

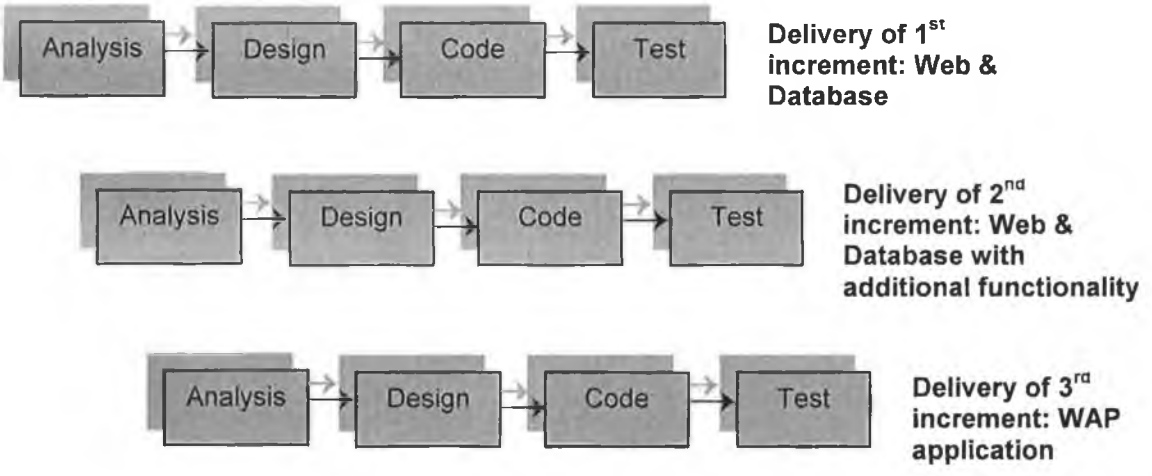


Figure 6.6 The Incremental Model

6.9 Lessons Learnt & Guidelines for SMEs

6.9.1 Lessons Learnt

The experience of working with and developing a technological system for an SME provided some valuable lessons on how to implement a CRM system. These include:

- **The requirements stated might not be the "real" requirements:** Users may find difficulty in formulating the issued that they need to address. This may be due to a lack of technical skills or an inability to visualise how technology can address business a problem. This leads to inaccurate requirements definitions and dissatisfaction with the solution. If the requirements not addressed it then creates additional work for the developer that goes beyond the scope of the initial project. If neither the business objectives nor the customer needs are understood, the right solution cannot be produced. The requirements gathering is a vital part of any project.

- **Know the people who are directly affected by the new technology.** It is of utmost importance that the developer and end users form a working relationship at the onset of a project. This is the very principal on which CRM is built. In the case of this project, the understanding between the materials engineer and the developer proved invaluable when the first implementation occurred. Both parties knew that the purpose of this development was to enhance customer service and had the interests of the company as a primary concern. Although the system lacked essential functionality, both parties were patient with one another. Both realised that the non-stated requirements came from a lack of technical expertise on the users part, and a lack of a complete understanding that "rule-bending" is accommodated within the company on the developer's part. If this understanding was not established either party might have decided to abandon the project.

- **Understand the original system.** This is a very big undertaking if the developer is not an employee of the company. Employees that work the system understand their roles. They may have been using the system for

years. However, attempting to extract the right information from the employees may be difficult as a developer who is new to the system and the environment in which it operates. The analysis carried out on the company served to give the developer a good comprehension of the company. However, even with this analysis issues such as the Purchase Order number problem encountered in the first implementation went unnoticed during the analysis.

- **Involve the Users in ALL phases of development:** Many perspective users may be intimidated by the development of a new system. The more involved they are in its development the more they will understand why the system is being developed, what its advantages are and they will also learn how the system operates. Most importantly, the users provide the best guidance in what should and should not be implemented. The system was designed to be used by them. Therefore, their acceptance and appreciation is critical to the success of the application. In the case of this project the end users were the employees of the company. However, the system will also have the company's customers as end-users. As it was infeasible to get customers involved, the materials engineer used the system from the customers' perspective. This was appropriate as the engineer deals with the customers on a daily basis and knows what the customers would require from the system.

- **SMEs may be reluctant to abandon their traditional systems:** The system that the company has worked with for years may be difficult to abandon. This is particularly true if the system is being replace with technology that is unfamiliar and requires the users to learn new skills. In the case of this project, one of the requirements was that the system would be easy to use. Therefore, it did not require a steep learning curve to use. The original system was also run in conjunction with the original system to allow the users to gradually adjust to the new system and, gradually, abandon the old one.

- **A technological solution does not end at the final implementation.** The effort required to get a system operational may cause an underestimation of the amount of effort. It is necessary to relentlessly communicate the CRM concept and monitor its implementation. The first post-implementation challenge was to address the end-users new requirements. After the final implementation the task was to ensure that the system was used for all the purposes for which it had been developed in order to make it operational.

- **E-commerce, CRM and m-Commerce can bring new opportunities to SMEs:** The development of this system has opened new channels to customer. It has eliminated many administrative tasks and thereby increased efficiency in customer service.

6.9.2 Guidelines for SMEs

Consider the type of customers: Some customers will always prefer personal services face-to-face, or via or other channels. Removing these points of contact will negatively impact on the satisfaction of theses customers. It is therefore imperative that these customers are served using the channels they prefer. Other customers will consider "self-service", direct data contact a more valuable method of interacting with the company. Therefore, Electronic CRM (E-CRM) is only an enabling element of a broader CRM project, rather than as an end in itself. (i.e. Make sure that the deployment of a technological solution will be better than what it supersedes).

Consider the Customer Base: Whether an SME should or should not implement a CRM technological solution should be based on the size of the customer base. If the company has a small customer base and is capable of effective and individual communication with customers, then that company is performing CRM perfectly well without technology.

However, if the company is struggling to maintain satisfied customers and is starting to loose personal customer relationships with their customers, it may be advisable to investigate whether or not technology can assist in achieving a stronger relationship with customers. The business needs should always drive CRM initiatives.

Technology will not solve all business problems by itself: Successful CRM initiatives are fundamentally business undertakings, with technology as an enabler. The most effective method to implement a CRM strategy is for the Business and developer to work together. They should focus on the business objective, not just the CRM concept, as well as the opportunity of variable customer communications and touch points. Both SMEs and the developer should have a clear set of objectives and aim at specific results. They both should measure and refine their programs, activities, communications, products, services, and relationships.

Technology need not be Expensive: Standard technologies were used in the development of the system developed for the materials laboratory. The expertise was provided for free by third level students. Therefore, the approach to deploying technology, in relation to minimising cost, is very important.

E-Business can deliver a more productive solution than M-Business. Given the current limitations of devices, it is difficult to deliver an array of services to customers via a WAP enabled mobile phone. E-Business is PC based, giving users greater display capabilities, faster access and a user-friendlier environment in which to interact with a company. Therefore it is more practical to deploy an e-business solution than an m-commerce one. For companies that already have e-business systems operational, wireless connectivity may be worth considering to create more value added services to customers.

6.10 Conclusion

This chapter provided a detailed description of the realisation of the Web and Wireless CRM applications that were implemented in the Materials laboratory of the Electronics Company. The chapter has discussed the experiences encountered from both the developers and end-users perspectives. In conclusion this chapter has extracted the lessons learnt and provided guidelines for SMEs who plan to embark on the development of a new technological CRM solution.

Chapter 7

Conclusions, Recommendations and Future Work

7.1 Thesis Summary

The research carried out in the development of this thesis is concentrated in the areas of wireless technology, customer relationship management (CRM) and small-to-medium size enterprises (SMEs).

Chapter 2 provided a review of wireless communication, which primarily focuses on wireless Internet technology.

Wireless technologies have enabled inventions such as the radio, the television, and the mobile telephone. The amalgamation of wireless and Internet technologies provides a new mobile dimension to electronic commerce, enabling Internet access anytime and at any location, without the necessity to boot up a computer or make a telephone call.

The development of highly functional and complex wireless technological solutions introduces new complexities and obstacles, when compared with traditional Web solution development. These complexities arise in the form of numerous devices, presentation standards, browsers, bandwidth limitations and network types. Many of these constraints are due to the nascent nature of wireless Internet communications, and are analogous to the issues that confronted solution development in the initial

onset of the traditional Web. However, on a global scale, networking issues pose the greatest obstacle as wireless networks have evolved along three different paths in three different continents: Europe, the United States, and Japan. The IMT-2000 program, outlined by the International Telecommunications Union seeks to overcome this obstacle by developing a single, digital standard that will operate all over the world. The program was expected to see an initial rollout in 2000. However, further obstacles were imposed in this rollout as a result of huge investment requirements, a global economic downturn, and a conflict in the choice of the network platform deployed. Despite these issues and obstacles, the forces of industry convergence, improvements in wireless technology and standards, together with cultural and regulatory effects are driving global adoption of mobile business. Wireless connectivity for corporate information access offers a variety of potential business benefits driven by user convenience, immediacy of information, and increased ability to transact business.

The opportunities for mobile commerce services are potentially huge. The mobile phone provides users with an information tool and a transactional device. This will enable electronic commerce activities of the Internet to evolve into mobile commerce, although the two are not the same, given the different environments each operate in (i.e. a PC is used to conduct e-commerce, a small mobile device for m-commerce). The evolution of these technologies, with improved standards, device capabilities, bandwidth and networks, will eventually enable Ubiquitous computing.

The pivotal critical success factor for m-commerce and, indeed, any technological solution is in the benefits its usage provides the users. This instigated the research carried out in chapter 3.

Chapter 3 involved research in two areas: the area of customer relationship management (CRM) and Small-to-Medium size enterprises. CRM is about placing the customers requirements at the forefront of all business initiatives. With the proliferation of Internet technologies such as e-business solutions and the imminent onset of m-commerce applications, this research aims to stress the fundamental importance of CRM in the development of these technological endeavours.

It is critical to enterprise agility that Information Technology and business objectives work together to focus on customer data management and analysis, as information assets.

In the Small-to-Medium enterprise category of business, the rate of e-business adoption has, so far, been alarmingly slow. This is particularly true with Irish SMEs. As more customers and businesses demand to use e-business as their preferred channel of communication, the likelihood of these businesses being squeezed out of the market becomes more imminent. The reasons for the slow pace of e-business adoption among SMEs are numerous. They include: lack of technical expertise in the development of e-business solutions, the complexity involved, the financial and resource expense required, and the risk that it may not be successful. As a main priority, Irish SMEs must adopt positive steps to ensure they realise the benefits of e-commerce in order to remain competitive and sustain an overall national competitiveness.

Many SMEs provide good customer relationship management as an integral part of the businesses they operate. While the adoption of e-business is critical, it is also essential that SMEs can still maintain the intimate customer knowledge that they are associated with. It is essential that technological endeavours do not detract from CRM. Therefore, the decision to adopt a technological solution must be designed with who it will serve in mind, and the benefits that will be realised. While there are many vendor CRM solutions available on the market, they tend to be designed for larger companies. They are rarely simple to use "out-of-the-box" solutions, and they tend to be expensive. Therefore a Web-based CRM application may prove to be a more financially and technically viable approach to adopting e-business while still being able to monitor, manage and personalise customer interactions.

In Chapter 4 one SME, which is the Electronics Company of AMT Ireland in county Limerick, was chosen for the purpose of identifying the nature of an individual SME with a view to addressing issues within the current system and procedures. An over view of the company and services provided was carried out. As the company is offering four distinct services, a detailed analysis of one section, the materials laboratory was carried out. The reason for this was to address the issues of one area of the company in order to demonstrate the value that can be realised in overcoming these issues without heavily impacting on the entire company. The process and

information systems were examined and explained. The CRM practices that were in place and in particular the system for dealing with customers have been delineated. The disadvantages of the current system have been concluded from this analysis.

Chapter 5 discussed the CRM solution that overcame these issues, and additionally brought the materials laboratory into the e-business realm, which enables the company to compete on a new platform. The requirements for the system were outlined, depicting the technical capabilities and constraints that the system should operate within. Based on the requirements a centralised database and an e-business website have been developed. Additionally, a wireless application for communicating with customers was also developed. The system interfaces, technological tools and their integration in the development of the solution were discussed. The advantages of the new system were outlined prior to the conclusion of the chapter. The main advantage of the system is the removal of disparate functionality from the many individual internal processes so that the customer relationship can receive clearer attention. This provides a more rapid and informed communication than is possible with manual intervention.

Chapter 6 reviewed the development process, discussing how the company analysis and requirements were achieved. The approach to the implementation that was adopted and the phases in the development of the solution were discussed. The issues with the approach taken were discussed, highlighting the significance of close co-operation and communication between the developer and the users. The lessons learnt from the development of this system and recommended guidelines for SMEs who wish to adopt a similar development are provided prior to the chapter conclusion.

7.2 Conclusions

- Content, not technology is what is of interest to users. The decision on connectivity between a company and its customers should be based on circumstances, cost considerations, the value the application adds to the user, frequency of information update, geography, and business processes supported.
- By centralising the source of data, synchronisation of data is simplified. If a customer changes a detail of their information it only needs to be changed once as opposed to in several different areas.

- Irish SMEs must adopt e-business practises if they wish to remain competitive in this century. Reports on European businesses indicate that investments in e-business solutions will increase in the near future and more European companies will have an online presence. As 90% of Irish businesses are SMEs it is critical that they are encouraged to adopt e-business in terms of both their own welfare, and the welfare of the Irish economy at large. The barriers that prevent this adoption must be addressed, both from within the SME companies and by technological solution providers.

- Currently, e-business is a better alternative to m-commerce for SMEs, given the current states of both technologies. E-Business has the underlying technology available to enable the more robust functionality as oppose to m-commerce.

- While wireless computing holds much promise in the future, it is still at an infancy stage. For Irish SMEs the adoption of efficient information systems and e-business practices should take precedence over a decision to adopt a wireless communication system. However, for SMEs that do have e-business operational, the deployment of a wireless communications system can deliver a value-added convenient service to customers and enable them to extend their market reach. Given the proliferation of mobile devices among Irish society, such a development is worthy of consideration for such companies.

- Given the constraints and significant challenges imposed in the development of wireless solutions, in terms of both development and usability, the prime consideration should be to develop applications that address a specific and required customer service. Solutions that are overloaded with functionality will prove complex to use, detracting from the value of the solution.

- It is of critical importance that the decision to deploy any solution within a company is based on providing its users with a more useful and efficient system than the one it replaces. The concept of CRM must play a pivotal role in realising solutions that address customers/users needs.

- Customers who are averse to using e-business or technological solutions must be catered for within a new technological system. It is essential that a business establishes that deploying a technology will address customer requirements, that the technology will be used by customers who benefit from its existence, and that the customers who are averse to using it are dealt with in the manner they prefer. In the case of the system discussed in this thesis, this was achieved by the creation of an administrative web site view.

- Given the cost, expertise, risk and financial resource constraints of SMEs, Web-based CRM may prove more viable for SMEs than Vendor CRM products. In addition to addressing CRM issues web-based applications enable SMEs to enter the e-business realm, enabling them to compete with larger companies on a global scale.

7.3 Recommendations for future work

Recommendations for the Electronics Company

The View Log Database should be completed. This will be used to store details relating to customer interactions with the system. The purpose of this is to enable CRM analysis capabilities within the system. The current system developer will develop this.

The solution developed has demonstrated to the SME the benefits that can be realised in utilising technology by the automation of the information system in one area of the company. The next logical step is to extend the solution to incorporate the other information systems and services provided by the company.

Promotion and marketing of the system should be carried out to encourage new customers and to extend the current customer base.

Archival of the database that is now the information system of the company. A regular backup of the database should be enforced to ensure the system could be retrieved in the event of destruction of the system.

Recommendation for SMEs

Irish SMEs need to adopt e-business solutions in order to sustain a successful business in the current economy. Additionally, the research shows that SMEs have an advantage over large-scale organisations in that they have a smaller customer base, which enables them to maintain intimate knowledge about what is important to customers and relationships. This essential and advantageous quality must be preserved and cultivated in any technological deployments.
This thesis has demonstrated the benefits that can be realised by the adoption of a CRM Web-based solution. This may provide encouragement to SMEs in the

realisation that technology does not need to be expensive and over burdening on resources in order to achieve a viable and efficient solution.

As a basis for future work, all of these findings should be disseminated to Irish SMEs. Additionally, the work carried out in this thesis may assist SMEs who require information regarding feasible technological solutions in the areas of:

- Centralised information systems,
- E-business solutions, and/or
- M-business solutions

Recommendations for Future Academic Research

- Computers will communicate using high-speed local area networks, wide area networks, and portably via infrared, ultrasonic, mobile and other technologies. One consequence of this is that technology will integrate into and become an integral part of society and becoming much more intimately associated with the users activities. This opens a research area in the study of Human-Computer Interaction to analyse the impact of technology on society and the advantages and disadvantages ubiquitous computing will bring about.

- Throughout the two year phase that this research has been carried out various events have occurred that have presented obstacles in the rollout of both 2.5G and the forthcoming 3G networks. The economic downturn and the September 11th events have created a new wariness and reluctance to invest heavily in technology. Approaches to regaining and re-instilling confidence and enthusiasm by creating proof-of-concept applications, as wireless technologies and networks become more sophisticated, will create useful well-researched solutions that demonstrate the advantages that may be realised in the deployment of such solutions.

- The next 3-5 years will see huge developments and changes in the area of wireless computing. Currently Japan is the leaders in wireless development and deployment, Europe is second and the United States is in third place. The rollout of 3G enabled technologies is in its infancy in Japan and has yet

to occur in Europe and the US. The unification of standards has not happened to date. The widespread acceptance of wireless Internet technologies in Europe and the States has not yet occurred. Therefore, there are numerous possibilities and scenarios of what will happen in the wireless computing area, most of which remain unknown. The research and development of technology roadmaps will assist both SMEs and large companies to plan and deploy technologies that can incorporate or be upgraded to accommodate new rollouts.

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Appendix A:

Testing Analysis at Materials Laboratory

SEM(Scanning Electron Microscope) ANALYSIS

•SEM is an instrument designed to produce high-resolution images combined with good depth of focus.
•SEM can magnify images up to 100,000X
•SEM provides detailed photographs and important information about the surface structure and morphology of almost any kind of sample.

EDAX

EDAX (Energy Dispersive X-ray Analysis)
Used in combination with SEM
Identifies elemental composition within single particles in a sample matrix.
Provides semi-quantitative information

Combining SEM and EDAX techniques produces a powerful tool for obtaining information.
Employed to assist in the following:
•Identification of contaminants.
•Verification of product integrity.
•Evaluation and identification of microsctrucutres on sample surfaces.
•Analysis of metals or oxides; allowing for the evaluation of corrosion of products.

These samples are actually outsourced to another university and take approx 2 days to complete.
Depending on difficulty of sample and number of sights for examination per sample

IONIC CONTAMINATION

•Practically, ionic contamination represents one of the most significant factors causing degradation and failure of electronic assemblies.
•Residual ionic contamination can cause surface leakage and chemical and electrolytic corrosion.

•Species of ionic residues include salts, acids and alkalines left on the PCB from operations like fluxing, cleaning, reflowing and manual handling.
•This test can quantitatively measure the residual ionic contamination on bare and assembled PCBs

Ionic Contamination is carried out using an Omegameter and results are compared to IPC specifications.
Test duration is 15 mins per sample.

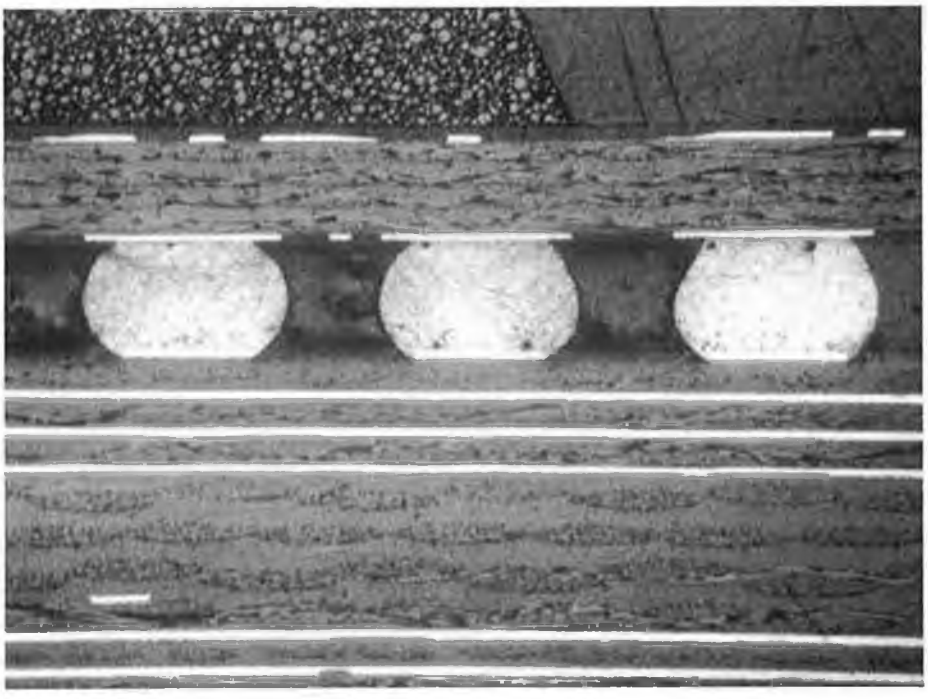
MICROSECTIONAL ANALYSIS

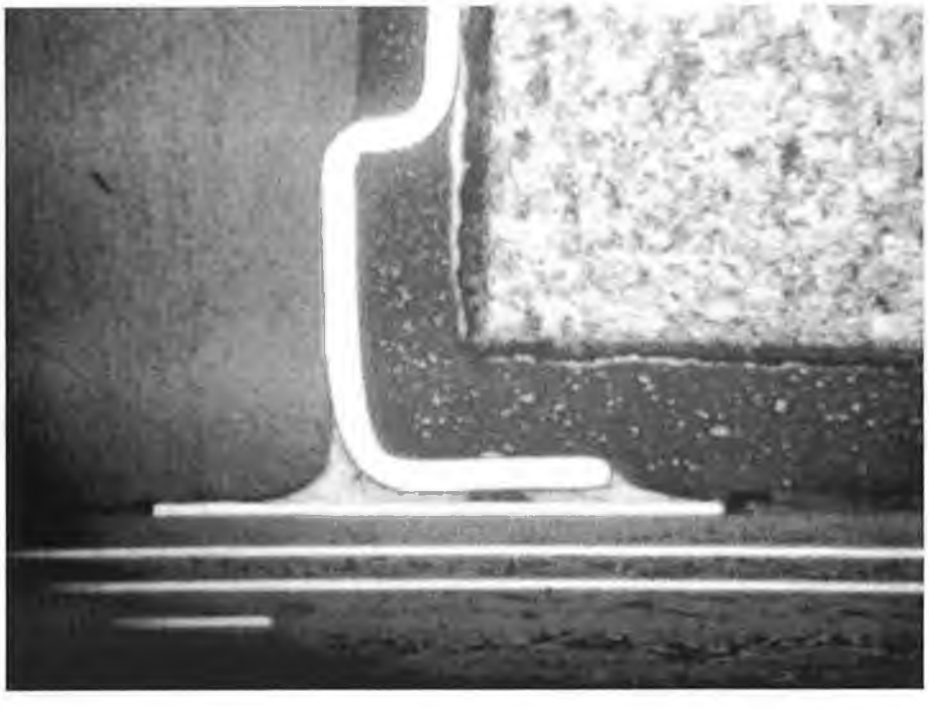
•Micro-section analysis provides critical information about the structure of a sample that cannot be obtained by looking at the surface alone
•Micro-sectioning of PCB's and PCB assemblies show important characteristics of the solder joints, vias, plated-through holes and the inner layers
•The area under investigation is isolated and set in an epoxy resin. The encapsulated area is polished to allow viewing at magnification under a microscope

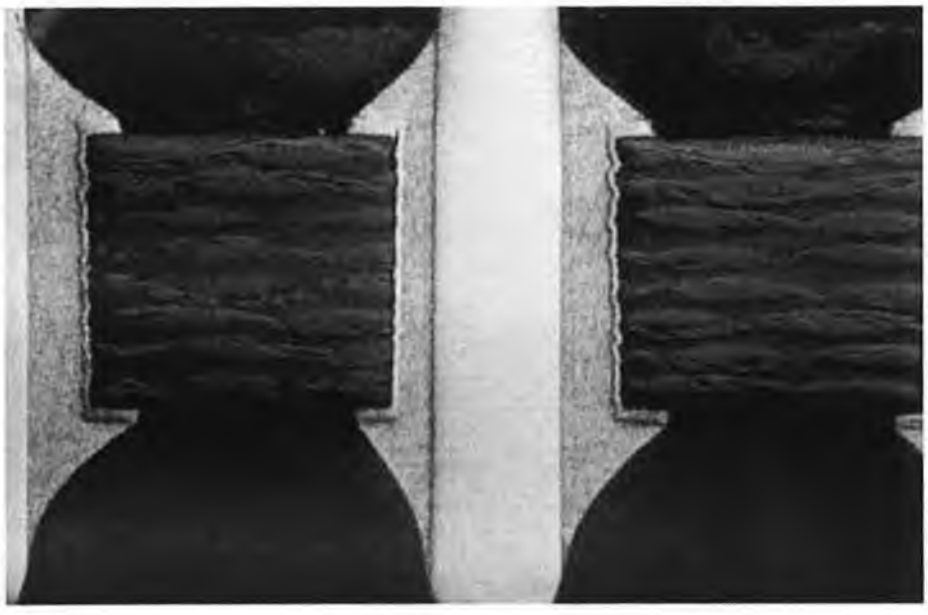
Applications:

There are numerous advantages in performing cross section analysis, mainly to detect defects and possible causes of joint failure. These include:
•Solderability Problems/Poor Wetting
•Co-planarity Problems
•Insufficient Solder
•Intermetallic Growth
•Voids/Pinholes/Blowholes

EXAMPLES OF MICRO SECTIONS







Samples take approx. 1 hour – 2 days to prepare, set, polish and photograph.

SOLDERABILITY TESTS

•Carried out using a Menicsograph Tester.

•Determines the solderability of Through Hole or Surface Mount components, their individual leads, terminations etc.

•Can also test the solderability of pads on bare boards.

•Poor solderability can cause the following:

–Poor wetting

–Tombstoning

–Skewing of components

Applications

Can identify the following problems:

•Poor metallisation

•Limited shelf life

•High thermal mass

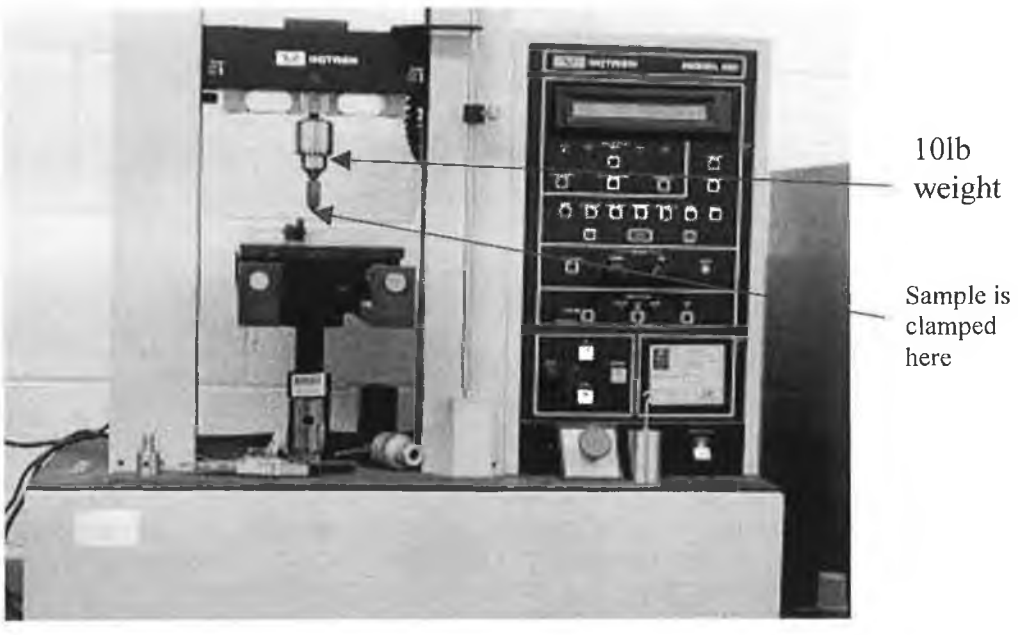
•Changes in flux activity

•Changes in solder composition

Carried out using a meniscograph tester. These tests take approx. 10 mins per sample.

TENSILE TESTS

Tensile tests are carried out using an Instron Model 1011 tensile tester.



Method: A 10lb/100lb/1000lb weight is used as the load on the Instron. The machine is operated in tension mode for testing tensile strength or compression mode for shear testing. Data selection was set to BREAK in order to read the point at which the break occurs. The sample was then clamped as shown above, and attached to the jig. The jig then moves upward until the sample breaks, and a reading is then taken. Samples such as IC leads, chip components, BGA solder spheres, connectors etc. can be tested and compared to recommended values or to a reference sample.

Time per sample is approx. 5 mins.

THERMOTHRON

Applications: This chamber is used to carry out environmental relability tests on PCBs, bare boards, components etc. The thermothron is calibrated annually to maintain operation at 85 degrees / 85% humidity.

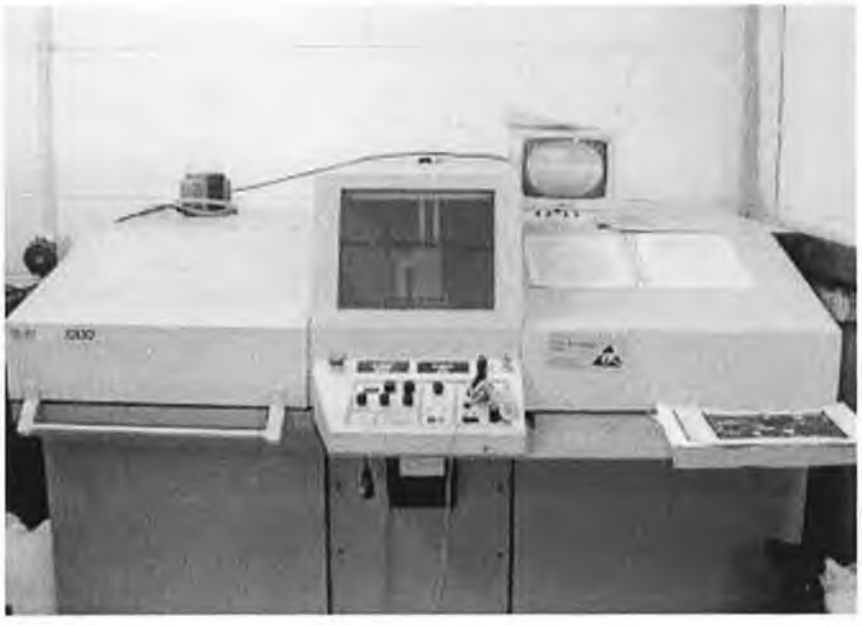
Sirometer – used for Sufrace Insulation Resistance (SIR) Test.
Applications: The SIR test is amined at determining the characteristics of solder flux. The test is performed under ontrolled temperature and relative humidity conditions in the Thermothron chamber, which allows the insulation resistance of IPC test comb patterns to be measured. The measurement of the effect of any ionic residue make this type of testing on of the most accurate conrtol tools available with regard to cleanliness and realbility. The tests is conducted in accordance with IPC-TM-650 Test Methods ref 2.6.3.3. The test board with the comb patterns is specified by IPC-B-25. The sirometer is calibrated annually to maintain accuracy.

Thermothron & Sirometer.

Testing takes from 1 to 3weeks.

X-RAY

Applications: The X-ray machine is used to x-ray mostly BGA components to check for bridging, misalignment, solder in the vias etc.



X-ray machine.

Samples take about 10 minutes to take x-ray.

ADDITIONAL TESTS

Carry out all the IPC-TM-650 tests for bare board evaluations e.g. rework simulation on PCB, copper thickness on PTH barrel measured, bow and twist measurements, dimensional checks.

AMT carries out full PCB vendor approval for customers when they are changing to a new supplier of their bare boards.

We also do this for new suppliers of paste, flux and other consumables.

Copper mirror tests

Solder ball tests

Dimensional Measurements (accurate measurements at macroscopic and microscopic levels)

Appendix B:
Sample Code

The following Code is from the login.asp file of the Web Application:

```
<!--#include file="Scripts/No_Right_Click.s" -->
<!--#include file="Scripts/Scroll.s" -->
<%Session.Timeout=1%>
<%Session("UID") = "new"%>
<%Application("Path") = Server.Mappath(".")%>
<%
Session("remote_addr") = Request.ServerVariables("remote_addr")
Session("remote_host") = Request.ServerVariables("remote_host")
Session("http_user_agent") = Request.ServerVariables("http_user_agent")
%>
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0 Transitional//EN">
<HTML>
<HEAD>
<TITLE> AMT Ireland - MOTTO Implementation Site </TITLE>
<META NAME="Company" CONTENT="AMT Ireland">
<META NAME="Author" CONTENT="Radu">
<META NAME="Keywords" CONTENT="Motto">
<META NAME="Description" CONTENT="Motto Project - AMT Implementaion">
<link REL="stylesheet" TYPE="text/css" href="amt.css">
</HEAD>
<body>
<table align="center" width="90%" height="75%" cellpadding="0" cellspacing="0"
border="0">
<tr valign="top" height="10%">
<td colspan="2" align="center">
<h3><i>Welcome to AMT Ireland!</i></h3>
</td>
</tr>
<tr valign="middle" height="25%">
<td colspan="2" align="center">
<FONT FACE="Arial" SIZE="8"><B><i>Login Page</i></B></FONT>
</td>
</tr>
<tr height="25%" valign="middle">
<td colspan="2" align="center">
<h3>Please supply your credentials</h3>
</td>
</tr>
<form name="UserInput" action="Verify.asp" method="post">
<tr valign="bottom" height="10%">
<td width="45%" align="right">
<b>Username: </b>
</td>
<td align='left'>
<input type="text" name="User" VALUE="<%=Session("UName")%>">
</td>
<tr valign="middle" height="7%">
<td align="right">
<b>Password: </b>
</td>
<td align='left'>
<input type="password" name="Pass">
</td>
<tr valign="top">
<td align="right">
<b>Click to submit: </b>
</td>
```

```
<td>
&amp;nbsp;&amp;nbsp;&amp;nbsp;&amp;nbsp;&amp;nbsp;&amp;nbsp;&amp;nbsp;&amp;nbsp;&amp;nbsp;&amp;nbsp;<INPUT
TYPE="submit" VALUE="Submit">
</td>
</tr>
<input type="hidden" name="BType" value="">
<input type="hidden" name="BVersion" value="">
<input type="hidden" name="BCode" value="">
<input type="hidden" name="BPlatform" value="">
<input type="hidden" name="Refferer" value="">
<input type="hidden" name="BResolution" value="">
<input type="hidden" name="BViewArea" value="">
<input type="hidden" name="BColorDepth" value="">
</form>
<tr><td colspan="2" align="center"><font size="2"><b>Click <a
href="NewUser.asp">HERE</a> if you do not have a user account and wish to create
one.</b></font></td></tr>
</table>
</p>
<p align="center">
<TABLE width="100%" cellpadding=0 cellspacing=0>
<TR>
        <TD width="10%" align="right" valign="top"><font size="2"
color=#3f3f3f><b>Note:</b>&amp;nbsp;</font></TD>
        <TD width="55%" align="left" valign="top"><font size="2" color=#3f3f3f>this site is
best viewed with Internet Explorer&amp;trade; 5 (or higher) at 1024x768 resolution.</font></TD>
        <TD align="center"><FONT SIZE="2" COLOR=#3f3f3f>Your local time
is:</FONT><BR>
<B><FONT SIZE="2" COLOR=#3f3f3f>
<script type="text/javascript">
var d=new Date()
var weekday=new
Array("Sunday","Monday","Tuesday","Wednesday","Thursday","Friday","Saturday")
var monthname=new
Array("Jan","Feb","Mar","Apr","May","Jun","Jul","Aug","Sep","Oct","Nov","Dec")
document.write(weekday[d.getDay()] + ", ")
document.write(d.getDate() + " ")
document.write(monthname[d.getMonth()] + ". ")
document.write(d.getFullYear())
document.write("<BR>" + d.getHours())
document.write(":")
document.write(d.getMinutes())
document.write(":")
document.write(d.getSeconds())
</script>
</FONT></B>
</TD>
</TR>
<TR>
        <TD></TD>
        <TD></TD>
        <TD align="center"><FONT SIZE="2" COLOR=#3f3f3f>The server time
is:</FONT><BR>
<FONT SIZE="2" COLOR=#3f3f3f><B><%response.write(WeekdayName(weekday(date)) &
", " & day(date) & " " & MonthName(month(date),true) & ". " & year(date) & "<BR>" &
time())%>
</B></FONT>
</TD>
</TR>
</TABLE>
```

```
</p>

</BODY>
</HTML>

<script type="text/javascript">
if (document.UserInput.User.value == "")
{document.UserInput.User.focus()}
else
{document.UserInput.Pass.focus()}

document.UserInput.BType.value = navigator.appName
document.UserInput.BVersion.value = navigator.appVersion
document.UserInput.BCode.value = navigator.appCodeName
document.UserInput.BPlatform.value = navigator.platform
document.UserInput.Refferer.value = document.referrer
document.UserInput.BResolution.value = screen.width + "*" + screen.height
document.UserInput.BViewArea.value = window.screen.availWidth + "*" +
window.screen.availHeight
document.UserInput.BColorDepth.value = window.screen.colorDepth
</script>
```

The following Code is from the login.asp file of the WAP Application:

```
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"
"http://www.wapforum.org/DTD/wml_1.1.xml">

<%
Dim SQLquery, userid, username, company, Eid, EventID, Status
Dim LoginR, password, email, retry, Red
Red = 0
'   userid = Request.Cookies("User-Identity-Forward-msisdn")
'          userid = Request.QueryString("userid")
           username = Request.QueryString("username")
           password = Request.QueryString("password")
           retry = Request.QueryString("retry")

  SQLquery = "SELECT Users.UserID, Users.Username, Users.FullName, Users.Company,
Users.Password FROM Users WHERE Users.Username = '" & username & "'"
  Set LoginR = conn.Execute(SQLquery)


           If LoginR.EOF Then

           Red = 1

Status = "Failed"
UserID = 0
Details = "Logon failed due to incorrect username"

           elseif  (password <> LoginR("Password")) Then Red = 1

Status = "Failed"
UserID = LoginR("UserID")
Details = "Logon failed due to incorrect password"

           Else %>

<wml>
 <card id="OK" title="  Logon successful ">
           <onevent type="onenterforward">
                     <refresh>
                               <setvar name="userid" value="<%=LoginR("UserID")%>"/>
                     </refresh>
           </onevent>
           <onevent type="ontimer">
    <go href="main.asp" method="get">
                               <postfield name="userid" value="$(userid)"/>
           </go>
   </onevent>
   <timer value="40"/>
   <do type="options" label="Ok >">
                     <go href="main.asp" method="get">
                               <postfield name="userid" value="$(userid)"/>
                     </go>
   </do>
   <p align="center">
           <em>
           <br/>
           Hello <%=LoginR("FullName")%> from <%=LoginR("Company")%>.
```

```
        </em>
        </p>
 </card>

<%
Status = "Success"
UserID = LoginR("UserID")
Details = "Logon successful"

End if %>
</wml>

<%

SQLquery = "SELECT MAX(EventID) FROM Events"
EID = Lconn.Execute(SQLquery)

If VarType(EID("Expr1000")) <> 3 Then
EventID = 0
Else
EventID = EID("Expr1000") + 1
End If

If Request.QueryString("username") <> "" Then
        username = Request.QueryString("username")
Else
        username = "-"
End If

If Request.QueryString("password") <> "" Then
        password = Request.QueryString("password")
Else
        password = "-"
End If

If Request.QueryString("retry") <> "" Then
If Request.QueryString("retry") = "1" Then
Details = Details & " (first attempt)."

ElseIf Request.QueryString("retry") = "2" Then
Details = Details & " (second attempt)."

ElseIf Request.QueryString("retry") = "3" Then
Details = Details & " (third attempt)."

ElseIf Request.QueryString("retry") = "4" Then
Details = Details & " (fourth attempt)."

ElseIf Request.QueryString("retry") = "5" Then
Details = Details & " (fifth attempt)."

ElseIf Request.QueryString("retry") = "6" Then
Details = Details & " (sixth attempt)."

ElseIf Request.QueryString("retry") = "7" Then
Details = Details & " (seventh attempt)."

ElseIf Request.QueryString("retry") = "8" Then
Details = Details & " (eighth attempt)."
```

```
ElseIf Request.QueryString("retry") = "9" Then
Details = Details & " (nineth attempt)."

Else
Details = Details & " (subsequent attempt)."
End If
End If

SQLquery = "INSERT INTO Events VALUES (" & EventID & ", '" & Status & "', " & UserID &
", '" & username & "', '" & password & "', '" & Now() & "', 'Wireless', '" &
Request.ServerVariables("remote_addr") & "', '" & Request.ServerVariables("remote_host")
& "', '" & Request.ServerVariables("http_user_agent") & "', '-', '-', '-', '-', '-', '-', '-', '-', '" & Details
& "')"

Lconn.execute(SQLquery)

Session("EventID") = EventID
Session("Wireless") = 1
Session("UName") = username
Session("UID") = UserID

Set EID = Nothing
Set LoginR = Nothing %>
<!--#include file="logdbdiscon.asp" -->
<!--#include file="discon.asp" -->
<%
If Red = 1 Then
Response.Redirect("LoginError.asp?retry=" & retry)
End If
%>
```

Appendix C:

Sample Interview with Materials Engineer

Interview with Claire Ryan AMT, Limerick

What is your role within AMT?

My job title is **Materials Engineers**. My job involves two separate areas:

1) The running of the materials service.

This is my core job. It involves interacting with the customers to identify what services they require.

For example a customer may call to tell me that he/she has a newly created PCB and he/she needs to have it tested to ensure it is of the correct standard. I will make recommendations as to the type of tests that need to be executed, approximately how long it will take, and how much it will cost.

If the customer accepts that the job should proceed, I will then ask him/her to send me the parts to be tested. Meanwhile I will draw up a proposal, which will contain details of the tests I will carry out and the costs involved. This proposal is then sent to the customer.

After the parts have arrived I log the projects into my material projects book.

Then each of the parts are assigned a job card. The job card is used in accordance with the ISO 9000 requirements. It is used for trace ability. It follows the parts around the line, in that as each test is completed it is recorded in the job card. This card contains the following information:

- The Job Card number (a sequential number)
- The project number
- Tests with adjacent tick boxes, identifying the tests that will be executed
- Another set of parallel tick boxes to identify what tests have been executed.

Then the tests are performed. As each one is finalised it is ticked off in the job card. The type of tests that can be carried out include:

- Micro-Section
- Tensile Testing

- SIR Testing
- Electro migration
- Solder Ball Test
- Wetting Test
- Cu Mirror Test
- Halides Test
- Fluorides Test
- Surface Organic Test
- Ionic Test
- X-Ray Analysis
- Visual Analysis
- Solder ability Tests

After the tests are all complete a report is prepared. The report comprises of details on the tests including:

- Procedures for the tests
- Test results and findings
- Conclusions
- Discussion and recommendations
- Appendices containing graphs and photographs

If the tests have been straightforward, without any issues an email is sent to the customer with the report attached. If issues have arisen the customer is contacted to discuss the report, the test findings and to make recommendations as to how the issues should be addressed.

When the project is complete a finish date is entered on the job card and it is closed.

In some cases the purchase order number may not have been received initially, so it is necessary to contact the customer to retrieve it. This is necessary to that the invoice can be sent.

The invoices are sent out at the end of the month. A Sales Requisition is drawn up and sent to the administrator.
From the sales requisition the total monthly income is calculated.

All the costs need to be monitored; the phone expenses, expenditure on stocks and my salary. All purchased are documented, including any new equipment. These are all summed up and compared with the income, the number of services required, the time taken to provide these services.
All of this information is recorded and placed in the performance review at the end of the year.

2) Participation in Research Activities.

The second element in my job is my involvement in Research activities.
I am required to research in the areas of materials and optics.
I also draw up proposals for grants.
If the proposals are successful, I am then responsible for the management of the projects received.
Additionally I am responsible for all of the administration work within my sector.
Our company adheres to ISO 9000 and I am responsible for adhering to its requirements in my own sector. I also prepare for the annual audit with is carried out to ensure that all of the company is adhering correctly to the specified standards, and also to draw up new specifications where necessary.

I also have to prepare any marketing campaign that will give me the opportunity to acquire new customers.

Outline your daily routine.

As mentioned earlier, my main role in AMT is the management and functioning of the materials services. I spend the majority of my time drawing up proposals, testing parts and preparing the final report.
I also spend allot of time interacting with customers on the phone. At the moment the phone and email are my two points of contact. I use email mainly at the end of a project to send the report containing the details of the tests. I get calls from customers there inquires are usually to:

- Make enquiries about the materials services
- Organise for parts to be tested
- Check that parts sent previously have been received
- Check the status of their project
- Ask for advice after receiving the report
- Ask for clarification on items in the report that they did not comprehend
- Inquire about additional services
- Ask for general advice

]

The outgoing calls that I make to the customers are usually to:

- Return a call that was received in my absence or when I was busy
- Enquire if all the required parts have not been received
- Clarify customers' details
- Get purchase order number from a customer

I also spend allot of time on administration work, which involves ISO documentation, ensuring the job cards are in their correct sequence, filling out log books, emailing customers etc.

Outline your monthly activities.

At the end of each month I document how many projects have been completed. Any of the problems encountered are noted. I identify the customers that I have not received a purchase order from and note that they must be contacted. I account for my monthly expenditure and document costs.

I draw up a sales requisition that details all the customers that I need to invoice, this is sent to the administrator who will send out the invoices. I also prepare a monthly report detailing all the previous months activities, and the materials sector performance. Approximately three times per year I attend a seminar, this involves some preparation including drawing up notes and presentations.

Martin, the manager of AMT, does an internal ISO 9000 audit, and the paper work needs to be in order.

Outline the end of year preparations.

The end of year preparations involves drawing up a performance review for the materials section. A repost detailing the budget for next year, the targets, estimated costs, marketing campaigns and their costs and any new equipment that may need to be purchased.

ISO 9000 paperwork needs to be amended and prepared for the auditor. If there are any new procedures that need to be put in place, they must be drawn up in accordance to the ISO 9000 standards.

Please explain the quality procedures that must be adhered to.

The reasons for implementing ISO 9000 are two fold; firstly in order to gain customers it is essential to have these quality procedures in place, as many companies cannot deal with those that do not. Secondly, having the procedures in place maintains the workflow in an organised and manageable situation.

ISO 9000 is a series of International Standards for Quality Systems.

There is an annual outside audit carried out to ensure that the employees are adhering to the procedures and that the procedures in place are beneficial and sufficient.

What are the disadvantages of your current system?

The job card follows a sequential pattern. In a case where I forget one there is a big problem

Customers frequently phone to check the status of there projects. In some cases there are delays in the delivery of the parts or the customer calls to confirm that they have been delivered. Enquires of this nature can prove very time consuming, allot of my time is spent answering mundane questions that are not profitable to me and it takes from the time that I could spend on either taking new projects onboard, or on the testing of the parts I receive.

Paperwork is another disadvantage. Notes have to be kept to record everything that has been done. I document how many hours I spend doing each task every day and the earnings per day. I currently store this information in a diary.

With new customers it can sometimes be difficult to get all of the required contact details. Phone calls may end prematurely as they are made in a working environment, if I meet the customer at seminar, I may not get all the required contact information.

What are the advantages of the current system?

The system that is in place at the moment is well organised. There are ISO procedures in place for virtually all of the tasks, therefore the job is easy to manage and I can clearly see what point I am at in a job at any point. New ISO procedures are drawn up as new issues arise and this provides guidelines that maintain a high quality.

I know the system very well and I have worked with it for a long time.

The customers are dealt with in a very personal way. I speak with them on the phone when they wish to place an order, and I get to know them over time.

How will WAP make your job more manageable?

WAP will enable the users to check their status form any location, using their mobile device. This will certainly be of great benefit to me in that I will not be receiving as many enquires in relation to status, however, I believe the greatest advantage of this application is for the customer.

It will enhance customer satisfaction.

Is giving customers the ability to check order status over a mobile device a big advantage? Why?

Yes, because not all of the customers will have access to PCs, but virtually all have mobile phones, and most of the phones are WAP enabled. This will give the customer the opportunity to see what status their project is at from anywhere and at anytime that suits them. This will eliminate the need for them to phone me to ask questions in relation to status. There is the possibility that I may not be available to take their call when they phone, therefore having this application means less frustration for the customer.

How do you feel about working with these technologies?

I feel it will be challenging initially, but I am happy to see what the outcome of having these technological applications will be. I feel that my job is changing from manual to technical.

As you are still running the paper-based system, do you see a way whereby an electronic system could be implemented to eliminate the paper based system and the current filing system?

With the ISO 9000 procedures in place, it is difficult to see how our current filing system could be eliminated. The paper could certainly be cut down in relation to my daily tasks. The proposals that I draw up at the onset of a project are relatively individual to that particular project; therefore, I don't think technology can eliminate the need for me to print these. Sales requisitions are also paper based and I do not foresee this changing.

Additional Questions

Types of customer enquiries?
Prices, types of tests available, status enquiries, lead-time, results of tests,

How much time is spent on administration work?
About an hour a day on average. Once a month it's more than that when I usually spend about 3 hours preparing the monthly meeting report and filling in other monthly admin such as metrix etc.

How much time is spent dealing with customers?
On average about an hour and a half a day

How much time is consumed working on project processes?
It varies a lot. Some projects such as microsectioning take at least 2 to 3 days cause the samples take a long time to prepare and they take a lot of manual work to complete. Other projects such as SIR testing the samples take about an hour to prepare and then the machine tests them for 7 days and I only have to compile the results at the end, so as regards profitability the tests generate different amounts of income for the amount of work done. However most costs are worked out according to the amount of hours it takes to complete the project and then an hourly rate is applied.

Average number of projects handled per day, per week etc.
About 60 completed projects in the year in the materials section. This is a little over 1 a week. However some days I might handle 3 / 4 projects and these would go on for a number of days.

Most required tests?
Microsectional Analysis
Detailed measurements and spec comparrisions (using the DMS test system)
Contamination Testing and Identification
X-ray Analysis
High Magnification Photographs
Tensile tests
SIR tests
Solderability testing

***Brief Description of* NAMESOURCE**
Tracks project numbers and the status of projects. Generates new project numbers sequentially and colour codes them according to whether or not they are at proposal stage, acceptance stage or invoiced stage.

When was AMT founded
1988

Describe the facilities and equipement
2 labs - one manufacturing, one materials analysis
Materials – test equipment such as Instron Tensile Tester, Thermothron Environmental Chamber, Struers Grinding Equipment, Mikon Optical Microscope etc.
Manufacturing – reflow ovens, pick and place machine, screen printer, wavesolder etc.
There are also 2 offices and a training/conference room.

Can you list the documentation that you use
Diary, project log book, customer supplied specifications, datasheets for the equipment.

PC skills?
Can use microsoft word, excel, powerpoint. Also use adobe photoshop and autocad 14 at a basic level.