THE DESIGN OF A MOBILE USER INTERFACE FOR AN INTEREST RATE CALCULATOR

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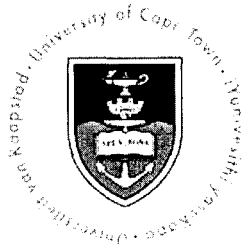

To my wife

Peggy

In GOD we Trust

Abstract

Customers of the bank need to hedge their exposure to interest rates risk on long term debt in order to protect themselves against adverse interest rate movements and request a fixed interest rate from the bank for this purpose. The bank in turn needs to go to the financial markets and off-set its risk by entering into an interest rate swap at the given market rates. The fixed interest rate quoted to the customer should therefore be market related to support the business model of the bank and prevent it from taking on undue interest rate risk.

The existing system used for this purpose is a cumbersome manual process and a new quick usable system at the fingertips of the Relationship Executives would give the bank a competitive advantage over banks using manual systems. In order for this system to be effective and adopted by the Relationship Executives the design of a user centred system and in particular the user interface becomes of the utmost importance.

In our search towards an interactive mobile fixed rate calculator, in this dissertation, we are interested in the human-centred design and in particularly exploring the mobile user interface design and the user experience (usability) thereof. A mobile solution will allow real time rate quotes to Relationship Executive while they are on the move or out of the office rather than a desktop application.

The methodology adopted was to make use of a structured approach for observation and scenario creation in the design by starting with a contextual inquiry. As the users are the most important stakeholders in user-centred design we made use of participatory design techniques as the users are seen as active collaborators rather than passive participants. While traditional design approaches focus on observations and questionnaires participatory design focuses on the user, what they think, feel and dream. In this study we make use of proven participatory design techniques namely the CARD (Collaborative Analysis of Requirements & Design)/CUTA (Collaborative User' Task Analysis) and PICTIVE (Plastic Interface for Collaborative Technology Initiatives through Video Exploration) methods of design. The outcome of these methods resulted in a low-fidelity paper prototype which then evolved to a low-fidelity software prototype. Finally, we evaluated the usability of this mobile interface design.

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I would like to express my heartfelt thanks to:

My supervisor

My Wife

My Friends and Colleagues

Table of Contents

List of Figures

List of Tables

List of Acronyms

ATM	Automated Teller Machine
BI	Business Intelligence
CARD	Collaborative Analysis of Requirements & Design
CUTA	Collaborative User' Task Analysis
IDS	Information System Development
MID	Mobile Interaction Design
MDD	Model Driven Development
Mobile BI	Mobile Business Intelligence
NCA	National Credit Act
ODK	Open Data Kit
PD	Participatory Design
PICTIVE	Plastic Interface for Collaborative Technology Initiatives through Video Exploration
RE	Relationship Executive
SAFEX	South African Futures Exchange
UCD	User Centred Design
UI	User Interface
USABILITY	User Experience

1. Introduction

The mobile banking market has grown significantly over the last several years with many financial institutions offering some form of mobile service to their customers. According to the Mobile Banking Associaion (2009) most large U.S. banks offers a basic mobile solution to their customers. The most common services available are:

- Account balances, updates and history
- Account alerts, security alerts and reminders
- Customer service via mobile
- Branch or ATM (Automatic Teller Machine) location information
- Electronic bill payments delivered by secured agents and mobile client applications
- Funds transfers
- Transaction verification

However, Hatch (2008) points out that a large number of companies are rapidly undertaking mobile BI (Mobile Business Intelligence) owing to market pressures such as the need for higher efficiency in business processes, improvement in employee productivity (e.g. time spent looking for information), better and faster decision making, better customer service, and delivery of real-time bi-directional data access to make decisions anytime and anywhere.

Fitzgerald (2010) states that Gartner analyst Ted Friedman believes that mobile delivery of business intelligence is all about practical, tactical information needed to make immediate decisions. "The biggest value is in operational business intelligence information in the context of applications, knowledge pushing lots of data to somebody's phone." The real-time flow of bi-directional data in a mobile fixed rate calculator will improve the efficiency and speed in the delivery of a fixed interest rate contract to the customers of the bank.

1.1. Motivations

1.1.1. Customer Fixed Interest Rate Loans

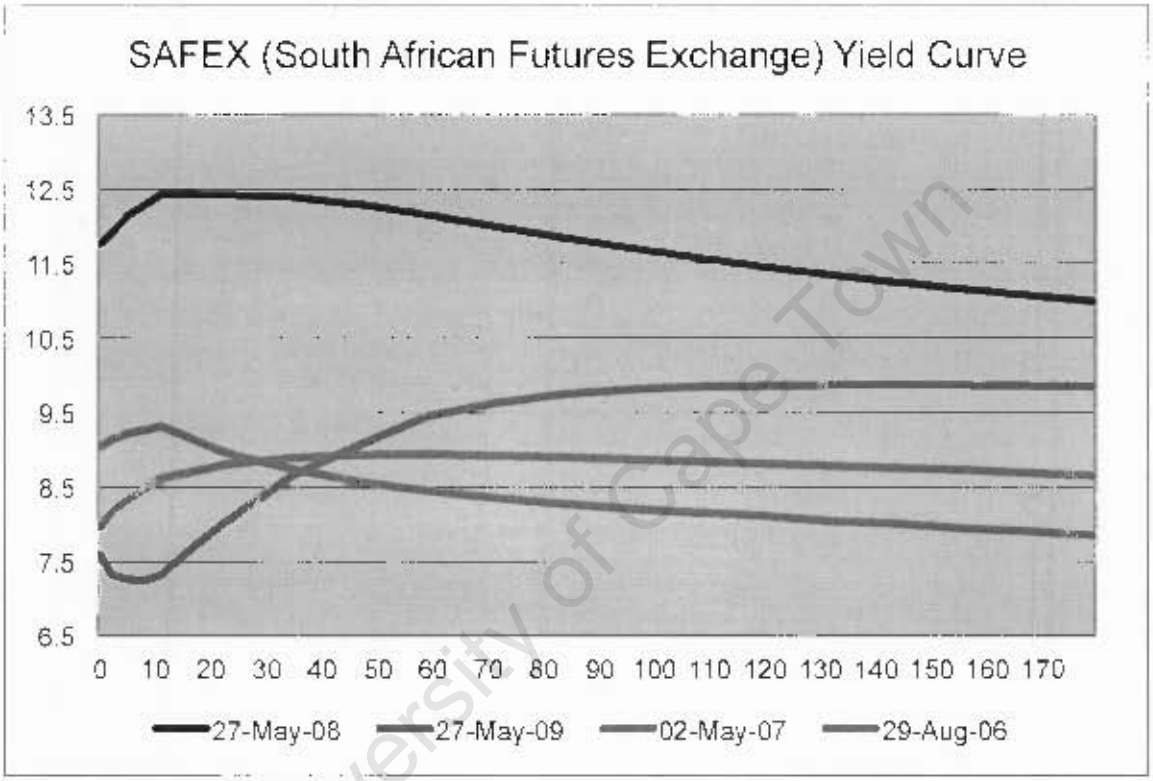
Sullivan (2003) states that an interest rate is the price a borrower pays for the use of money they borrow from a lender; for instance a small company might borrow capital from a bank to buy new assets for their business, and interest is the return a lender receives for deferring the use of funds, by lending it to the borrower.

Volatility in interest rates is a given as the economy follows a cyclical trend. In order for the borrower to protect against future adverse interest rate movements the interest rate may be

fixed, especially in the case of long term borrowings. The question is at what level must the fixed interest rate for a specific term be set to take into account the risk associated with adverse movements in future interest rates?

1.1.2. Pricing of a Fixed Interest Rate Loan

Figure 1: The Term Structure of Interest Rates



Interest is the cost the borrower pays for borrowing money for a certain term. Crousehore (2010) defines the relationship between interest rates with different terms to maturity as the term structure of interest rates and the yield curve the plot of interest rates for a given date for debt securities with differing times to maturity in which the yield to maturity is shown on the vertical axis and the time to maturity is shown on the horizontal axis. For example, the South African Rand interest rates paid on treasury securities (risk-free securities) for various maturities are plotted on a graph by the South African Futures Exchange (see figure 1) which is informally called "the yield curve." More formal mathematical descriptions of this relation are often called the term structure of interest rates.

Marshall & Bansal (1992) point out that the yield curve is not static. It is continuously changing in response to evolving market conditions. Such shifts, however, are usually not parallel. Rather, the short-maturity end of the curve (short end) might shift by more than the long-maturity end (long end) or vice versa. The financial market yield curve (see figure 1) is the starting point for all interest related pricing by the bank. From this curve the bank determines the risk-free fixed interest rate for a specific customer for a specific term and allows the quote to be valid for 30 minutes even if the yield curve moves during this time. This riskless rate forms the base fixed interest rate for the contract with the customer and statutory costs, consisting of cash reserving costs and liquid asset cost, as determined from time to time are added. Depending on the liquidity position of the bank a liquidity premium may be added to the base rate and statutory costs. Finally a customer credit risk margin is added to arrive at an all-in customer fixed rate. This credit risk margin is determined by the risk profile determined by the bank for every customer.

The validity period of 30 minutes of the fixed rate quote allows a window of opportunity for the customer to accept the fixed rate quote or reject it. The bank in turn needs to go to the financial markets and off-set the risk of future interest rate movements by entering into an interest rate swap at the given market rate (see figure 2.). Should the quote be accepted by the customer the bank will enter into the interest rate swap agreement with a counterparty to hedge its own position. The interest rate quoted to the customer will be in the format as per table 1 reflecting the all in fixed rate to be off-set in the market.

Table 1: Example of a fixed interest rate quote for a specific customer

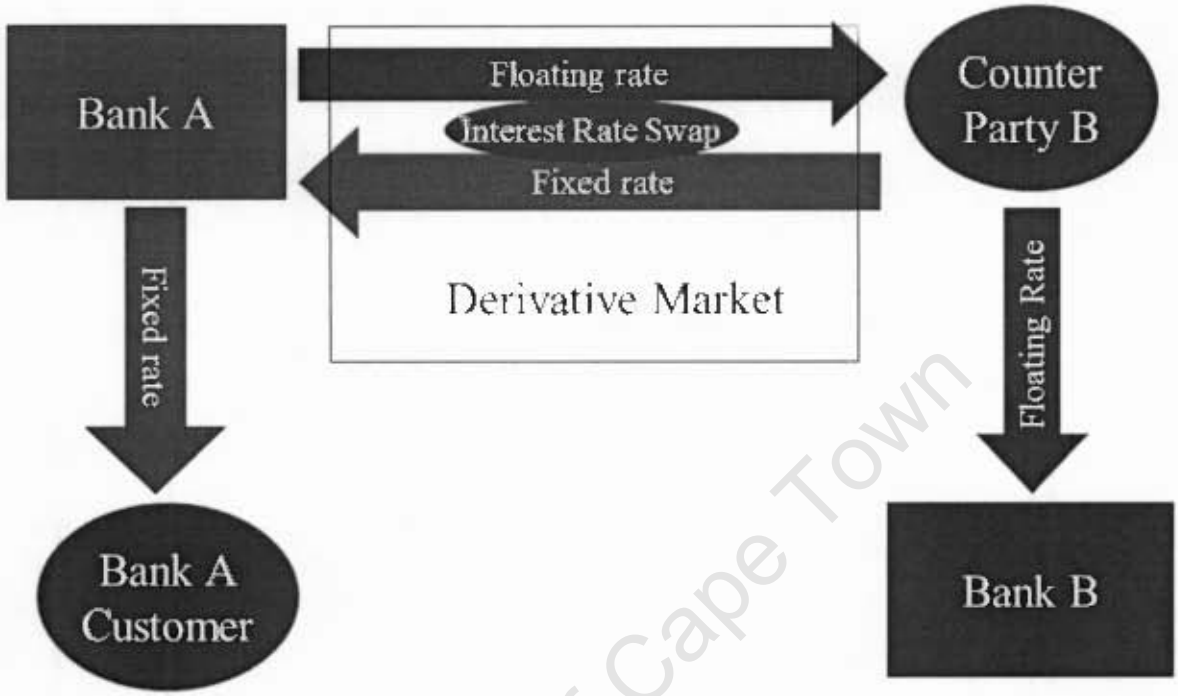
This is an example quote at a specific point in time for a specific term, say 10 years.

Fixed Term Base Rate	8.70%
Statutory costs – Cash Reserving & Liquid asset costs	.30%
Liquidity Risk Premium	.15%
Credit risk margin (the bank's margin)	3.00%
All in customer fixed rate	12.15%

Marshall & Bansal (1992) indicates that hedging takes place when the bank does an opposite transaction in the derivative financial market to swap a variable interest rate cash flow for a

fixed interest rate cash flow to be able to provide the customer with a fixed rate loan. This is called an Interest Rate Swap (IRS) agreement.

Figure 2: Structure of a Fixed Rate Loan



According to Marshall & Kapner (1993) a swap is a contractual agreement evidenced by a single document in which two parties, called counterparties, agree to make periodic payments to each other. Marshall & Bansal (1992) explains that in interest rate swaps the exchangeable nationals take the form of quantities of money and are called notional principals. In such a swap, the notional principals to be exchanged are identical in amount and involve the same currency. As such, they can be dispersed with; which explains the origin of the term notional. Furthermore, since the periodic usage payments, called interest in this case, are also of the same currency, only the value differential needs to be exchanged on the periodic settlement dates. He points out that swaps are used to reduce cost of capital, manage risks, exploit economies of scale, arbitrage the world's capital markets, enter new markets, and create synthetic instruments. In the above fixed rate structure the IRS is used to manage interest rate risk for the client and the bank.

The existing fixed rate process is a cumbersome manual process prone to human error with a validity window of 30 minutes to perform the following actions:

- The Relationship Executive must establish whether the proposed fixed rate customer falls within the National Credit Act or not. This is done without the required information being readily available and requires further investigation into the qualifying criteria;
- Obtaining a market related fixed rate quote by the Relationship Executive is difficult as at least two centralised departments (Structured Product and Treasury) are involved and the mode of communication is by phone or e-mail;
- After the fixed rate quote is given by the Treasury Department the validity period to establish a market related hedge in the derivative market is 30 minutes. Once this time expires a new quote must be obtained as there may have been movements in the yield curve since;
- Once the customer accepted the fixed rate quote a contract must be drawn up and signed by the customer and the bank.

This manual fixed rate process place tremendous strain on resources:

- **Time**

  - The process is time consuming using time that the Relationship Executive could spend with other customers.

  - As the fixed rate quote is only valid for 30 minutes this deadline is often missed resulting in the process to be repeated for a new quote.

  - Time is wasted as the process to contact centralised department e.g. Structured Products and Treasury by phone or e-mail is slow.

- **People**

  - Comprehensive training needs to be provided to the Relationship Executives to prevent human errors in the execution of the process.

  - More Relationship Executives are required to service the customers in view of the slowness of the process.

- **Finance**

  - Costly investigations and loss of income may result should human error in the manual process cause incorrect fixed rate quotes.

- **Marketing**

  - Marketing efforts are curtailed in view of the processes not being customer friendly as delays in rate quoting are experienced. This would sometimes lead to customers accepting fixed rate quotes from competitors.

- **Operations**

- the processes have too many manual intervention allowing for human error.

The solution may be an application that ties all the information together in one place on a platform that people take with them. A mobile system would therefore be the ideal solution as it would be a system which would allow the Relationship Executive to have immediate real time access to market interest rates and other relevant information while at the customer's premises or on the move. This would allow the Relationship Executive to properly negotiate and set the fixed interest rate for the customer. This will allow for the transaction to be concluded within' the timeframe of 30 minutes without placing the bank at any undue interest rate risk. A web based solution would not allow the same flexibility as experienced by a mobile solution.

The challenge is to design a system that is useful that would provide an overall pleasant experience. Jones & Marsden (2006) considers two useful ways of improving the overall user experience. The first concerns the identity of a product – the message the design sends to the user; the way it makes them feel and act. Then there's the need to extend the influence of interaction design beyond the technology itself to the whole package presented to the user: the marketing, customer care, charging plans, etc. In both cases, the aim is to present the user with an experience that is solid, distinct, understandable, trustworthy and satisfying.

1.1.3. Mobile User Interface Design

Mobile technology is not fully used in the South African banking sector. Although mobile technology is used where clients interact with the bank to conduct their daily banking, it is not used in the internal processes of the bank to assist in delivery of enhanced products. Most banks use mobile technology to deliver e-mail communication where technology such as Blackberry phones and Blackberry Enterprise Servers make use of "push technology" to deliver e-mail messages. The delivery of an interactive mobile fixed rate quote calculator that the Relationship Executive can use whenever they are the customer's premises or at any different location would be a first in the South African banking sector.

1.1.4. User Centred Design

A fixed rate calculator with mobile interaction will provide the Relationship Executive with the ability to price the customer effectively at their business premises and enhance the delivery of this product. However, the users (Relationship Executives) should be central to

the design and particularly the user interface thereof. They should accept or "buy in" to the design and it should provide a pleasant usability to the Relationship Executives; in other words, it should be a user centred design. The focus of this study will be the user centred design of the calculator and especially the interface design.

In addition, this research pursues the interface design of the calculator resulting in a paper prototype and ultimately an e-prototype. This research will not go beyond the interface design of the quote calculator, and future research may well include design of a fully workable fixed interest rate system which will include the establishment of the fixed rate contract with the customer.

1.2. Research Objectives

The research is aimed at answering the following questions:

1. **Is it possible to make use of user centred design techniques and methods to effectively design a mobile interface that includes all the elements and functionality needed to obtain a fixed rate quote for a customer?**

2. **Does the evaluation of the Interface Design using Conceptual Model Extraction indicate a design that is in line with the mental model of the users?**

   Will the existing Relationship Executives be able to use the tool to complete the tasks successfully? By successfully, we expect the Relationship Executives to use the interface to complete a task more efficiently and effectively than with existing methods.

   Will the usability of the interface design be such that the Relationship Executives "buy-in" and want to use the interface? A low level prototype will be produced for this purpose.

1.3. Organisation of this dissertation

This thesis is organised into the following chapters.

In Chapter 2 we provide an integrated, organized overview of significant literature published on our research topic of user centred design, user interface design and mobile interaction design. The methodology used in this thesis is explained in Chapter 3. Chapter 4 presents

participative design work sessions and the results thereof to produce a first paper prototype of the interface and the evolving e-prototype that follows. The e-Prototype is then evaluated using the Conceptual Model Extraction technique. This is followed by a conclusion in chapter 5 on the research questions raised and possible future research.

2.Background

In this chapter, we review and evaluate the existing literature regarding the issues of developing a mobile interaction interface design for a customer fixed rate calculator for use by the Relationship Executives of a South African bank. The headings described in this chapter are based on the topics established in the motivations section in the introduction chapter.

2.1. User Centred Interface design

The topic of designing a mobile user centred interface was briefly introduced in the previous chapter.

In this section, we examine this topic in more detail. We consider participatory or collaborative design and prototyping in more detail with emphasis on interface design.

Tim Brown (2008) defines "design thinking" as a methodology that includes the full spectrum of innovation activities with a human-centred ethos. He explains that innovation is powered by a thorough understanding of what people want and need in their lives. He describes it as a discipline that uses the designer's sensibility and methods to match peoples' needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity.

In our search towards the usability of an interaction mobile fixed rate calculator, in this dissertation, we are interested in the human-centred design and in particularly exploring the mobile user interface design and the usability thereof. User centred design is a multi-disciplinary design approach focusing on the user (Moa et. al., 2005). The goal is to better understand the user and the task analysis.

Pekkola, et. al. (2006) points out that in the past numerous information system development (ISD) projects have failed. Budgets or deadlines have been exceeded or a significant portion of features is excluded from the final implementation. Regardless of the type of failure, the reasons can often be traced back into inadequate and incomplete requirements specification. The process of requirements development and specification – elicitation, analysis and validation throughout the development process – is complex even when designing 'simple' single user systems. This is because often users cannot properly articulate their needs. Obtaining the proper user requirements and needs for an information system development is part of a user centred design and without this the project would not be successful. Various methods may be used to gather user requirements e.g. Contextual Inquiry, Artefact

Walkthroughs, Participatory Design methods, Traditional ISD methods, Technology Probes, and Model Driven Development to name a few.

According to Jones & Marsden (2006) **technology probes** may be used to assist in gathering information where prototypes are installed and people's behaviour with and around them are studied. This may sound like the standard design practice of evaluating a prototype in context; however, these pieces of technology are not designed to meet a specific need, tightly providing a constrained set of services; rather, they facilitate a basic activity – such as communication – in a way that is very simple for the user to operate and also highly accommodating of their whims.

Bergman (2010) sees **Model Driven Development (MDD)** as a technical ICT design approach which divides software design into two distinct phases. Firstly, the software functionality is modelled in a modelling language such as Unified Modelling Language (UML). UML provides a method for visualizing and modelling software architecture, including the actors in the system, the business processes, the software processes, and database transactions and messaging. Importantly, a UML model of a system is independent of the underlying implementation technology. In the second stage of software design, the UML description is translated, either manually or automatically, into a particular implementation, using specific software components, database systems, messaging systems, and distributed systems middleware. The principles of MDD will be used to provide a means of describing the system's operation separate from the underlying implementation technology. MDD is therefor rather a valuable addition to methods used for gathering user requirements and needs by modelling functionality.

Pekkola, et. al. (2006) indicates that **Traditional ISD methods** have proved to be insufficient in involving users in the design, since the methods are not flexible enough for changing situations, environment and context. One reason for the deficiencies in ISD methods and obscurities in systems development is the difficulty of anticipating its use in working environment. As a consequence of this, systems developers cannot create complete use cases or make appropriate design decisions. Instead, they have to rely on end-users and consider them as the sources of information and most important factors in successful systems development. User participation is especially critical when anticipating the changes the

system will cause when it is introduced into an organisation or when acquiring appropriate domain knowledge.

Lee (2007) describes that the **Participatory Design** approach has been known to be very useful to elicit users' tacit and latent needs, and thus can provide abundant data on user's cognitive process for design. Participatory design process uses stakeholders' collective generatively rather than a designers' individual creativity to solve design problems that are very specific to the context. By analysing what users create, researchers can elicit users' tacit needs, which cannot readily be expressed in words.
We start the PD (Participatory Design) with a Contextual Inquiry and Requirements Analysis. The basic method of research in a Contextual Inquiry involves observing people as they go about their work and identifying the tools they use and the problems they encounter while performing certain tasks.
Bergman (2010) advocates that Participatory Design is a technique which has been used successfully for more than 20 years in the design of technology. The key principle of PD is to actively involve the real end users of the system in the design, implementation and evaluation of the systems that they will use.

Lim & Stolterman (2006) concludes that evaluation of an interface design is done by testing the prototype of that design, be it a low-fidelity, high fidelity or a fully functional prototype. The results of the PD workshops are transformed into a low-fidelity prototype design of the interface that was used during the iterative design process and after completion of the PD sessions to evaluate the usability of the design.

Finally testing the usability and the interface we used the technique of Conceptual Model Extraction with the goal to evaluate how the users experience the usability of the interface for the first time.

2.2. Participatory design

Lee (2007) advocates the use of participative design for user centred design. He writes that while traditional design research methods focus primarily on observational research and questionnaire, participatory design focuses on what people make to elicit what they think, feel and dream. By having workshops and discussing design issues with users, managers, and sales people, designers can discover problems that are very specific to the context. This is

confirmed by Bergman (2010) as he states that the key principal of participatory design is to actively involve the real end users of the system in the design, implementation and evaluation of the systems that they will use.

Spinuzzi, (2005) sees participatory design as a methodology that uses method to iteratively construct an emerging design and states: "*It attempts to examine the tacit, invisible aspects of human activity; assumes that these aspects can be productively and ethically examined through design partnerships with participants, partnerships in which researcher-designers and participants cooperatively design artefacts, workflow, and work environments; and argues that this partnership must be conducted iteratively so that researcher-designers and participants can develop and refine their understanding of the activity. The result of the research typically consists of designed artefacts, work arrangements, or work environments.*" He describes participatory design methods as "explore, approximate, and then refine." There are certain criteria that identify PD or Collaborative Development. Spinuzzi (2005) lists the following criteria for PD:

- Empowering the users as the users and designers interact closely through interviews, focus groups, workshops, organizational games, prototyping sessions, and other techniques to continually reassess the activity under investigation and to synchronize their interpretations.
- Collaborative development which means interaction of users and designers, a mechanism for consensus and agreement between participants, representation of a large group of user by a smaller sample of users, and the use of common language games such as contextual design's work diagrams and PICITVE's pictures.
- It is an iterative process which includes continual participation with re-visiting stages and sustained reflection on the progress made with the design.

2.2.1. Reasons for using participatory design

There are many reasons and benefits for using PD for our interface design. Participatory Design is very useful for generating new ideas according (Lee, 2007). He points out that *"Participatory design process uses stakeholders' collective generatively rather than a designers' individual creativity to solve design problems that are very specific to the context. By analysing what users create, researchers can elicit users' tacit needs, which cannot readily be expressed in words."* This is confirmed by Bergman (2010) who is of the view that workers are the prime source of innovation. PD is valuable as it brings tacit knowledge to the

fore (Spinuzzi, 2005). Much knowledge is tacit which is what people know but are unable articulate, it is implicit rather than explicit in order words is not written down or systematised. The issues of user knowledge and the collaboration with users in the design process features very strongly in literature as it facilitate "buy-in" and innovation.

2.2.2. The process of participatory design

Participatory Design is an iterative process that goes through several phases to complete (Bergman, 2010).

He makes use of four phases in his participatory design process namely:

- Phase 1: Conceptual design and requirements analysis;
  This initial phase is used to involve the users in the initial design of the system.
- Phase 2: Prototype implementation;
  This phase in the prototype implementation is the translation of the outcomes of the initial PD requirements captured into a formal model of the workflow.
- Phase 3: Trial deployment;
  The third phase is to run a short trial of the software amongst an example set of users.
- Phase 4: Evaluation.
  The users recruited for the trial deployment will then participate, along with the designers and software developers, in a PD evaluation of the success of the software system and the methodologies used to develop the software.

Our user centred development of an interface design for the calculator will concentrate on Phase 1 (Conceptual design and requirements analysis) and Phase 2 (Prototype implementation). For the conceptual design and requirements analysis we will use the CARD and PICTIVE participatory design techniques. According to Muller, (2001) the CARD participatory method was discovered by Tudor in 1992 and refined in 1993. It works well as a "task level" participatory design technique which combines well with the "screen level" participatory design technique PICTIVE.

The results of this conceptual design and requirements analysis phase will be transformed into a prototype design of the interface. This iterative process will be followed until a prototype emerged that is acceptable to all participants.

2.3. Prototyping

The importance of paper prototyping in user centred design is well documented in literature. Liu & Khooshabeh (2003) are of view that paper prototypes give the designers more flexibility in the early phases of the design process. This is confirmed by Li, et. al. (2010) indicating that paper prototyping is a widely used technique for the early stages of user interface design, suggesting that a designer can create an interface design mock-up using paper artefacts such as hand drawing and test an early-stage idea with a user in visual and tangible way. Liu & Khooshabeh (2003) captured 3 major usability issues with their paper prototype workshops namely, error handling, help support, and input handling. In early stages of design for mobile devices paper prototypes presents a unique challenge to the designers in view of the limitation to simulate factors such as touch screen input, number of tabs etc. (De Sa & Carriqo, 2006). Their paper prototype was tested in a controlled environment with role playing scenarios. The paper prototype was developed by using printed templates with sticky note widgets as components. These interface elements are used in order to make it easy to quickly change an element should the need arise. Labels or buttons and screens can be easily renamed, added or removed with ease. Some functional results are explained to the developers/users rather than being shown.

In view of the tacit expert knowledge of the fixed rate specialists (Relationship Executives), this research will make use of user-centred design and in particularly use participatory design techniques. We will use the CARD/CUTA and PICTIVE participatory design techniques to produce a paper prototype of the interface design. This will then be extended to an e-prototype to provide the users with better visuals of the interface together with a solid platform for further research and development of a fully-fledged fixed rate calculator.

2.4. Usability and testing of the Interface Design

In this section, we consider the usability of the interface design.

Lee (2007) describes lab based usability testing as one of the popular ways to test for usability in modern software development in view of its rich data and user's involvement in the testing. However, this kind of usability testing has many draw backs:

- It is associated with high costs;
- It takes time and effort to test;
- It presents an unnatural testing environment;

- It lacks user's direct participation to idea generation.

Hellman & Hao (2011) identifies five critical usability factors for total holistic design namely:

- Usability - This is something that users take for granted. This will not be noticed by the users until the product's usage or performance does not live up to expectations.
- Total Product Design - Products must be attractive in all aspects of design from hardware to software.
- Branding - It is an important part of the total product design.
- Trends – Trend awareness and understanding about marketing, brands, and target group behaviours have always been important, but in the usability era they will be vital for success.
- Timing – The maturity of a market for specific new technologies are of vital importance in the planning of the launch of a new technology product.

They developed a new procedure that ensures a usability approach in their organization that makes it possible to visualize usability requirements early in the process for all stakeholders to discuss and agree on. They believe Apple has been successful because they have managed to handle the five critical usability factors—usability, holistic usability, branding, trends, and timing— better than most to establish and maintain their position as the leading mobile usability manufacturer.

It is clear that when it comes to the early design of a user interface usability is a very important component in the holistic usability of the product.

Finally the e-prototype was used to evaluate the interface design by using Conceptual Model Extraction to determine if the conceptual design of the interface corresponds with requirements and needs of the users in completion of the required tasks.

2.5. Other Mobile Systems in use

The use of mobile solutions to improve employee productivity outside of financial institutions, however, does exist and is gaining in popularity. The following are a few examples:

2.5.1. Open Data Kit (ODK)

ODK is a platform that demonstrates the versatility that can be achieved by a mobile platform. According to Clarke (2010) ODK is a suite of tools developed by computer scientists and engineers at the University of Washington. They used an open source platform which makes it easy for developers to customise the tools to satisfy their needs. The main purpose of ODK is for data collection and analysis but can also be used to distribute information in the form of video or photos. Data collection and analysis is faster and more accurate than paper-based forms and cheaper and open to wider utilization than other types of computer or handheld-device applications. ODK is enabling users around the world to quickly, efficiently and accurately collect and process data ranging from medical records to environmental dynamics. It can successfully be used in developing countries with limited infrastructure by using existing cellular networks. Some of its uses include:

- HIV research and treatment in Africa.
- The Jane Goodall Institute: In tandem with Google Earth, the institute is using ODK to monitor deforestation in Tanzania.
- The Surui Tribe: The Brazilian indigenous tribe uses ODK and Google Earth to police its territory, request satellite photos when it thinks an area is being illegally logged and contact police.
- The Grameen Foundation: Shared Phone Operators in rural Uganda survey their customers about available phone-based services and the results are used to guide the development of services like Google's Clinic Finder and Farmer's Friend.
- Human Rights Centre At University Berkeley: Records human rights violations in the Central African Republic.
- Small Meadows Farm: Virginia farm uses the ODK to collect pH, humidity, soil moisture, plant observations, etc., in greenhouses and gardens.
- Foundation for Democratic Process: Fodep, which monitors elections so they are free and fair, is attempting to use ODK to gain real time results from every polling station in Zambia.

The main advantage of ODK is that it is an open source platform that is easy to implement in developing countries where technology and technical knowledge are limited. The software allows for a fair amount of customization, is flexible and allows attending to the needs as they emerge. With a generic framework like ODK a solution can be adapted and don't need to be built in from scratch every time. Although the focus of this study is on the development

of the user interface, the ODK open source platform will provide quick development of the interest rate calculator back-end and is a candidate to consider in further development.

2.5.2. Applications for Mobile Business Intelligence

Fitzgerald (2010) describes business intelligence (BI) as systems that take vast quantities of data and put it into visually useful forms (such as graphs and charts) for sophisticated analysis of business trends. Making that analysis mobile, most typically by tapping the power of today's sophisticated smartphones, can give companies the ability to interact in real time with their customers and business partners, thereby improving service and boosting productivity.

Hatch (2008) indicate that according to the Aberdeen Group, a large number of companies are rapidly undertaking mobile BI owing to a large number of market pressures such as the need for higher efficiency in business processes, improvement in employee productivity (e.g., time spent looking for information), better and faster decision making, better customer service, and delivery of real-time bi-directional data access to make decisions anytime and anywhere.

A good example is a San Diego company called MeLLmo who develop and deliver innovative mobile apps that allow users to view and interact with critical business information on-the-go. Their flagship product, Roambi was designed from the ground up for the mobile environment. It is a native iPhone/iPad application that makes business data and reports easy to access, navigate and interact with right from a handheld device.

Figure 3: Example of a Roambi BI Dashboard Application

Source: www. Roambi.com

Fitzgerald (2010) states that businesses have started to adopt mobile BI solutions for their workforce and they are becoming key components of core business processes. In an Aberdeen survey conducted in May 2010, 23% of companies participating indicated that they now have a mobile BI app or dashboard in place, while another 31% indicated that they plan to implement some form of mobile BI in the next year.

Ramakrishnan (2008) made the following comments as regards Mobile Business Intelligence (Mobile BI) *"Globally we see an increasing trend that the knowledge workers choose to have the liberty of mobility instead of being held in office. A virtual office may be a reality very soon. The last decade witnessed the growth of data warehouses, while the previous decade saw it as a luxury. Mobile BI will also become a critical component of IT architecture soon. Power of information is the mantra behind the success of winning enterprises. Because delayed information is like no information, by making business-critical information available on wireless handheld devices. BI has the potential to make intelligent businesses."*

He further states that Active Mobile BI gives provisions for users to interact with the BI systems on-the-fly. Active Mobile BI often works as a combination of both "push and pull" techniques. An initial view of a report could be push and further analytical operations on the report could be pulled to get any additional required information.

The Relationship Executives working with fixed rate quotes need specific information at specific times and, while at the customer's premises, can browse for the required real time yield curve interest rate, can browse for required historical quotes for this customer, negotiate an interest rate with the customer, request a firm interest rate quote from Treasury Department, etc.

The demand for real time critical yield curve information by the interest rate calculator system and the availability of real time data integration technology creates a necessity for Mobile BI.

In this research we will create an interface for a program similar to Roambi using PD, prototyping, and evaluating the usability of the interface.

3. Methodology

3.1. Significance of research

As introduced in the background chapter, customers of the bank make use of fixed interest rate loans from a bank to protect themselves against volatility of interest rates caused by normal economic cycles. For the bank to be able to supply them with these loans their Relationship Executives should have access to market interest rates at their fingertips to properly set the interest rate for the customer and not place the bank at any undue interest rate risk. At the moment it is a cumbersome manual process as most banks do not make use of mobile technology or any other technology for this purpose. In designing a fixed interest rate quote calculator the knowledge of the users (specialists) is of utmost importance and "buy-in" from them is vital. Workers are a prime source of innovation (Bergman, 2010). We will therefore make use of user centred design and in particularly participatory design techniques which holds numerous advantages. It brings tacit knowledge to the fore (Spinuzzi, 2005), and will assist in unlocking the knowledge of the fixed interest rate specialists. It will also get the necessary "buy-in" from the Relationship Executives as they will be the users of the system. We will evaluate the system by way of Conception Model Extraction, by using an e-prototype and users who were not involved in the design of the interface.

3.2. User Participatory Design for Interface Design

The goal of user centred design is to better understand the user and the tasks they perform - (Mao et. al., 2005) and Lee (2007) advocates the use of participative design for user centred design and writes that participatory design focuses on what people make to elicit what they think, feel and dream. We need a method that would bring the tacit knowledge of the fixed rate specialists to the fore in our interface design. Spinuzzi, (2005) advocates that PD is valuable as it allows for the communication of this tacit knowledge which is what people know but are unable articulate, it is implicit rather than explicit in order words is not written down or systematised.

Lee (2007) states *"While traditional design research methods focus primarily on observational research and questionnaire, participatory design focuses on what people make to elicit what they think, feel and dream. By having workshops and discussing design issues*

with users, managers, and sales people, designers can discover problems that are very specific to the context. In the user-participatory design workshop, designers use so-called 'Make Tools' (or generative toolkits) to connect ideas of users from different disciplines and perspectives. Participants use this 'quick-and-dirty' prototyping to visualize their thoughts in the generative phase of design process, which designers analyse to understand their needs."
From the above it is clear that the users are the most important stakeholders in the participatory design process and must be seen as active collaborators rather than passive participants. They are the subject matter experts that know all about the work content and context as they are involved in the quoting of fixed rates to customers of the bank every day. The question is what prototyping methods will be the most appropriate methods to use in our participation design workshops?

3.3. Choosing the Prototyping Methods to Use

Hocko (2001) states that there are a variety of prototyping methods that can be used in the software design process. Each method requires a different commitment from the project team and may be used at a different stage in the design process.
However, this is a difficult process to validate the design with a myriad of variables to consider especially when it comes to new emerging technologies such as mobile technology used for the fixed rate calculator. Choosing the right type of prototype to evaluate the fixed rate calculator in a cost-effective way is therefore important. In our case the design focus on the interface and the usability and user experience thereof would imply that low-fidelity prototype should be sufficient to evaluate the design.

De Sa & Carriqo (2006) explain that the goal with low-fidelity prototyping is to provide an option for testing actual scenarios. This is possible with a low-fidelity prototype of the calculator that evolves from low-fidelity paper prototype to a low-fidelity software prototype. However limited information is available on how to apply common UI design guidelines on small screens using low-fidelity paper prototypes e.g. sketches must be drawn with the same size of the device's screen using similar components and fonts to those available for real devices. For this reason we decided to start off with participatory design techniques namely contextual inquiry, the CARD/CUTA and PICTIVE methods of design. A quick survey of these techniques is first presented, followed by detail of these methods used during the design process workshops. The outcome of these methods resulted in a low-fidelity paper prototype and this was then evolved to a low-fidelity software prototype.

The methodology adopted was to make use of a more structured approach for observation and scenario creation in the design by starting with a contextual inquiry. This will be followed by the use of CARD/CUTA and PICTIVE participatory techniques resulting in an e-Prototype to be evaluated by a conceptual model extraction method.

3.4. Contextual Design

Beyer & Holtzblatt (1998) defines contextual inquiry as a field data-gathering technique that studies a few carefully selected individuals in depth to arrive at a fuller understanding of the work practice across all customers. Through inquiry and interpretation, it reveals commonalties across a system's customer base.

Beyer & Holtzblatt (1998) are of the view that most projects begin with an idea about what problems must be solved and also a rough idea about how to solve them. Contextual Inquiry clarifies and focuses these ideas by discovering the exact situations in which these problems occur, what these problems entail, and how people solve them. Thus, it's best done before the process of creating solutions has begun, which is most often the very beginning of the development cycle.

3.5. Participatory Design Techniques

3.5.1. The CARD/CUTA Technique

CARD stands for (Collaborative Analysis of Requirements & Design) and CUTA for (Collaborative User' Task Analysis) (Hocko, 2001) which is a variant of CARD. CARD/CUTA is a technique of participatory design to be used in the early stages of the design process to develop a comprehensive task analysis (Hocko, 2001). It uses playing cards with pictures on them, looks at the flow of tasks, and gives a macroscopic view of task flow. The users are empowered to become co-designers, requiring a small group of participants, every user an expert/specialist. Users can use their thoughts by additional cues, and it will not require repeated visits to the users for re-design. Muller (2001), states that the intended atmosphere of a CARD session "is presented as being open, non-judgmental, and safe for all participants. Discussions focus on the issues, not on the participants, and the group attempts to remain committed to collaborative exploration and clarification of conflicts, with the hopes of resolving any conflicts that occur". Both are participatory design methods to be used in the

early stages of the design process to develop a comprehensive task analysis. The basis for both CARD and CUTA is to develop activity cards and then arrange them in a specific order to comprise a specific task.

Hocko (2001) describes this method as "*creating and ordering activities that may be observable interactions with an object in the work environment, a mental activity required to complete the task, and so on. Activities are typically grouped into non-technology activities, technology-driven activities, and non-object-based activities (such as talking with a colleague in the hallway). A card is created for every object and situation users may encounter as they attempt to complete a task.*"

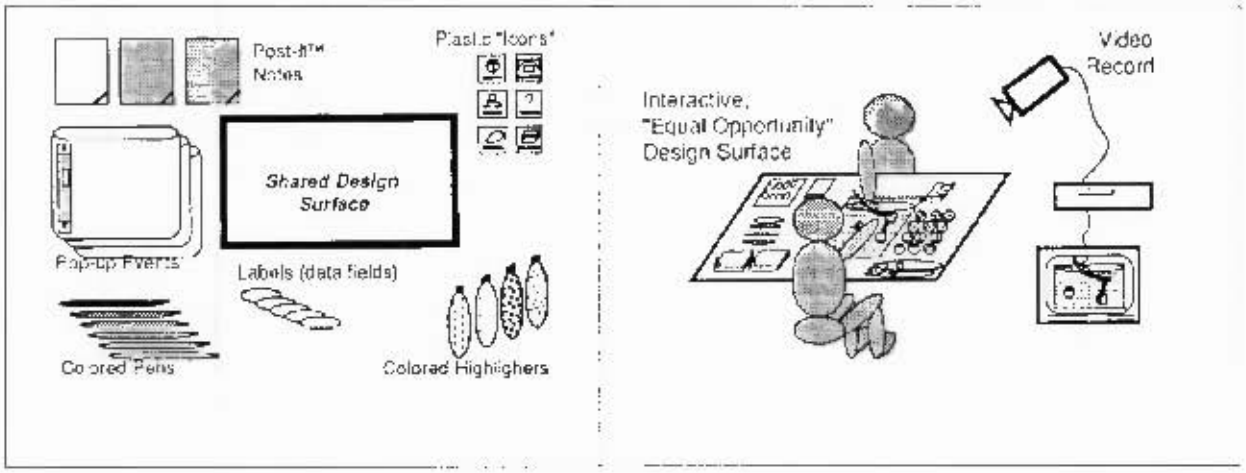
The method was discovered by Tudor in (1992) and it represents a high level of abstraction by typically allowing for screen flows for specific tasks and states only the type of information on a screen rather than detailed screen design.

3.6. The PICTIVE (Plastic Interface for Collaborative Technology Initiatives through Video Exploration)

PICTIVE participatory design techniques produce a mock-up of the system that is being designed and this prototype will give the users and developers an insight as to how the system will eventually look and behave (Murray, 2004). PICTIVE uses low-fidelity office products, such as pens, papers, and sticky notes to produce a low-fidelity paper prototype of the interface. In our case PICTIVE would give a microscopic view of the interface to design. PICTIVE is complementary to CARD/CUTA which will be used as the starting point for the PICTIVE session.

PICTIVE (Hocko, 2001) is participatory design techniques that become popular in 1990. It is a technique to allow the users to become familiar with and collaborate in the design of the intended target technology that they will be using. According to Murray (2004) PICTIVE produces a mock-up of the system that is being designed and this prototype will give the users and developers an insight as to how the system will eventually look and behave.

Figure 4: Equipment and materials used in PICTIVE technique



Source: Muller, (1992).

PICTIVE uses a video recorder and the design objects on a design surface to manipulate the design in collaboration between the users and designers until an agreeable design is reached which satisfies users and designers.

3.7. A Comparison between CARD/CUTA and PICTIVE Techniques

- CARD/CUTA uses playing cards with pictures of specific items on them while PICTIVE uses low-fidelity office products, such as pens, papers, and sticky notes.
- CARD/CUTA looks at the flow of tasks, just as storyboarding while PICTIVE concentrates on the detailed aspects of the system and the actions of the users are videotaped.
- CARD/CUTA gives a macroscopic view of the task flow while PICTIVE giving the microscopic view of the system.

These techniques are complementary towards each other in the design process and may be used together.

3.8. Conceptual Model Extraction

Jones & Marsden (2006) describe the goal of this technique as follows: "*Mobile computing opens the opportunity to develop entirely new types of application for which users will have*

no precedent. This is daunting to the interface designer, as it is not possible to exploit familiar metaphors and ideas which the user may be comfortable with already. The goal of this technique is to extract how users interpret a completely new interface, given their existing mental models of how interfaces should work."

The goal of this technique is to evaluate how the users experience the usability of the interface the first time they use it.

This will include how easy and simple the interface functionality is to use, how it conforms to the users' mental model, and whether the intended user results are achieved.

The data will be collected by conducting a CME workshop where the participants will include users that were not part of the design team as this technique evaluates the user's experience the first time they uses the interface.

Evaluation of the acquired workshop data will indicate to what extent the user interface behaves and looks as expected and any deviations may then be rectified.

4. Participatory Design

4.1. Introduction

While traditional design approaches focus on observations and questionnaires participatory design focuses on the user, what they think, feel and dream. This is confirmed by Jones & Marsden (2006) who states that *"If you really care about having input from your users in the design process, this technique is hard to beat"*.

Lee (2007) quotes: "*In the user-participatory design workshop, designers use so-called 'Make Tools' (or generative toolkits) to connect ideas of users from different disciplines and perspectives. Participants use this 'quick-and-dirty' prototyping to visualize their thoughts in the generative phase of design process, which designers analyse to understand their needs. Whereas the user needs collected from the conventional methods are based on explicit knowledge or observable behaviour, the needs elicited from participatory design are based on tacit knowledge, which cannot readily be expressed in words*".

We decided to start off with a Contextual Inquiry as a data-gathering technique to arrive at a better understanding of the work practices of the stakeholder involved in the fixed interest rate quoting process. This was then extended to make use of the CARD/CUTA and PICTIVE participatory design techniques for the following reasons:

- Users are empowered to become co-designers in the design process and can freely contribute to the design activities.
- The completion of the design activities will not take a long time.
- It will not require repeated visits to the users for re-design.
- These techniques only require a small group of participants.
- Every user is an expert/specialist in the fixed rate quoting environment.
- Users are allowed to have direct communication with designers and these strong partnerships between designers and users allow for more freedom for the users to express their design ideas.
- Users can express their thoughts by using additional cues, such as hand gestures, facial expressions, tone of voice, and other responses which can facilitate user's design activities rather than just providing an 'evaluation.'
- PICTIVE does not involve a technology environment for design activity.

- The goal of PICTIVE is to provide an equal opportunity for users to participate in the design process with designers of the prototype.

4.2. The Design Team

The design team consists of a small team of users and a facilitator namely:

- **Two Fixed Rate Relationship Executives.**

  Their main responsibilities and duties are:

  - All customer negotiations,
  - All documentation are properly signed by the customer,
  - Ensure that all the information are loaded on the production system e.g. fixed interest rate, expiry date etc.
  - A separate fixed rate contract and contractual repayment profile must exist for each fixed rate loan.

- **Two Structured Products Consultants and one Manager,**

  Their main responsibilities and duties are:

  - Entry point for all fixed rate pricing from Group Treasury,
  - Preparation of the Fixed Rate Contract.
  - Obtain indicative and firm contract breakage cost from Group Treasury should the customer terminate his fixed rate contract before expiry date.

- **Two Group Treasury Managers.**

  Their main responsibilities and duties are:

  - Determine all fixed rate pricing, indicative and firm rates.
  - Take all hedging decisions relating to fixed rate loans.
  - Ensure that transfer pricing (cost of funds for the bank) applies to all transactions.

- **One IT Development Manager.**

His main responsibilities and duties are:

- Ensure that all system limitation is incorporated in the design.

The design team was chosen from the fixed interest rate team of the bank for their knowledge of the way a fixed rate is quoted and administered to a customer. The participants are users of the system and not the administrators of the system. They are professional people well versed in the processes followed in order to quote a fixed rate to customers of the bank and needed limited facilitation in the working of the system.

4.3. Data-Gathering with Contextual Inquiry

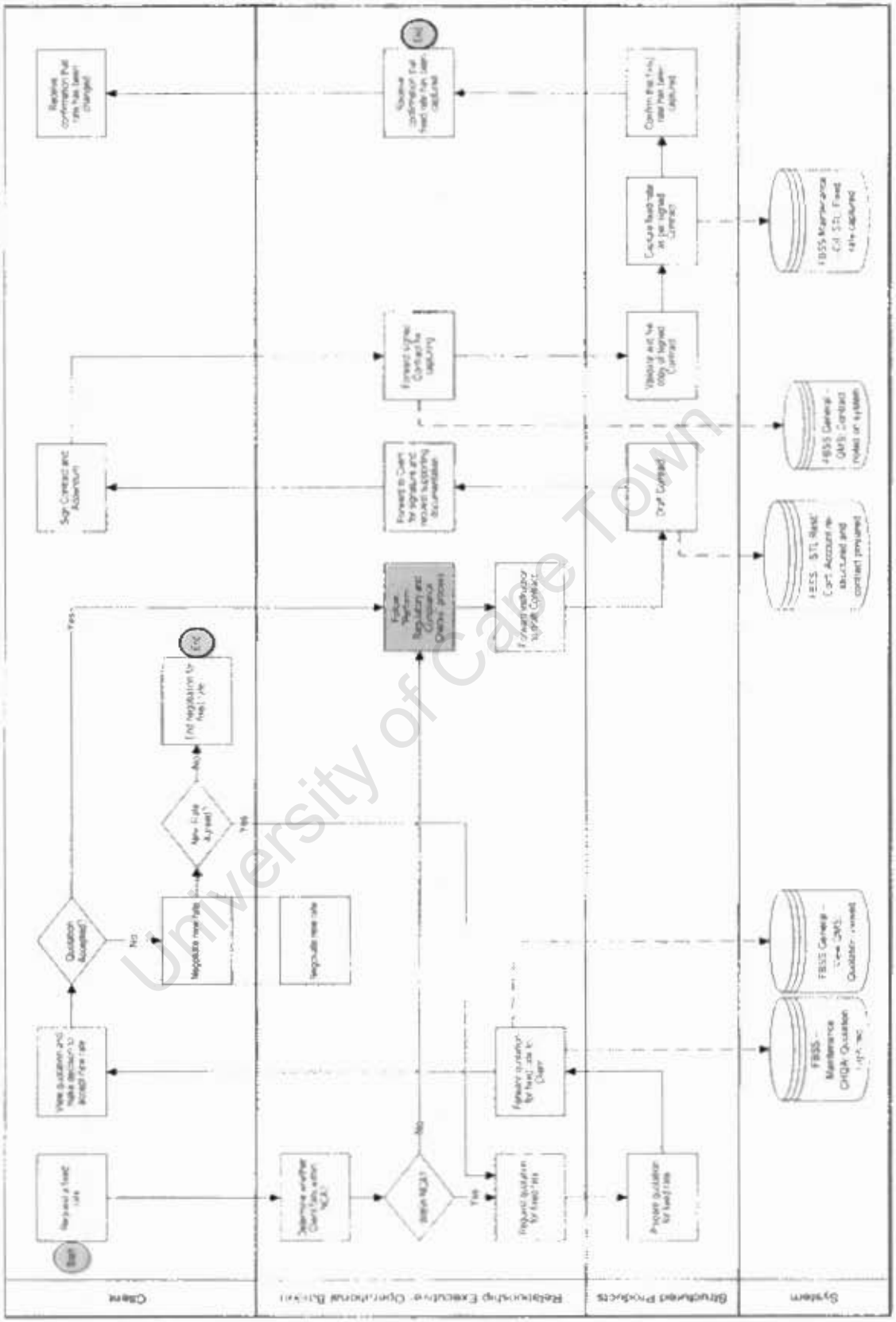
The appropriate target audience chosen for the contextual inquiry consisted of eight individuals as per the above mentioned design team and concentrated on the behaviour of these individuals as regards:

- Their demographics;
- What tasks they regularly do;
- What tools they regularly use;
- The tools they occasionally use to solve specific problems;
- How they use these tools.

Sessions were scheduled with the individuals to observe the activities they perform relating to the establishment of a customer's fixed rate quote and contract. Each session lasted as long as it took to complete a task or activity. Each participant was briefed and or given an idea what to expect without going into too much detail. The idea was not to stifle a spontaneous response while they complete a task or activity.

The kind of information gathered included; the tools used the sequence in which actions occur, the methods used and organisation of information, kinds of interaction and parties in the transfer of knowledge, the nature of interaction, etc.
From this we derived the following diagram of the manual fixed rate quoting process.

Figure 5: Manual fixed interest rate quoting process flow diagram.



The following main tasks were identified:

- Customer requests a fixed rate from Relationship Executive (RE) by e-mail, in person or by phone.
- RE checks if the customer falls within' the National Credit Act (NCA) or not.
- If so, the fixed rate quote is abandoned and client advised by the RE.
- If customer falls outside the NCA, a fixed rate quote is obtained from Structured Products Department and forwarded by the RE to the customer for acceptance. This is normally done by e-mail and may be delayed if attention is not given to the email in time. The process also involves obtaining the customer's credit rating to add a credit margin.
- The customer accepts or rejects the quote.
- If the customer accepts, the contract for signature is prepared by the Structured Products Department and handed to the customer by the RE for sign. This must be done within' the timeframe of one hour as market interest rates may have move during this time. It often happens that this takes longer than the timeframe of one hour and the process needs be repeated.
- On receipt of the signed contract by the RE from the customer the fixed interest rate is loaded on the clients account by the RE.
- A copy of the signed contract is forwarded to the Structured products Department to verify correctness and confirm the correct interest rate is loaded.
- The RE supplies the customer with confirmation that the fixed rate is loaded.

4.4. Findings of the Contextual Inquiry

We found several problems associated with this manual process, for example:

- Relevant information (credit rating, liquidity premiums, and yield curve) was daily out of view and at different sources namely: Treasury production systems and Data Warehouse.
- Excessive amount of time was spent to get to the required information. This would sometimes result in days before the required information was gathered.
- Help on fixed rates was not easily accessible as no help system was located in one area.
- The process had too many manual interventions which was prone to human error.

It was important that the solution was not characterized by these problems and we specified a set of high-level design principles as project success criteria, these included:

- The relevant information must be readily available.

- This information must be at the fingertips of the Relationship Executive- anytime anywhere.
- The process flow of information must be automated.
- The mobile interface must be easy and simple for the Relationship Executives to read and understand.

The existing fixed rate quoting process was a manual process, paper based, slow, and labour-intensive. The key business drivers were to develop a usable and useful mobile electronic interface and interaction for the fixed rate quoting calculator that would be readily accepted by the Relationship Executives.

The results of the contextual inquiry was used as the starting point for the CARD/CUTA and PICTIVE sessions of design.

4.5. Turning Understanding into Design

4.5.1. Preparation for the CARD/CUTA Session

The emphasis was to concentrate on the tasks at hand that will be used in the calculator and the manual fixed rate quoting process. These were used as the starting points in identifying the tasks needed in the CARD/CUTA session.

The participants were chosen from the above design team and included one Fixed Rate Relationship Executive, one Structured Product Consultant, one Group Treasury Manager and the Structured Products Manager as the facilitator.

The session was run on the bank's premises in a board room with the necessary privacy in a relaxed atmosphere. The duration of the session was approximately 90 minutes with a rest break after 45 minutes. Cards with specific pictures were prepared for the CARD/CUTA session. The session was recorded by still photographs of the cards used and also the outcome of the main task analysis.

Figure 6: Sample playing cards for the CARD/CUTA session

4.5.2. The CARD/CUTA workshop session

The CARD/CUTA session was conducted informally as a semi-structured Brainstorming session.

Muller (2001), states that the intended atmosphere of a CARD session *"is presented as being open, non-judgmental, and safe for all participants. Discussions focus on the issues, not on the participants, and the group attempts to remain committed to collaborative exploration and clarification of conflicts, with the hopes of resolving any conflicts that occur"*. These principals were explained to the group at the start of the session. The participants then all introduce themselves, their workplace group, interest and the area they represent e.g. sales, technology, design etc. This was followed by a brief discussion of the fixed rate quoting

calculator to be modelled. The key ideas and designs were discussed and included the following:

- In view of it being a mobile design, tasks must be kept as simple as possible.
- Focus on the main tasks and issues.
- Explore new ideas and avenues.
- Collaboration between users.

The group then examines the cards used in the session (figure 6 presents a few examples). Each card contained a template to describe an activity, or a component of an activity. This included a mental operation, a screen activity, a computer task or a computer screen activity. The templates also asked questions whose answers are useful in describing the activity. One participant would explain their work as regards fixed rates and the others would ask questions. The participants in the session used the cards to lay out a sequence of activities, to explain not only what is done but also why it is done, and to add commentary and interpretation that helps people to understand the nature of the work and its context. This sequence of tasks was then taped to a large blank piece of paper to lay out the design of the important tasks. The initial cards were not a given and the participants were encouraged to be innovative and even create new cards or change the cards.

4.5.3. The results of the CARD/CUTA session

The design team designed the tasks by placing cards; intertwining the design with documentation and reflection/assessment with the support of the facilitator. The participants were encouraged to follow up design moves by demonstrating and suggesting alternatives of design moves, or prompting the participants to explore the alternatives further. The main tasks design was therefore produced collaboratively. There were no *showstoppers* that resulted in a major disagreement between the members of the design team. The analysis in the session was of a high standard and helped to make informed decisions regarding meeting business constraints while maximising the opportunities for the Relationship Executives to add unique value to the customer's request.

The key decision and the rationale behind each task design were documented:

- In view of it being a mobile interface design the task design culminated into only three main tasks. The number of task flows was kept to a minimum to simplify the design.
- A decision was taken to keep the Relationship Executive's bank ID and password for sign-in. The reason being that the Relationship executive uses this sign-in information every day and it is already managed by other bank systems.

- As the Relationship Executives are not legal experts, the process to check if the client falls within' the NCA or not, was automated. This was to assist the Relationship Executive with this decision making as there is some confusion whether the customer is subject to this law or not.
- The help system would be of great assistance to the Relationship Executives as some are less experienced than others.

Results from this session included a tangible sequence of cards (tasks) on a blank piece of paper. There were three main sequences of tasks that emerged:

Figure 7: Task 1- Sign In

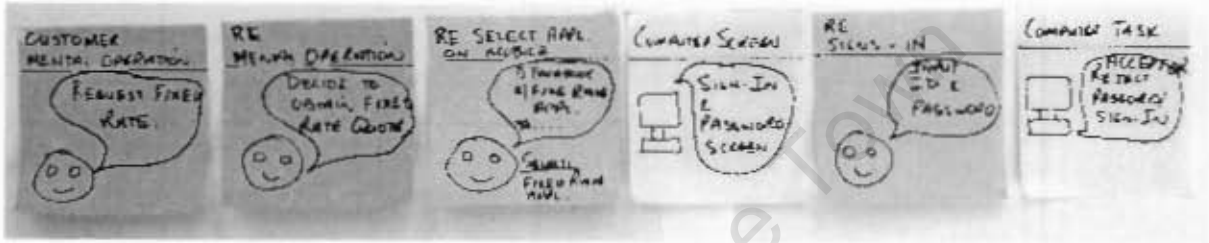


Figure 8: Task 2 - Fixed Rate Quote

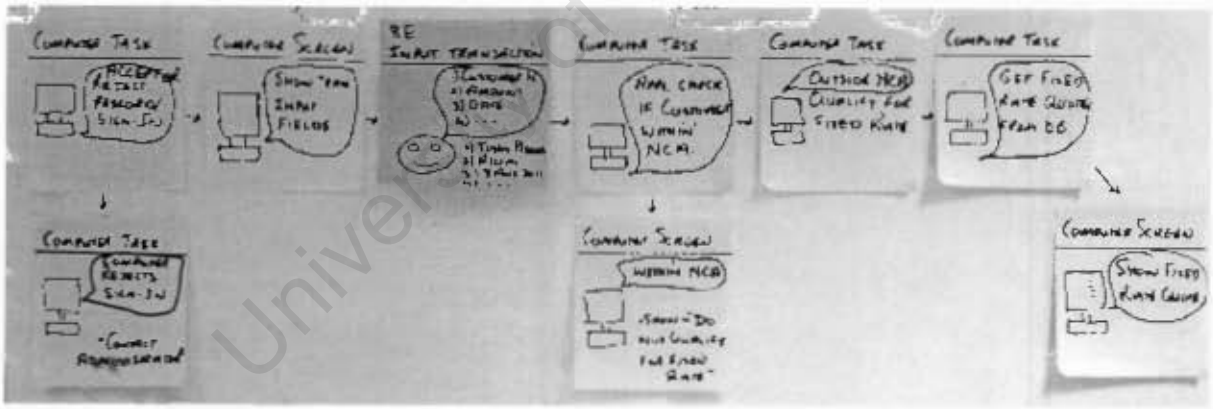
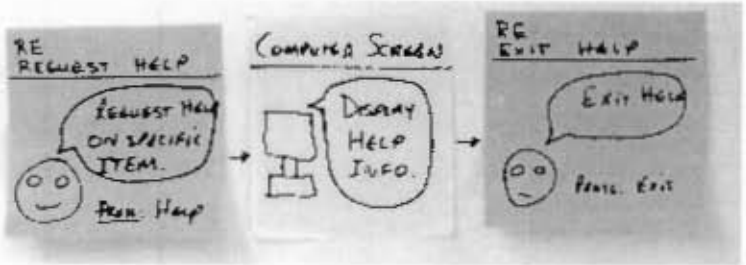


Figure 9: Task 3 - Help System



Intangible outcomes from this session were enhanced personal and organizational communication, improved teamwork, greater organizational cohesion, and stronger commitment and buy-in by participants to the success of the design.

4.5.4. Preparation for the PICTIVE session

The participants chosen included one Fixed Rate Relationship Executive, one Structured Product Consultant, one Group Treasury Manager, and Structured Products Manager as the facilitator and an IT Manager as the developer. Apart from the Structured Products Manager the other participants were not the same design team members used in the CARD/CUTA session. The participants were chosen from stakeholders in the existing fixed interest rate team of the bank with the author not being part of this team.

The session was run on the bank's premises in a board room with the necessary privacy in a relaxed atmosphere. The duration of the session was approximately 120 minutes with a rest break after every 30 minutes.

The task results of the CARD/CUTA session were given to the users, as the homework assignment, to access and establish the scenarios that he/she will be using when engaging with the fixed rate calculator as preparation for the PICTIVE session. The users were asked to list the things they would like the system to do for them.

The designer, on the other hand, made a list of the system components based on preliminary conversations with the users and the designer's own observations and experience as well as the results of the CARD/CUTA session. The equipment and materials as per table 2 are prepared by the designer for the session.

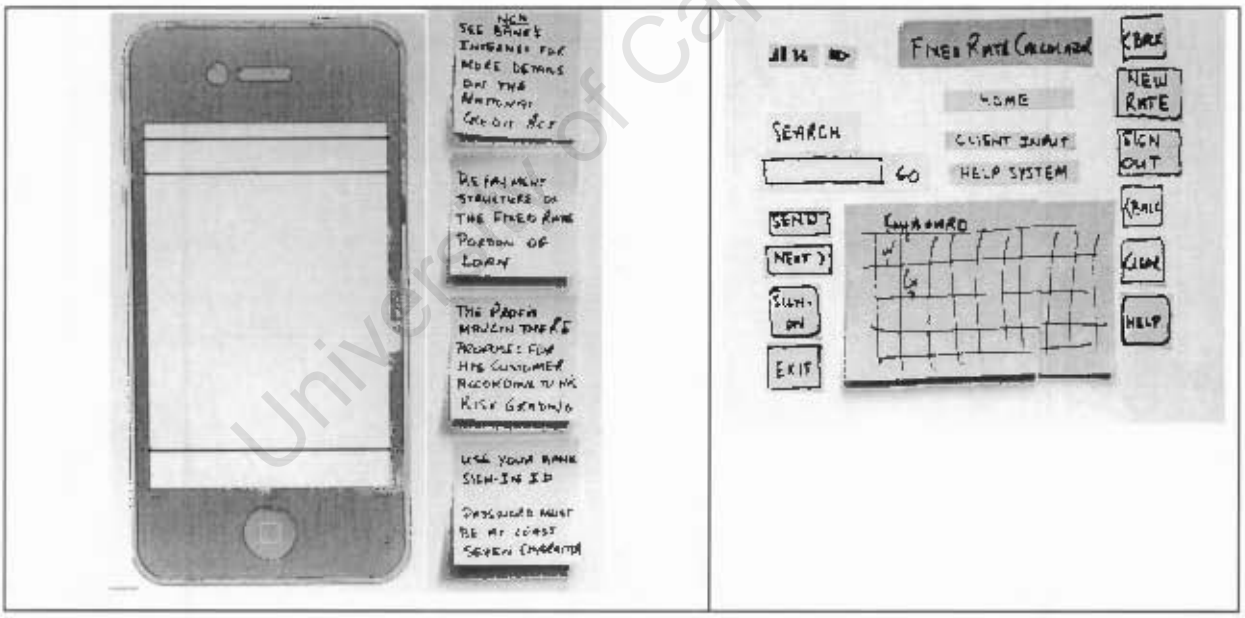
Table 2: The equipment used for the low-fidelity prototyping in PICTIVE

1. Video camera
2. A collection of design objects used
- Office materials that are in use every day: coloured pens, coloured highlighters, coloured paper, and coloured Post-It notes of various sizes, coloured stickers, coloured labels, and coloured paper clips.

	- Materials prepared by the developer to present multiple design exercises (e.g., command line, query fields, menu bars, and dialogue boxes) □ Icons: coloured plastic icons for graphical user interfaces □ Pop-Up Events: a suite of paper images of pop-up events □ Menu Bars and Window Frames □ Several other tools to modify these items: scissors, erasers, and the coloured pens and highlighters.
3	A design space in which prototyping activities are performed with design objects

Figure 10: Examples of materials prepared by the designer

query fields, menu bars, dialogues, boxes, pop-up events, & "plastic icons"



4.5.5. The PICTIVE Workshop Session

The users all introduce themselves as experts well versed in the use of the manual fixed rate quoting process.

The results of the CARD/CUTA session were introduced as the starting point for the PICTIVE session. The designer gave a brief tutorial of the CARD/CUTA session and the results and the rationale behind were discussed by all participants.
Liu & Khooshabeh (2003) used no automation in running their prototype as the facilitator played the "computer" who manually updates the screens in response to spoken queries and user movement events. The same process was followed in our design workshop.
During the session each of the users brought their own experience and expertise to the table to share in the design of the calculator. The goal was for each participant to educate the others to his view of the design and ultimately produce a collaborative design which has the consents and approval of all participants.

Williams (2002) conducted his design sessions in the participant's places of work and explain the purpose of these design sessions as follows:

- reviewing with participants the progress of the system's design;
- developing and refining the system specification;
- fostering participation in the design of the fixed rate calculator.

He points out that despite the best intentions of using prototyping with the goal of stimulating talk and design ideas the real work of fostering participation occurs in the specific interactions that make up the design sessions. Our design workshops had the same objective of fostering participation and the session was conducted at a convenient location on the bank's premises. The session was conducted as an "informal" discussion without any dedicated leader. The whole PICTIVE session was video recorded by the designer for later reference and to assure all the participants that their views were taken into account. It was also a technique for record-keeping, and to simplify the social dynamics of the design session.
The design was then brainstormed, using the results from the CARD/CUTA session, the prepared objects and the information from each participant as regards the home assignment.

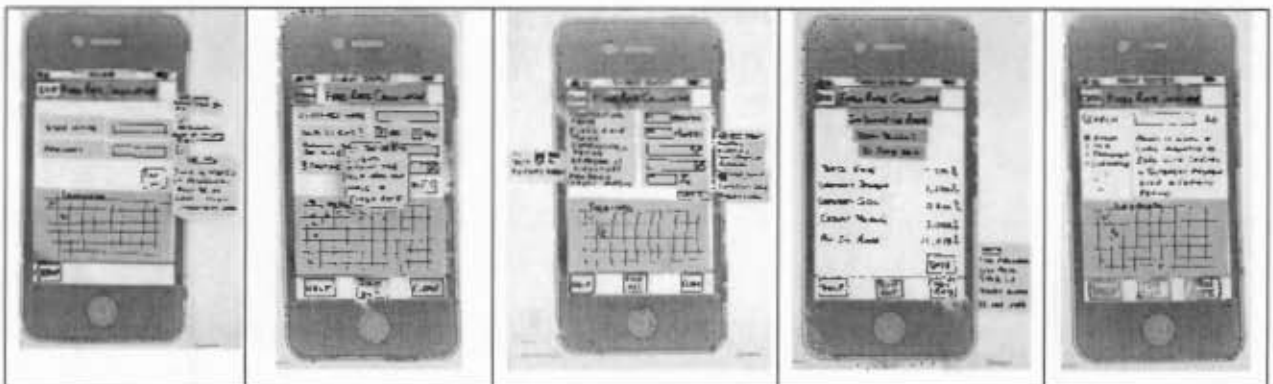
Figure 11: The PICTIVE session in progress.

4.5.6. The results of the PICTIVE session

The outcome was a first paper prototype as per figure 12.

In this conception phase of our interface design, the paper prototype shows only the important parts of the system and is therefore limited in scope. It allows for the creation of a quick copy of the system interface and is without much detail. De Sa & Carriqo (2006) found that in some cases, the efficiency of paper prototypes in identifying usability problems is almost as high as software prototypes. According to De Sa & Carriqo (2006) several studies have demonstrated that paper prototypes can be efficiently used to prevent design errors and improve the usability of applications.

Figure 12: The prototype of the design



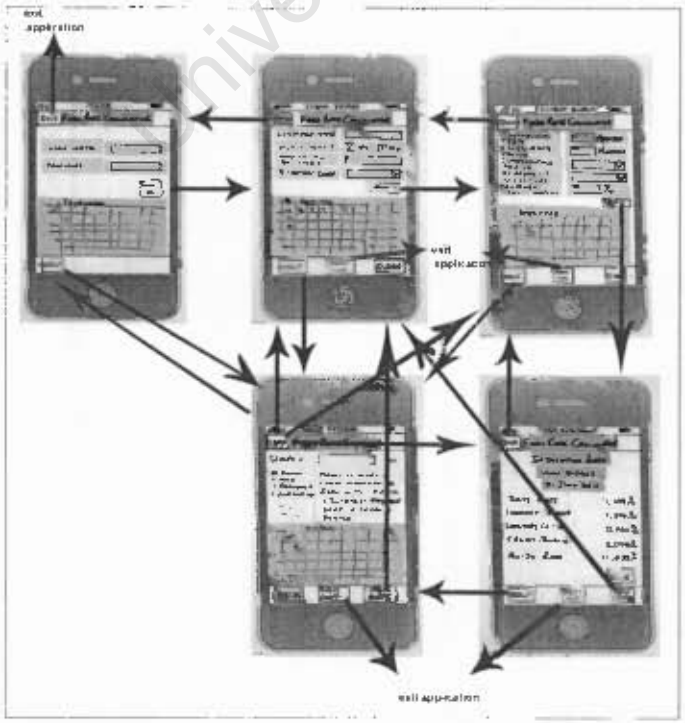
The session was characterised by full participation from the users. The technique worked well, the session proceeded as a sort of informal group brainstorming session, without any particular party driving or controlling the session. The knowledge of the participants in the fixed rate environment was a critical input to the interface design while working as a team, listening and communicating facilitated buy-in. Because the developer was involved in the participatory design session the system limitations and concept was incorporated into the paper prototype design. He initiated a discussion of design alternatives that were more technologically feasible, and led users to new technology-based capabilities that will enhance the workplace value of the target system.

This will ultimately produce a well-designed, developed, and better interface.

During the session changes made in moving objects around included a re-design of screens, adding components e.g. a keyboard, and improving the help and error recovery system. With good communication during the session changes to the system were not resisted.

The screen movements are set out as per Figure 13 below. All the screens have a "back" button to return to the previous screen. There is also a button to move to the next screen. The "New Rate" button allows for movement to the first rate input screen should the user wish to input a new rate. The "Sign Out" button will take the user to the sign in screen. A "Help" button will allow for the help screen to be accessed from any screen in the application.

Figure 13: Screen movements of the paper prototype



The design effort was a success: all the participants believed that they had had the opportunity to express themselves, and that they had collaboratively solved their problems. The next step was to produce an e-prototype of the paper prototype.

4.6. e-Prototype

Spool (1998) states: *"The purpose of a prototype is to provide feedback on a design. But implementing, testing, and shipping an entire release is an expensive way to get critical information. The use of paper mock-ups substantially shortens the implement phase, allowing more iterations than would be possible with electronic prototyping techniques."*

Paper prototypes are normally used early in the design process when their advantages are the greatest and although paper prototypes solve most of the design problems they cannot solve all. For example, it is not possible to assess response times with a paper prototype, and it may be harder to get accurate feedback on the visuals of the product. We therefore also decided to produce an e-prototype of our design. The developer was one of participants in the PICTIVE session allowing for the system limitation e.g. limited mobile screen estate etc., to form part of the interface design. This made it easier for the developer to produce an e-prototype of the design.

The materials used for the e-prototype are:

- Adobe Flash Builder software;
- Mobile phone simulator toolkit;
- Laptop computer with mouse;

The resolution used:

- Simplified screens using given interface formats from the simulation toolkit;
- Partially working interface limited to the screen navigations without back-end or any link to a database;
- Fixed rate result information are hard coded into screen and not real data;
- Keying with a mouse and not touch screen.

Scope:

1. Limited to the five screens as per Figure 14.

Figure 14: e-Prototype - Screen layouts

4.7. Findings and Analysis

The CARD/CUTA and PICTIVE sessions were iterative design session by themselves allowing participants to freely share knowledge and question the design until all participants were satisfied with the interface that was designed. During the sessions the participants managed to complete most of the task on the paper prototype with ease.

The indications are that the paper prototype has served the purpose of allowing the design focus groups to be creative and mock up their ideas and sort out most software usability problems and the next step was to design the e-prototype.

Spool (1998) indicates that the majority of usability problems can be addressed by three principles namely: affordance, mental models, and tool time. Affordances are the build in "clues" of how the interface should be used. The visual language that help the users know what to do are reflected by the objects like buttons, icons, words and other controls. A lack of affordance would result in usability problems. Users subconsciously develop their own mental models of how an interface should work. While tool time is the time that the user take to figure out how to interact with the interface or what the next step should be.

In the design of the e-prototype, by concentrating on the above design principles the developer was able to eliminate further usability problems e.g. a "back" button on each page, a "yes" "no" radio button used for NCA customer or not, the words "submit" "next" "save" on specific buttons.

4.8. Evaluating the Interface Design

The e-Prototype is the result of the iterative participatory design process followed in terms of a set of integrated ideas and concepts about what the system and in particular the interface

should do, behave, and look like, that will be understandable by the users in the manner intended. We evaluated the interface to determine if the conceptual design of the interface corresponds with the mental model of the users in completion of the required tasks.

4.8.1. Conceptual Model Extraction (CME)

The goal of this technique is to evaluate how the users experience the usability of the interface the first time they use it.

The success criteria for the interface design were:

- The user interface of the calculator must be easy and simple for the Relationship Executive to read, use and understand,
- The use and the result of the intended functionality must conform to the mental model of the users.

4.8.2. The Users

The CME workshop participants consisted of two Relationship Executives and two Structured Product Consultants who were not part of the design team. They were all hand-picked as they have a thorough knowledge of how a fixed rate is quoted to a customer. They therefore have their own mental model of how such a calculator interface should look and work.

4.8.3. The Conceptual Model Extraction Session

The process that we followed was to show the users the e-Prototype interface screens and ask them to explain the function of each screen element and how they would perform a particular task. The particular tasks to complete were to sign-in and obtain a new fixed rate quote for a customer. They have not seen the interface before and screenshots of the interface was presented to them.

The session was conducted with all four participants present, in a controlled environment being a boardroom at the bank's premises. The session took most of two hours to complete. The different screens were presented to the participants on a computer and the questions as per table 3 put to them.

Table 3: Questions

Sign-In Screen

1. If you wanted to start a fixed rate quote, what is the first thing you would do?
2. If you wanted to sign-in, what would you do?
3. If you lost your password, what would you do?

Rate Input Screen 1

4. What would you do if it was a quote for a new customer?
5. What would you do if it was a quote for an existing customer?
6. How would you determine if the customer is affected by the NCA?
7. How would you get help on any of the inputs?
8. How would you advance to the next / previous screen?

Rate Input Screen 2

9. How would you input the "contractual term"?
10. What would you input as the "Fixed rate term"?
11. What would you input as the "compounding period"?
12. At what level would you input the "proposed credit margin"?

Rate Quote Output Screen

13. How would you interpret the rate quoted on this screen?
14. How would you save this quote and what does it mean?
15. How would you abandon this quote and request a new quote?
16. Can you exit the quote at any time?
17. How would you change the quote or credit margin?

Help Screen

18. How would you return to the previous screen or the screen you last worked on?

Other questions?

19. Where do you expect the base rate to come from?
20. Where do the liquidity costs and statutory costs come from?
21. Is this an indicative quote or a firm quote?
22. What happens if you save a quote?

4.8.4. Findings and Analysis

All the participants managed to complete the tasks of sign-in and obtaining a fixed interest rate quote successfully. However, a number of questions were raised by the participants and the following were instances where elements differ from the user's mental model.

4.8.4.1. Existing functionality that differs from expected functionality.

1. One of the users wanted to know what would be the correct format for the id and password. The user expected to have an indication of what format the user id and password should be. This would be the user id and password used to lock into the bank's overall systems, in other words one id and password for all bank systems. This is explained by the "help" system and would be clear to the user after repeated use.

2. During log-in the question was raised by one user why the other buttons were not greyed out before the user was signed in as it creates confusion as the other button may be used without signing in.
3. One user was not clear what was meant by "NCA Customer". Again this is explained by the "help" system and would be clear to the user after repeated use.
4. If it was an existing customer the users were expecting some search facility to search for the customer details.
5. No indication was given by the interface elements whether the user can search previous quotes for a specific customer.
6. The question was raised whether the quote details presented was an indicative quote and for how long was it valid before it expires. The user indicated that it would be a good idea to show the time left before the quote expires. The quote will be indicative and will be valid from time of quote for 30 minutes.
7. The users question if the help system is contextual to the element in focus at the time. This would make it easier for users to use the help system.

4.8.4.2. Changes to be made to the interface design.

1. Before log-in all buttons needs to be greyed out except for the "exit" and "Lost Password" buttons.
2. Add a search facility to search the customer database for existing customers.
3. A facility must be added to search previous quotes for an existing customer.
4. The presentation of the quote needs to indicate that the quote is indicative, valid for 30 minutes, the time of quote, and time left to expiry.
5. The interface needs to indicate that the help system is indeed contextual to the element in focus.

4.8.4.3. Users impression of the interface design

As the users were well versed in the fixed rate quoting process and terminology they understood what was meant by the following elements; "contractual term", "compounding period", "proposed credit margin", "DG rating", "ROEC", "liquidity premium", "statutory costs", and interacted with ease and understanding.

In terms of the user requirements the interface design was, in view of the users, sufficient to facilitate the task completion. Apart from the above questions the system's interface offers the right features, is easy to reach, use and easy to learn.

The exercise contributed to understand the user's conceptual model of the system. However it did not indicate how the system is learned over time.

5. Conclusion

This research aimed at producing a user-centred mobile interface design for a fixed interest rate calculator that will ultimately be developed and used by the Relationship Executives of a South African bank. Currently the existing system in use is a cumbersome manual process which makes it difficult to respond to customer request fast enough and is prone to human error.

Research has proven that to develop a user-centred interface that will provide "buy-in" from the users, the users need to be involved in the design. This calls for participatory or collaborative design methods. In this research we have made use of CARD/CUTA and PICTIVE participatory design techniques to allow for the capture of the tacit knowledge of the specialist users in the interface design. These techniques were proven to be effective since 1990 and have changed little over the years.

The result was a mock-up of a paper prototype which was extended to an e-prototype by the designer involved in the CARD/CUTA and PICTIVE sessions.

5.1. Research Questions

The studies conducted were aimed to answer the following questions:

Is it possible to make use of user centred design techniques and methods to effectively design a mobile interface that includes all the elements and functionality needed to obtain a fixed rate quote for a customer?

From our evaluation it is clear that the user interface does satisfy the user needs and required functionality. During the sessions the Relationship Executives were willing to share their tacit knowledge with the design group and in view of the openness of the discussions freely engage in participative or co-design of the interface. They took ownership of the process and became the driving force behind the design.

The CARD/CUTA participatory design technique used resulted in a comprehensive task analysis. The CARD/CUTA workshop were informal, fun, and inexpensive to run and encouraged interaction, collaboration, communication, and new ideas. Hocho, (2001) the CARD/CUTA techniques allow the project team to focus on the user and the task flow rather than other, extraneous and possibly distracting aspects of the interface design. In this research

the result was to focus on the tasks that is important in the establishing the design of the interface for the fixed rate calculator. The CARD/CUTA technique delivered a poster board with the cards completely filled in and attached in the appropriate sequence. However the fact that the focus was only on the quoting tasks of the calculator created a dilemma for the participants, who being experts in this field wanted to list all the tasks related to the whole fixed rate contract process. This was rectified by the facilitator keeping the participant's attention on the quoting tasks of the calculator.

The use of the PICTIVE participatory design technique resulted in a low-fidelity paper prototype that eliminated most of the interface design errors and provided a satisfactory usability experience. The PICTIVE design session delivered a good conceptual paper prototype for further development which was mainly due to:

- The participants being experts in the establishment of fixed rate contracts for clients.
- The environment that was created fostered participation of all participants.
- The interface design was focussed on the task at hand and the design was kept as simple as possible.

However a lack of knowledge in mobile design technology of the participants resulted in the facilitator playing a substantial role in what elements would be feasible and what not for the interface design especially in the design of the e-Prototype.

The PD process was short in duration, inexpensive to administer and resulted in a low-fidelity prototype that was compliant with what the users think, feel and anticipate about the tasks to be completed.

Does the evaluation of the Interface Design using Conceptual Model Extraction indicate a design that is in line with the mental model of the users?

The interface design was in-line with the mental models of the users as they completed all the tasks without difficulty and indicate that the low level prototype performs as expected of a fixed rate calculator. They were also of the view that the interface was simple, easy to understand and would be a delight to use.

5.2. Contribution

Our research focussed on the effectiveness of using participatory design techniques for the design of a user centred interface for a fixed rate calculator. The focus was therefore on the design of the user interface and not on system design. During the study is became clear that using participatory design techniques would involve direct user participation, allow for user idea generation, will take limited time and effort to accomplish, and would be inexpensive. Overall, our research provided an insight into the effectiveness in using participatory design techniques like CARD/CUTA and PICTIVE methods to design a user interface. The result does not limit any future work of developing new and more suitable user centred interface design techniques. With the advent of new technologies in mobile design and new design tools being introduced every day, new user centred interface design methods are most likely to follow.

5.3. Future Work

There are number of areas in which our work could be extended, and the following are some of the areas.

5.3.1. Extending the Fixed Rate Calculator

During this study it was suggested that the tasks be expanded to the full process of building an interaction fixed rate calculator to be used in a bank. Further user centred design study could be undertaken to expand this interaction system development to a fully functional product that can be productively used in the banking sector.

5.3.2. New Design Tools

With the explosion in mobile technologies and as mobile banking becomes more popular further research may include design tools and new mobile technologies used in the design of mobile systems e.g. building quick, inexpensive and effective prototypes.

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