The London School of Economics and Political Science

"Social Construction of IS Evaluation: A Case Study of IT Investment Appraisal"

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Declaration

I certify that the thesis I have presented for examination for the MPhil/PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

23rd October 2011

Abstract

This study explores the phenomenon of the social construction of IS investment evaluation in the financial services industry. The extensive literature on information systems (IS) evaluation stretches back more than thirty years and it is widely agreed that IS evaluation is an important and complex issue. Constructivist evaluation, which serves to develop the interpretivist strand of the literature, concentrates on the notion that evaluations are the outcomes of an interaction and argumentation process between various interested parties.

The purpose of this research is to shed further light on the IS investment evaluation area. Explaining the practice of IS evaluation within the dynamic and technologically sophisticated financial services industry would benefit academics and financial services firms alike. This context is relatively neglected in the existing literature.

The chosen case study reflects the demands in the financial services industry to upgrade their infrastructure in order to manage an ever increasing number of transactions, as well as increased regulation. The fieldwork produced extensive data concerning traditional trading, brokerage, high frequency algorithmic trading and transaction clearing. The rapid rise of derivative transactions during the last few years caused problems in terms of clearing and managing the transactions. At the same time, hedge funds' growing demand for low latency execution services and changes in regulations increased, pressuring firms in the industry to invest heavily.

Actor-network theory (ANT) is used in order to describe and explain the formation of networks between human and non-human actors. The theory's specific vocabulary allows IS evaluation to be seen in a new light and the study uses ANT analysis to produce insight into the longstanding problem of IS evaluation, human and non-human interactions and roles within the context if IT investment appraisal. Building on ANT, this thesis is an in-depth case study of the employment process of an IT evaluation method at a global financial services company.

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Chapter 1 - Introduction

1.1 Introduction

Angell and Straub (1999, p. 179) asked "whether computerisation has become the neurosis of our age". By comparing the application of IT methodologies with ritual behaviour within human social institutions, they proposed that the so-called rationality of management science, with its tidy benchmarking, auditing, categorization and performance measurement etc., is actually a pseudo-science. They showed that from the position of Nietzschean epistemology, this rationality is merely a false claim to the instrumental efficacy of data modelling that is indistinguishable from the rain-dancing of primitive tribes.

Twelve years later, from 7th June until 9th June 2011, a High Frequency Trading (HFT) World conference will take place in Amsterdam. The following topics will be discussed according to the organiser Terrapin: Assessing the viability of proposed regulatory change and its effects on HFT practitioners. Identifying the latest development in data feeds, connectivity and co-location. Assessing whether traders can cope with increasing volume and scale in their models. Securing the right minds for your organisation: the rise of celebrity culture. Updating your chip technology to improve execution and monitoring. Understanding how to balance latency, data access and energy costs in your trading models. Can exchanges really keep up and for how long? Are trading venues set-up to cope with large volume spikes? What technologies can trading venues offer beyond data and transactions? Impact of machine-readable news.

According to Nick Garrow, Global Head of Electronic Trading at Newedge Group (in a presentation on 1st March 2011), the financial services industry is witnessing the following challenges:

- Data consistency and transportation
- Lack of consistency in the way exchanges provide real-time drop copy reporting
- Big data normalisation challenge (3000+ traded instruments)
- Architecture design needs to deliver data with lowest possible latency
- Huge quantities of data to be processed and stored (millions of orders per day)
- Implementing low latency pre-trade controls
- No single supplier providing ultra-low latency controls for all asset classes

- Adding pre-trade controls adds latency. Commercial considerations.
- Impact on the clients' set-up
- Regulatory conformance
- Need to deliver different solutions in different regions to ensure local regulatory conformance
- Need consistency in rules moving forward
- Costs Estimate for Newedge is at $4 Million set up costs and $4 Million to $6 Million per year to run
- Take 12 to 14 months to fully implement; initial focus on conformance with SEC July 20111 requirements
- Need to invest in people / skills / training with costs running around $1 Million per year.

On 3rd March 2011, the Futures Industry Association announced:

> "The importance of pre-trade risk controls was one of the main topics discussed at a March 1, 2011 meeting of the CFTC's Technology Advisory Committee (TAC). They discussed a series of recommendations. "Speed and coordination dominated the first two TAC meetings as we explored computerised trade strategies and their role in the events of May 6, 2010," said Scott O'Malia, the CFTC commissioner who chairs the advisory committee. "Today, we are going to take our first shot at tying all of this together in the interest of preparing for the new regulatory world, which is a world dominated by high speed and demands a coordinated approach" (announcement from the Futures Industry Association, 3rd March 2011).

A good example is the way computers are able to read economic news automatically now.

> "Algo news feed provides macroeconomic data to algorithmic computers. The feed was jointly developed by Deutsche Börse, Need to Know News and Market News International to deliver macroeconomic data from the U.S., Canada and Europe immediately upon release. The design enables trading algorithms to react within milliseconds. Low latency direct data feed technology was launched in summer 2010." (Vice President, Market Data and Analytics, Deutsche Börse AG).

The purpose of this research is to shed further light on the Information Technology (IT) investment evaluation area in the financial services industry, more specifically in the electronic trading space. Highlighting how IT evaluation methods have been broadly

employed would benefit financial services firms (FSFs) such as investment banks and brokers across the globe. Certain evaluation methodologies would benefit the industry according to some academics, industry professionals and politicians. This thesis aims to investigate and understand the employment of IT evaluation methods in a selected FSF. Building on actor-network theory (ANT) this thesis is an in-depth case study of the employment of an IT evaluation method at a global financial services company. IS evaluation is important but difficult to perform. FSFs are very sophisticated IT users and depend on IS. It is important to see what FSFs are doing regarding IS evaluation.

In the 1980s the IS evaluation literature tended to be positivistic, although it changed to a more interpretative approach in the 1990s. However, today's practice does not follow this apparent trend witnessed in the literature. This may be due to the nature of IS evaluation being socially constructed. The proposal poses the following research question: "How is IS evaluation socially constructed?" This research, which focuses on evaluation in terms of IT investment appraisal, contributes to the interpretivist stream of IS evaluation research.

In order to conduct an in-depth study, a case study of the social construction of IS evaluation was conducted of a financial services company. The theoretical framework that underpins the study is ANT, which enables the researcher to shed light on the way decisions are made and evaluation practices are used within the financial services industry. It highlights that during a process of 'mutual translation' both the evaluation method and also its surrounding actors enter into a dynamic negotiation mutually translating each other. These actors capitalise on weaknesses in the method's inscriptions and try to leverage those weaknesses. The surrounding actors may continue with their ordinary day-to-day activities.

The financial services industry is in a period of rapid change brought about by information technology and deregulation. The most important trend in the financial markets today is the growth of electronic trading. According to Valdez (2000, p. 354) "by mid-1999, various sources were estimating the number of Internet users worldwide at 150 million". In 2011, 28.7%, or in other words more than 1.9 billion people, use the internet (Internet World Statistic, 2011). At the same time, the use of electronic trading is growing rapidly and providing new distributions channels and shifting the balance of power to the consumers according to Valdez (2000).

Valdez continues:

> "For the user, the effect will be a cheaper and more efficient service. For the supplier, it will bring exposure to new competition and redundancy to large ranks of sales staff, brokers and administrative personnel generally. The effects will be felt in all our financial markets-banking, bonds, equities, foreign exchange, derivatives and insurance. There is a dramatic effect on back office and front office costs" (Valdez, 2000, p. 354).

Evaluation methodologies are used in various ways by the industry. The main case study, of a company called Refco, shows that financial services organisations can collapse if a sound evaluation methodology is not implemented. The role of the IT investment evaluator needs to be seen within a specific context. Problems like wrong position account bookings appeared in Refco's clearing department regularly. These problems highlight that finding solutions is important. However, a certain minimum investment is required to obtain higher quality operation and clearing infrastructure. IT investment is crucial for any financial services company; especially for companies focusing on derivative brokerage, derivatives trading and related areas. Financial services firms affect many of us directly or indirectly. Therefore, conducting a study is highly worthwhile.

Without effective IT evaluation, firms can face systemic risks and can cause risks to the entire financial services industry. National economies depend on these FSFs. Many investment banks such as Barclays, JP Morgan, Goldman Sachs, UBS and Deutsche Bank have a handful of main core business areas and IT investment varies from department to department. Departments with a lot of constant flow business have to rely on IS.

The main business area of Refco was trading and brokerage of derivatives. Traditional investment banks however have various other business areas such as underlying cash trading of bonds and shares, mergers and acquisitions (M&A) with the aim to generate more income. The third and fourth main income stream for traditional investment banks is generated by consumer credit business and mortgages to retail clients and institutional clients. Some FSFs have no retail clients in order to keep the number of employees and infrastructure costs low. They offer e.g. credit derivatives to certain intermediaries such as Fannie Mae, Freddie Mac, or to any mortgage and credit broker.

Most investment banks are also engaged in proprietary trading and in research. Proprietary trading means buying or selling on behalf of your own company, using the company's own money rather than client money. The profit and loss based on proprietary trading can be very volatile. We have witnessed multi-billion dollar profits and also huge losses in 2008 and 2009, although, this is not a new phenomenon.

A few people working for traditional investment banks are empowered to buy or sell certain products such as derivatives with the aim to reverse the original trade into a profit. Depending on size, liquidity and duration, certain risky short term or long term investments can be disastrous for the investment banks. In case a large loss occurs, the handful of decision makers will be replaced. Refco's business was based on buying and selling derivatives on behalf of investment banks and other direct clients with the need to be hooked up with most exchanges. It earned a pre-defined fee based on the number of transactions on behalf of the investment banks' proprietary trading orders. Its main business was to execute and process orders from clients such as banks and institutional clients.

1.2 Current Trends in Financial Markets

As mentioned, proprietary trading is one of the main income streams for many investment banks and brokerage firms. Those proprietary trading details are little known and the proprietary trading pattern is not evaluated by external or independent evaluators either. Occasionally, the public finds out about these proprietary trading patterns if something goes wrong, such as a massive loss or a fine imposed by one of the local regulators. An example of proprietary trading is 'basis trading'. According to the theory, proprietary trading houses engage in trading if either the future price's theoretical price is too high or too low compared to the underlying product or composite index. FSFs benefit from conducting a buy or sell order. During the last five years, those buy and sell orders have been more and more automated. In order to be able to engage in automated proprietary business, a lot of IT investment is required. An IT platform and infrastructure need to be established across the organisation. Often, these departments are called 'high-frequency' trading desks. Investment banks using 'high frequency' trading treat this as a synonym for IT driven trading or 'black-box' trading activities. Banks and brokers with established IT driven execution desks are able to execute high frequency orders such as 'basis trades' regularly. A basis trade is an arbitrage between the underlying product or index and the related

derivative, the correspondent future. Details and examples of basis trading, black-box trading and algo-trading are presented in Chapter Six.

An algorithm is a process for reaching a goal, structured in a sequence of accurate steps. In an IT setting, this process is a computer program. Chaboud et al. (2009,) define algorithmic trading, which correlates with HFT as:

> "In algorithmic trading (AT), computers directly interface with trading platforms, placing orders without immediate human intervention. The computers observe market data and possibly other information at very high frequency, and, based on a built-in algorithm, send back trading instructions, often within milliseconds. A variety of algorithms are used: for example, some look for arbitrage opportunities, including small discrepancies in the exchange rates between three currencies; some seek optimal execution of large orders at the minimum cost; and some seek to implement longer-term trading strategies in search of profits. Among the most recent developments in algorithmic trading, some algorithms now automatically read and interpret economic data releases, generating trading orders before economists have begun to read the first line" (Chaboud et al., 2009, p. 1).

Depending on the sources, it seems that up to 40% of global exchange-traded derivatives are conducted by machines. A Deutsche Bank press release from the end of 2010 highlights how much trading is driven by computers and the emerging new role of IT globally. According to press news from 12 August 2010, Deutsche Bank AG was disciplined by Osaka Securities Exchange (OSE) for accidentally selling orders worth Yen 16.7 trillion in June due to an algorithm trading error (OSE press release August 2010). The error resulted in placing sell orders of Nikkei 225 futures contracts worth $182 billion. The fault was quickly detected and only 0.3% of the orders were processed by the back-office. Deutsche Bank later acknowledged that the faulty trades were the result of a change in an automated proprietary trading system that had been specially designed and implemented for its Asian Quantitative Trading (AQT) unit.

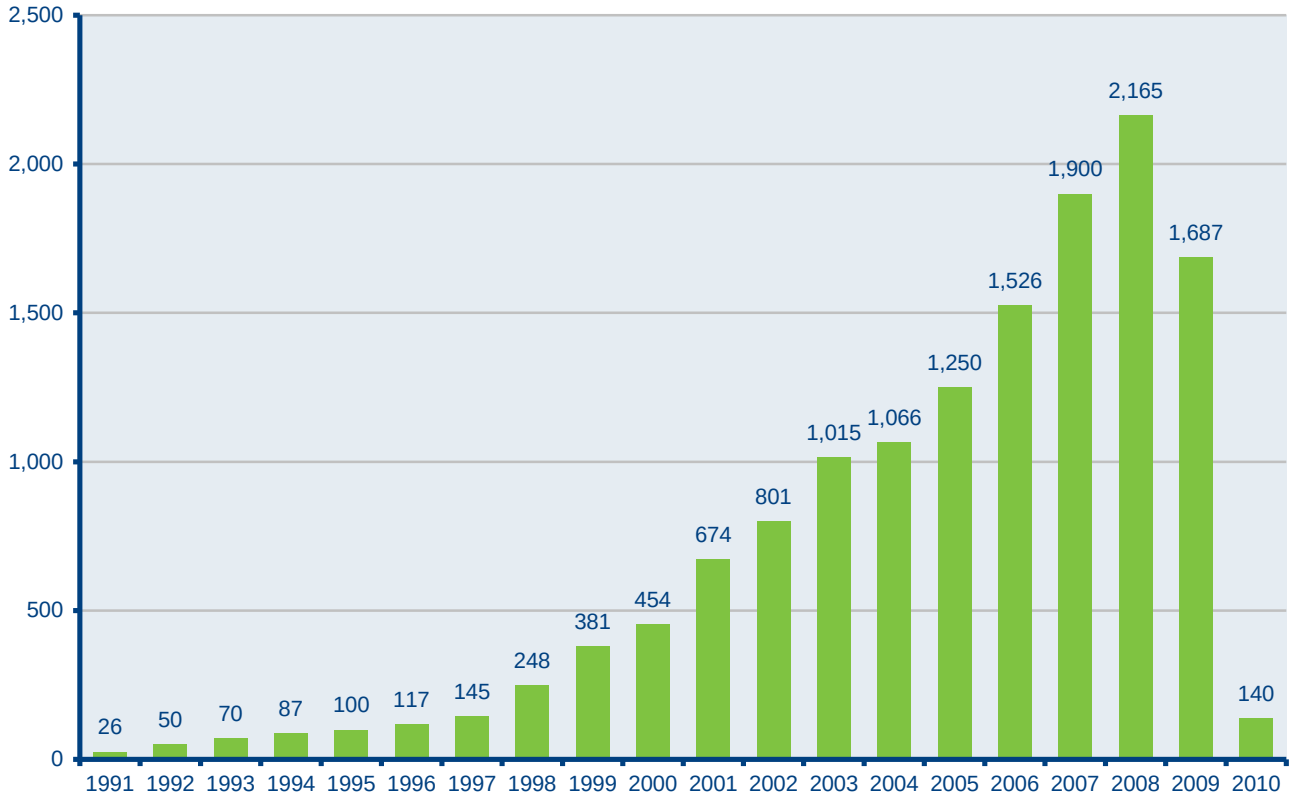
Having changed this system previously, separate data files used to obtain prices could now be integrated into one data file that combined product and market information throughout Asia, according to Deutsche Bank. For the first time, the system was operated using the new integrated data file in the evening trading session of 31st May 2010. On the following day, the system triggered excessive orders because it was not able to obtain a required

benchmark price. As a result, the Nikkei 225 futures index was calculated as zero and the system continuously sent selling orders. As soon as Deutsche Bank became aware of the problem and decided to cancel the orders, the AQT system was suspended and the bank discontinued this specific business in this region afterwards. The bank has been given an admonition by OSE for lack of sufficient control of the electronic information processing system. Deutsche Bank gave a statement saying it 'takes the matter seriously and continues to implement measures to further strengthen its system-related processes and governance and to prevent such an incident from reoccurring'.

Continuous advances in Information and Communication Technologies (ICTs) have transformed the nature of many operations in the financial markets. ICTs have facilitated the emergence of electronic trading allowing the automated routing of orders directly to the exchange via a network infrastructure. Gallaugher and Melville (2004) believe this sector has been changed more than most other sectors. Exchanges offer participants Direct Market Access (DMA) as the client is able to conduct his trades with no physical intermediary for execution but rather clearing from the broker. According to Schmerken (2007), in 2008, 85% of all matched orders in the U.S.A. were routed via DMA. Brown (2010) highlights that orders executed via DMA were just 1% ten years ago. Kim (2007) refers to High-Frequency Algorithmic Trading (HFAT) where orders are matched through an algorithm program. The program triggers buy or sell orders for a specific product when certain predefined conditions are met. Profits can only be made when the current opportunity is used and arbitrage trades take place.

Low latency in data updates is crucial for any arbitrage opportunity. Latency within a given network refers to any delay incurred in information transmission. HFAT systems need to perform faster and faster and the industry is recognizing the limits of technology. In terms of infrastructure network latency, speed of transmission, information processing time and speed of clearing dictates the efficiency of the trading algorithm. According to Clark (2008), reducing latency by six milliseconds drives the cost up by an additional $1.5 million. Exchange members aiming to retain a competitive advantage in the field set up their data centre very close to the exchanges. Being physically next door to the exchange or even within the same building keeps latency low. Some exchanges such as Deutsche Börse offer members the service of hosting their infrastructure within the same building, known as co-location. More and more financial services firms have no other choice than investing in such low-latency trading infrastructure. FSF's customers had to change their operation

and infrastructure in order to cope with the new reality. The table below shows the rise of volume generated on the electronic trading system Eurex during the last few years (source: Eurex Deutschland GmbH).



Algorithm trading platforms in the industry

The following summary shows how much the industry has moved on since the 1990s. Deutsche Bank's algorithmic trading platform is called 'Autobahn Equity' and combines the bank's algorithms with its DMA offering to more than 500 clients. Other banks have the following algorithm trading platforms:

- Barclays Capital: BARX provides access to more than 60 equity trading venues through various Execution Management System (EMS) and Order Management System (OMS) platforms. Core algorithm: Iceberg, Volume Weighted Average Price (VWAP), Time Weighted Average Price (TWAP). Number of Algorithm clients: not disclosed. Launch date: 2001.
- BNP Paribas: Global Execution Services (GES) with focus on equities and derivatives. Core algorithm: Paris, VWAP, TWAP. Number of Algorithm clients: not disclosed. Launch date: 2003

- Bank of New York (BNY): BNY ConvergEx focuses on liquidity and execution management. It offers interfaces to more than 50 markets. Core algorithm: Closing Price, Per cent of volume, VWAP, TWAP. Number of Algorithm clients: not disclosed. Launch date: 2006
- Credit Agricole Chevreux (CA): CA Cheuvreux offers access to more than 60 markets. Core algorithm: Closing Price, Per cent of volume, VWAP, TWAP. Number of Algorithm clients: 200. Launch date: 2001.
- Citigroup: offers access to more than 50 markets via algorithm. Core algorithm: Market on Open, Market on Close, VWAP, TWAP. Number of Algorithm clients: not disclosed. Launch date: 2000.
- Goldman Sachs (GS): GS electronic trading offers all asset classes. Core algorithm: VWAP, TWAP, per cent of volume. Number of Algorithm clients: more than 2000. Launch date: 2002.
- HSBC: Access to 35 markets. Core algorithm: synthetic close, Per cent of volume, VWAP, TWAP. Number of Algorithm clients: 500. Launch date: 2006.
- Nomura – Instinet: covers all markets via Cobra. Cobra is a liquidity seeking algorithm designed to maximise shares traded. Core algorithm: Pairs, VWAP, TWAP. Number of Algorithm clients: 1500. Launch date: 2008.
- JP Morgan: J.P. Morgan's algorithmic trading. Core algorithm: Iceberg, VWAP, TWAP, per cent of volume, close. Number of Algorithm clients: not disclosed. Launch date: not disclosed.
- Merrill Lynch / Bank of America: Core algorithm: Market on close, market on open, percentage of volume, VWAP, TWAP. Number of Algorithm clients: not disclosed. Launch date: not disclosed.
- Morgan Stanley: Morgan Stanley Electronic Trading (MSET): Core algorithm: arrival price, VWAP, TWAP. Number of Algorithm clients: not disclosed. Launch date: 2009.
- UBS: UBS Direct Execution offers algorithmic trading. Core algorithm: VWAP, TWAP, at open, at close. Number of Algorithm clients: not disclosed. Launch date: not disclosed.

Advances in technology continue to transform how our financial markets operate (Hasan and Hunter, 2003). As we have seen in the Deutsche Bank Japan example above, the volume of financial products traded through computer automated trading taking place at

high speed and with little human interaction has increased. Almost a quarter of European equity trading volume is generated through high-frequency automated computer trading.

The Department for Business Innovation & Skills (BIS) announced in January 2011 a so-called Foresight project, sponsored by Her Majesty's Treasury. It is led by the Government Office for Science under the direction of the Government's Chief Scientific Adviser, Professor Sir John Beddington. It will explore how computer generated trading in financial markets might evolve in the next ten years or more, and how this will affect:

- Financial stability,
- Integrity of financial markets including price information and liquidity,
- Competition,
- Market efficiency for allocating capital,
- Transaction costs on access to finance and
- Future role and location of capital markets.

On the BIS website they announce the following:

> "It will also assess options for addressing the key challenges ahead, and consider how the opportunities offered by advancements in computer technologies could be capitalised upon by the financial sector. … The aim of this project is to make a significant contribution to the efficiency, integrity and resilience of financial markets, by identifying options for policy makers in the UK and internationally." (Announcement of the Department of Business Innovation & Skills, January 2011).

It is most interesting reading Angell and Straub (1999) where they stated:

> "For these crazy algorithmic (so-called) solutions delivered by 'the science of management', most often aided and abetted by the wizardry of information technology, have themselves become a problem! Underlying so much of the general sickness is a mechanistic drive for categorisation and standardisation and by implication comparison, measurement and method, in the mistaken belief that they deliver the utility of valuable 'knowledge'" (Angell and Straub, 1999, p.1).

1.3 Need for Research into IT Investment

This research attempts to develop an understanding of the employment of information technology (IT) investment and the evaluation methods used in organisations. Many researchers have developed methods and concepts in order to help organisations to understand and also to manage IT costs. Researchers provide various investment evaluation methods and approaches for use by industry. The aim is to understand and make the benefit of IT investment visible. My aim is to understand the benefit of IT investment and various evaluation methodologies. It is striking that many organisations are still not able to understand potential intangible benefits of IT investments. The thesis analyses an organisation's use of an IT investment evaluation methodology based on quantitative data rather than qualitative evaluation methodologies. However, an information system is not restricted to the physical artefacts or the use of IT in organisations.

The financial services industry has been transformed also by more regulation and banking regulation that "[…] does not come cheap. Tougher capital rules for dealers, higher clearing fees and closer business conduct rules will all generate increased business costs" (Belchambers, 2010, p. 16). This is reflected in the case study. The recent collapse of various investment banks and FSFs highlights the need for sound evaluation methodologies. The industry is using mainly quantitative evaluation methodologies based on return on investment (ROI) (Butler Group, 2004, p. 113). Qualitative methodologies are generally not used for IT and other investment evaluation approaches.

However, research in this area is rare, partly because the underlying business is complex and secretive. Most FSFs do not want to reveal their business practices. A good example is the Credit Default Swaps (CDS) market. This multi-trillion market almost collapsed in terms of market activity and market liquidity. Unfortunately, we all are directly or indirectly influenced by the development of the CDS market, since mortgages and other debt markets are dependent on those markets.

Industry people are very concerned about their jobs and related bonuses and many do not want any change, even if those potential changes such as migration to electronic exchanges may mean more transparency or better evaluation methodologies. One reason why investment banks and FSFs do not welcome change is the high margin earned for certain products they trade over the counter (OTC). The share of the over the counter derivatives

industry is around 83% of the total global derivatives market and much bigger compared to the standardised and regulated financial futures and options industry (White Paper: The Global Derivatives Market, An Introduction, April 2008, Deutsche Börse AG, p. 7). The author's argument is that the financial services industry can benefit from additional academic research that could benefit firms' organisational learning.

Standard regulated exchange traded derivatives can be evaluated constantly and a 'mark-to-market' price is available whenever a risk manager or an investor needs it. Mark to market is a daily industry evaluation of a current long or short position. On a daily basis, positions need to be valued based on the previous closing price. Traditional OTC traded derivatives are evaluated on a less regular basis because they are less liquid and not centrally monitored. If the traded products are not evaluated regularly or if they are not easily evaluated, why should IT related investment - one step ahead of the value chain - be evaluated and who is interested to evaluate the IT investment? The point here is that, without an alternative evaluation methodology, the existing quantitative methodologies such as ROI will still be used in future.

Competing IT evaluation methodologies will not be considered by the financial services industry unless regulators such as the Security and Exchange Commission (SEC), Bundesanstalt fuer Finanzdienstleitungsaufsicht (BaFin), or Financial Services Authority (FSA) force the pace. The industry, which depends on IT for its daily operations, was on the verge of collapse and yet many evaluation tools have not been used. For example, the balanced scorecard perspective of Kaplan and Norton (1996) recommends evaluation from four perspectives: financial, customer, business process and learning and growth perspectives.

The literature review in Chapter Two demonstrates the importance of evaluation and argues for a research focus on IT investment appraisal, as this is carried out much more often in practice than post-implementation evaluation. Chapter Two briefly surveys the positivistic literature of the 1970s and 1980s, which still forms the basis of much of today's practice, as well as the interpretive approaches of the 1990s. The latter approaches highlight the political, social and organisational aspects of evaluations in practice. The literature on IS evaluation stretches back many years (e.g. Land, 1976). IS evaluation is an important and complex issue (Farbey et al., 1993; Land, 1999; Hirschheim and Smithson, 1988; Willcocks, 1994; Willcocks and Lester, 1999; Smithson and Tsiavos, 2004).

Evaluation of IT investment recognises that the use of information systems has become part of every manager's job. This thesis tries to understand IT investment evaluation in information systems that support management decision making at the operational, tactical and strategic planning levels. It is also necessary to understand the application of these information systems in various organisational departments. The development of information systems within organisations has been characterised by a process of evolution where we need to look beyond technology (Angell and Straub, 1999).

One of the tasks firms like Refco need to perform is the role of resource allocation. Resource allocation determines who will have which role and who will get which role in a specific context. He or she has to decide how much money to spend for various things like advertising, attending conferences, training needs and number of employees. For the understanding of this thesis and the understanding of the findings mentioned in the analysis in Chapter Six, it is noteworthy to highlight involved actors who play a crucial role in this topic. Many organisations understand that IT investment is embedded in a project. By definition, a project is temporary in nature. Projects have a specific start and a specific end. In an ideal world, the project consists of a well-defined collection of smaller tasks and is company specific. Projects are different from one to another. Mostly, the environment and people involved in larger projects will change in due course. Employee fluctuation is one of the reasons for lack of available historic background information.

Opportunities and needs arise in any organisation. A new opportunity such as penetrating a new market or employing automated proprietary trading systems are examples to which the management must address and implement specific project processes. Implementation of processes and working towards solutions entails a change for the organisation (Kawalek et al., 2005). Projects are generally established to carry out changes. Someone is responsible for the successful completion of the project. The evaluator is often the project manager or a *'change agent'*. In this context, implementing change is seen as a project management process (McManus and Wood-Harper, 2003). The process can be seen as temporary and undertaken to achieve a particular aim. Project management is the discipline of planning, organising, and managing resources to bring about the successful completion of specific project goals and objectives, according to Wikipedia.

Investment banks and brokerage companies decided to increase electronic exchange traded volumes dramatically with the support of automated processes such as algorithmic trading.

They implemented specific 'automated trading processes.' For example, a very large U.S. investment bank employed a managing director for fixed income automated trading desk in October 2010 in order to build the necessary infrastructure. A financial benefit occurs if the project is launched and managed properly. A project is a unique, one-time undertaking and will not be done again exactly as before. The reader of this thesis should be aware that project managers or *'change agents'* often have no historical data related to previous similar projects in the firm. The new managing director mentioned she had no historical data or information within the firm. Initially, the change agent has to start the project with limited information and the desired outcomes may consume additional time, money, workforce and materials.

An example of a project is arbitrage trading between liquid products via automated trading systems. This project management can be defined as the application of skills, knowledge, tools and techniques to project activities. The project should have identifiable phases, namely initiation, planning, execution and closure (Kerzner, 2009; Fuller, Valacich and George, 2008). The project manager has to manage each of the four phases. The initiation phase reflects the need for potential upcoming action. Potential actions need to be justified. In the planning phase, the project solution is further developed. Also, interim deliverables are identified, the amounts of money spent are estimated and a formal approval to go ahead with the project is required. During the third phase it is necessary to monitor the development. During this execution phase, intervention should take place in case it is necessary. The fourth phase should reflect expected changes. In order to help the evaluator or project manager, it is suggested to follow a 'to do list', which comprises a six step process:

- Define the opportunity or problem
- Suggest a project plan
- Identify task and resource requirements
- Estimate resource allocation and a related control plan
- Define potential risk and involve stakeholder
- Communicate internally and keep stakeholders updated regularly.

The process of IT evaluation employment needs to be analysed in order to understand how organisations employ IT evaluation method(s). Also, the characteristics of IT evaluation methods are a topic that is often analysed. How to incorporate such a method in an organisation is a challenging task (Fuller, Valacich and George, 2008).

The Oxford Dictionary defines evaluation as 'the activity of finding out or forming an idea of the amount or value of something or somebody'.

> "We all evaluate, that is assess, against implicit or explicit criteria, the value or worth of individuals, objects, situations and outcomes, informally and often unconsciously every day of our lives" (Legge, 1984, p. 3).

According to Smithson and Tsiavos (2004) IT investment evaluation needs to be researched further. One of the main problems is to quantify the outcome of IT investment over a period of time. Evaluation is subjective and dependent on individual value judgements and contributes to the ambiguity surrounding IT evaluation. To address these IT evaluation problems, numerous methods and techniques have been developed in the past to aid organisations in managing IT costs benefits.

Most of the research in the area of IS evaluation claims that it is complicated and an elusive concept. Therefore it is difficult to approach both conceptually and operationally. As mentioned, the majority of evaluations are performed using capital investment appraisal techniques. Those organisations being aware of shortcomings in the evaluation of IT continue avoiding the topic. Within the industry, not many people seem to have an interest in sound, systemic and sustainable IT evaluation technique or approach. Also, the term evaluation creates a problem itself, which shows that evaluation is difficult not only in the IS field but also in other disciplines such as social research. Ballantine et. al. (1994) confirmed that organisations use simplistic financial techniques for IT evaluation in

principle and they did not believe that this approach and behaviour would change in the near future.

One of the aims of the research is to understand how the employment of IT evaluation methods occurs. Another aim is to highlight that we need to develop IT evaluation methods and we also need to employ them. If we are not able to employ them, we will not be able to make a change within the evaluation field. Evaluation is a very subjective activity, difficult and influenced by culture, human, social organisation and history. In conceptual terms evaluation is never context free or value free. Serafeimidis (1998) highlighted in his PhD:

> "[…] the impact of IS can be seen as the interactions of their technical and social components. Consequently, when an IS is evaluated, multiple dimensions are expected to be exposed. These include technical, economic, managerial, social and behavioural aspects. Each dimension is different and has its own underlying theories, measures and inherits its own assumptions" (Serafeimidis, 1998, p. 18).

It is very difficult to extract or isolate the potential influence from other internal day-to-day activities. Other departments may not be able to get access to the new IT system. Serafeimidis (1998) continued:

> "[…] the dilemma for decision makers is not whether to invest or not in IT but it is more about the selection of the most appropriate investment, the effective use of resources, its integration with other investments, the maximisation of the rewards achieved […]" (Serafeimidis, 1998, p. 19).

Based on an extensive study of the literature, the author argues that the IS evaluation process is necessarily subjective and is strongly influenced by prevailing norms and beliefs within the organisation and, in particular, within the management hierarchy. Hence, the main research question is:

> ***"How is IS evaluation socially constructed?"***

This question can be broken down into a number of sub-questions:

- How is the appraisal process constructed in the context of high frequency and algorithmic trading?
- How is the appraisal process being transformed due to recent significant changes in electronic trading?
- How are the various actors enrolled into the project?
- How are the key roles in an IT investment appraisal enacted?

- How do actors understand the appraisal of IT investment?
- How much is the appraisal of IT investment dictated by changing regulation(s)?

It should be noted that the terms IS and IT are used synonymously in this thesis.

1.4 Case Study Background

Since the 1990s, we have witnessed significant transformations in economic, political, social and cultural issues. There is a continuous debate on the globalization of contemporary societies (Giddens, 1990). The term globalization has been widely used to discuss a large range of ideas related to global interconnections and interdependences, across time and space from the flow of information, production of goods, services and use of capital and people (Hayes and Walsham, 2000). Nowadays, we take the term for granted and the topic is not debated as it used to be anymore.

The idea of the information society derived from Daniel Bell's (1973) concept of post-industrial society. Bell (1973, pp. 13 ff) claimed that industrial societies have developed towards societies of services. Beniger (1986, pp. 6-13, pp. 21-25) argued that the information society emerges from the control revolution. According to him, various technologies, structures and processes have been developed to allow control of the increasing level of information flow. Controlling information flow is one of the new main objectives of investment banks and brokerage companies. Notions such as proximity and co-location are used frequently by investment banks and trading arcades. Specific IT related terms are used and employed by sales persons, managers, compliance and traders regularly. Investment banks have built and are building complex infrastructures in order to be able to process and execute large numbers of orders in milli- and nanoseconds. The landscape is changing and the way flow business is handled and processed between the end client, the FSFs and the exchanges is being transformed radically. Numerous firms need to invest in the infrastructure constantly.

On that point, exchanges provide customers connections to integrated electronic derivatives trading and clearing platform(s). Regulated exchanges offer connection alternatives to the market via dedicated lines and also via the internet. Exchanges establish 'technology roadmaps' well in advance, which is the exchange's strategic plan for evaluating and implementing software and hardware enhancements. Those exchanges also introduce

optional market data and high-frequency trading interfaces, enhanced broadcast solutions and enhanced transaction solutions. They have designed interfaces that provide high-performance, low latency access to market data, order management as well as risk and position information. An enhanced broadcast solution provides access to un-netted market data in real-time and with comprehensive market depth. Enhanced confirmation solutions allow an exchange member to receive recoverable order and matching event information.

According to Eurex, more than 60% of all options orders and quotes and more than 80% of all futures orders entered were using enhanced transaction solutions by the end of 2010. An enhanced transaction solution is a two-way socket interface used by a member to send orders and quotes to the exchange and receive confirmations. Terms such as low latency and open interface are day-to-day terms used in the community.

It should be noted that the main case study firm, Refco, had a certain notoriety and not for the sophistication of its IT infrastructure. The firm's history is described in Chapter Five but it grew spectacularly during the late 1990s and early 2000s with the boom in the number of transactions, such that it became the largest broker on the Chicago Mercantile Exchange. However, in October 2005, two months after its successful IPO, it was announced that the CEO (who also served as chairman) had 'hidden' $430m in bad debts. The share price dropped from $28 to 80c overnight and the company was bankrupted. In 2008, the CEO pleaded guilty to securities fraud and other charges and was sentenced to 16 years imprisonment.

This thesis does not examine the criminal aspects of Refco, which refer to financing and are beyond the scope of the thesis. The focus here is mostly on operational issues. Refco is treated as a very successful financial services company that was enjoying a huge growth in business and this is how it was viewed by the market before the scandal. As described in Chapter Five, although Refco itself failed, its constituent operations continue to this day, albeit under new management and ownership.

1.5 Structure of the Thesis

This thesis is organised into seven chapters. In this first chapter a brief overview of the need and justification for this research is provided, in order to establish the background for the research question(s).

Chapter Two presents an overview of the literature on IS investment evaluation. It also provides a review of the development of IS investment evaluation. It introduces the research domain and examines the past and current research literature on evaluation of IT investment. During the brief discussion of the existing research, it is argued that one of the key problems is that most studies have restricted their focus to issues related to the evaluation of IS investment effectiveness. Contextual issues are involved and should have been taken into account as well. This neglect of context dealt with throughout the work of this thesis.

Chapter Three discusses the conceptual framework I have chosen for this thesis. It is argued that an investment appraisal, like other evaluations, is socially constructed. It is not a mechanical application of accounting but is rather a social process based on human perceptions and interaction. It involves the interpretation of evaluation methods and accounting conventions. The use of actor-network theory (ANT) and the use of the moments of translation are discussed. In particular, the enrolments and activities of the principal actors are discussed.

Chapter Four covers the research approach, method and design for this study. It describes and justifies the approach, which is interpretive, and the method, which is a case study with elements of action research. It also recounts how the research was conducted and some of the difficulties encountered.

Chapter Five presents the findings of the case study of the selected financial services firm (Refco) in depth, using the empirical data collected from 2004 onwards. It shows the organisational context of the case and a description and the background of the case. The main part of this chapter describes the events regarding the employment of IT evaluation method(s) at Refco as well as describing some of the key regulatory changes since Refco imploded.

The findings are analysed in detail in Chapter Six using ANT in order to present the case in terms of an actor network involving both human and non-human actors. The chapter emphasises the inability of Refco's (actor) network to respond effectively to the changes in the market; in particular, the failings related to its evaluation of IT in the shape of failure of the link between Refco's management and its IT infrastructure.

The final chapter, Chapter Seven, concludes the thesis and reflects on the long journey of this research. Previous research has not reflected the transformations triggered from the emergence of HFT in the financial services industry. HFT including processes in operations draws attention to the theoretical and practical contributions of this thesis. In addition to identifying these contributions, the researcher also highlights the limitations of the research, followed by suggestions for further research.

Chapter 2 - Literature Review

2.1 Introduction

This chapter provides a general overview of the literature relevant to this thesis; its purpose is to shed further light on the core concepts relevant to information systems (IS) evaluation. In the 1980s the IS evaluation literature tended to be positivistic, which changed to a more interpretative approach in the 1990s. However, the practice did not follow the literature. It is suggested that this may be due to the nature of IS evaluation as a social construction. Based on this assumption, this chapter poses the research question: "How is IS investment evaluation socially constructed?" This research, which focuses on evaluation in terms of IT investment appraisal, contributes to the interpretivist stream of IS evaluation research. This chapter also identifies some of the gaps in the current literature.

The literature on IS evaluation stretches back more than thirty years (Land, 1976). While most authors differ on the solution to the problem, they mostly agree that IS evaluation is an important and complex issue (Farbey et al., 1993; Land, 1999; Hirschheim and Smithson, 1988; Willcocks, 1994; Willcocks and Lester, 1999).

The scholarly reflection on evaluation research has resulted in an enormous growth of categorization (Stufflebeam, 2001). A distinction is often made between formative (ex-ante) and summative (ex-post) evaluations (Scriven, 1991). Another distinction is made according to the person who evaluates (Shulha and Cousins, 1997). Constructivist evaluation concentrates on the notion that objectives are the outcomes of an interaction and argumentation process between various interested parties (Fischer and Forester, 1993; van der Knaap, 2004). A number of trends can be perceived in the development of evaluation research. Van der Knaap (2004) believes that there are some common basic elements in the mainstream of traditional evaluation research.

Hansen (2005) identifies the following categories of evaluation models in the literature:

- Results models
- Process models
- System models
- Economic models

- Actor models
- Programme theory models.

He argues:

> "Design should be determined by the purpose of the evaluation, the object of evaluation or the problem to be solved by the evaluated programme or agency. The recommendations are based on different rationales: goals-means, context-based values and programme theory. Furthermore, in practice other logics may influence the evaluation design processes. Four hypotheses concerning such logics are proposed: negotiation, appropriateness, 'routine' and projection of competence." (Hansen, 2005, p. 447).

This literature review demonstrates the importance of evaluation and argues for a research focus on IT investment appraisal, as this is carried out much more often in practice than post-implementation evaluation. It briefly surveys the positivistic literature of the 1970s and 1980s, which still forms the basis of much of today's practice. The more interpretivist approaches of the 1990s are reviewed as well. They provide evidence of the political, social and organisational aspects of evaluations in practice.

The evaluation literature covers a variety of alternative approaches to evaluation. During the last years

> "[…] the evaluator's toolbox has continuously expanded. The options are multiple, such as opting for summative or formative evaluation or stressing the clients', experts' or general stakeholders' concerns. But the choice is also between subscribing to realistic evaluation, theory-based evaluation, utilization-focused evaluation or empowerment evaluation, just to mention a few examples." (Hansen, 2005, p. 447).

Some authors claim their particular evaluation model to be the best but there is a need to study alternative approaches to evaluation comparatively and maybe to develop "meta-models" in order to enable us to reflect upon designing evaluations. The wide variety of alternative approaches in the evaluator's toolbox raises the important question of what criteria should be used to compare one approach with another or perhaps decide to combine several approaches.

In the conceptual framework (Chapter Three) I argue that an investment appraisal, like other evaluations, is socially constructed. It is not a mechanical application of iron rules of accounting but is rather a social process based on human perceptions and interaction, which involves the interpretation of evaluation methods and accounting conventions. There I propose the use of actor-network theory (ANT) to 'model' the enrolments and activities of the principal actors.

Saunders (2000, p. 7) has conducted research into evaluation and on the tacit practices used in an evaluation agency to develop an approach to initiating new evaluators into evaluation planning processes. Using these two sources as a base, he suggests that it is possible to conceptualise evaluation as a series of knowledge-based practices. These knowledge-based practices form the resources of 'communities of practice', i.e. a group of practising evaluators. In that, this conceptualisation refers to any job, work or occupation, beginning to be an evaluator, just like beginning any job or work, requires the 'novice' to be inducted or socialised into the 'community of practice'. He believes that understanding evaluation activity in this way should provide the basis for some enabling 'tools' for thinking about an evaluation design. The learning as an outcome of 'process use' is, in fact, the way we might prompt access to a reservoir of experiential and other knowledge in order for evaluations to be carried out by evaluators, within the normative frame of a group of evaluators. It involves a process of reflexive questioning during which key procedural dimensions of an evaluation are addressed, leading to an accelerated induction into key aspects of evaluation design. His article is derived from a framework used in CSET (Centre for the Study of Education and Training) to undertake commissioned evaluations and research and development work with the British Council (BC) which aims to chart evaluation practices undertaken by members of staff and to develop evaluation capability. The two sources combine to prompt an examination of evaluation as a collection of 'communities of practice' based on knowledge resources, into which new evaluators might be inducted. It is highlighted that evaluators are understood as working in forms of community.

This idea has been introduced mainly by Lave and Wenger (1991) who coined the term "communities of practice". It is a variant on the notion that any social group forms recurrent behaviours, which are governed by certain norms and values into which a new 'recruit' or 'entrant' would need to be socialised. Wenger (1998) has captured the essence of this process succinctly:

> "Over time, this collective learning results in practices that reflect both the pursuit of our enterprises and the attendant social relations. These practices are thus the property of a kind of community created over time by the sustained pursuit of shared enterprise. It makes sense, therefore, to call these kinds of communities, communities of practice" (Wenger, 1998, p. 45).

Critical to the discussion in Wenger's work, as in the argument of Saunders (2000), is the notion of practice. Her book explores the dimensions of practice in terms of 'meaning production', the ways communities work, the way practice is bound into the process of learning and knowing. She identifies what practices do but does not construct a definition of a 'practice' as such. Saunders (2000) draws on the concept of a 'practice' from the work of Giddens (1976, 1979, 1986), which refers to behaviour which is recurrent or routine, i.e. happens on a day-to-day basis and is embedded in the normal routine of daily life. Therefore a 'practice' is a way of doing something, the pattern of which is reproduced in a social context (i.e. work) according to certain rules. The idea of 'routinization' is important for us because it refers to the habitual, taken for granted character of the vast bulk of the activities of day-to-day working life. Giddens uses the notion of 'ontological security' to refer to the impulse we have to create and sustain 'routines' through practices in order for us to feel safe and secure in our day-to-day actions. We can then predict with a degree of certainty what is likely to happen as a result of a particular event or act.

Saunders (2000) argues for:

> "[the] need to make explicit group 'ways of doing something', or the 'experiential' knowledge held by a group or an individual in the work place. Often this knowledge is somehow locked in practice and wholly implicit, with its contribution to collective learning thus muted or constrained. A worthwhile goal therefore is to enable such implicit knowledge to become accessible, enter the public domain and initiate a 'learning spiral' through some kind of learning process. From an evaluation point of view there are two other distinctions which seemed immediately relevant to our discussion. Giddens distinguishes between two types of consciousness which have bearing on the process we have described above. He gives the designation 'discursive' to the consciousness of the conditions and meaning of a person's own actions in the work place to which they are able to give verbal expression. However Giddens also identifies what he calls 'practical consciousness', which is what someone might know about their work practices,

including the conditions of their own action, but cannot express 'discursively'" (Saunders, 2000, p.10).

Giddens (1979) argues:

> "Where what agents know about what they do is restricted to what they can say about it, in whatever discursive style, a very wide area of knowledgeability is simply occluded from view. The study of practical consciousness must be incorporated into research work" (Giddens, 1979, p. 105).

Saunders (2000, p. 11) believes that, by definition, a practice is given shape by recurrent social relations over time. It seems plausible to look for examples of discursive and practical consciousness in evaluators, because it:

> " […] consists of all the things which actors [evaluators] know tacitly about how to 'go on' in the contexts of social [working] life without being able to give them direct expression" (Giddens, 1979, p.107).

Wenger talks about experience becoming 'congealed' into 'points of focus around which the negotiation of meaning becomes organised' (Wenger, 1998, p.8). A community of practice produces:

> " […] abstractions, tools, stories, terms and concepts that reify something of that practice in a congealed form…with the term reification I mean to cover a wide range of processes that include making, designing representing, naming, encoding and describing […]" (Wenger, 1998, p.59).

Assessing the value of investing in IT becomes very important since certain firms and academics believe that a lot of money is wasted. Lucas (1999) discusses the evidence about the value from IT investments. He presents the Investment Opportunities Matrix, a framework for classifying different kinds of IT initiatives. The matrix indicates which kinds of IT investments are most likely to show a return, and the type of return, and the type of return one might expect from them. He also discusses the "garbage can model" of information technology. It emphasises the importance of conversion effectiveness, turning an investment into a successful application, in obtaining value from IT investments. Lucas (1999) also introduces a new category of IT initiative, one that shows an indirect return. An important point is that the value the firm receives depends on the type of IT investment.

Lucas (1999, page 3) highlights that:

> "it is important to understand under what conditions one can expect to find a measurable return from IT investments. We also need to find creative ways to measure IT value. If we can accomplish these two tasks, it should be possible to predict what investments will lead to a return and the nature of that return" (Lucas, 1999, p.3).

2.2 Sociology of Scientific Knowledge

The sociology of scientific knowledge focuses on the analysis of the content of scientific ideas, theories, and experiments (Pinch and Bijker, 1987). It emerged as a distinct field out of the sociology of science literature which was primarily concerned with science as an institution, focusing on the norms, practices, reward schemes and career patterns of those involved in science (Pinch and Bijker, 1987). One distinct feature of this literature has been that scientific knowledge is seen as a social construction. It can be interpreted in various ways. Scientific knowledge and technological practices are both seen as made through a process of negotiation and construction. Consensus between conflicting social groups can be reached during this process. A key point of this approach to the study of science is that all knowledge is to be treated as socially constructed, regardless of particular claims to truth. The processes involved in the acceptance and rejection of knowledge claims in the social world are of central interest for this study. Controversies are an outcome of interactions between involved actors leading to the production of new knowledge (Pinch and Bijker, 1987).

2.2.1 Social Construction of Technology (SCOT)

A key concept in SCOT studies is that of relevant social groups who share a set of meanings in relation to a specific artefact. SCOT enables us to understand the mechanisms through which a technological artefact is developed through its interaction with social actors (Pinch and Bijker, 1987).

> "In deciding which problems are relevant, the social groups concerned with the artefact and the meanings that those groups give to the artefact play a crucial role: a problem is defined as such only when there is a social group for which it constitutes a problem" (Pinch and Bijker, 1987, p. 30).

Related social groups are seen as crucial in the definitions of functions and resolutions of controversies out of which change and development take place. They aim for stabilisation. It is noteworthy that the interpretative flexibility of scientific findings and concepts plays a key role before consensus emerges potentially. We witness controversies in this research which help us to focus on the debate around those controversies in question. The involved actors highlight the controversies within the specific framework in which they exist, followed by searching for consensus. Actors help to 'reduce' the complex project towards a more 'streamlined' project. The actors are able to highlight the controversies in a specific and often different way even when we realise that those controversies continue to exist. Practically, it is helpful to know this, since this enables us to see the complex projects and the environment around with a different lens.

2.2.2 The Social Construction of IS Evaluation

Hughes (1987) believes that components, whether physical or non-physical, are interdependent artefacts and he refers to technologies as systems made up of many "messy, complex, problem-solving components" (Hughes, 1987, p.51). He believes that external intractable factors are not under the control of the system managers (Hughes, 1987, p.52). The integration of social, technical, political and economic aspects of systems plays an important role (Hughes, 1987). He sees such systems and infrastructures as evolving. This evolution follows "a loosely defined pattern". Key concepts deployed by Hughes include those of *reverse salient, critical problems, technological styles*, and *technology transfer*.

In his opinion, if the complexity of the infrastructure grows, problems of control appear that can result in a breakdown of control. These can be linked to the development of 'reverse salient' in which component elements of the system become less relevant. According to Hughes, when systems grow and evolve, "they acquire style and momentum" (Hughes, 1987, p.56). This can be seen as evidence of the social construction of technology. Crisis may appear followed by the appearance of a new system. We can distinguish between an ANT approach and Hughes's systems-based social history of technology approach. Hughes presupposes a boundary that delineates the system from the wider environment within which the system exists. We can refer to inside and outside to such technologies. If we want to find an approach that supports an analysis that extends from the detail of technological design to encompass social, economic, and political

aspects, then we need to engage actor network theory and Science and Technology Studies (STS) as well.

As mentioned, a key assumption within this research is that IS evaluation, and IT investment appraisal in particular, is socially constructed within a particular context. Various managers and accountants interpret and apply particular methods and accounting conventions to a proposed IT investment. However, this is not a mechanical process of applying a tool to a problem. It needs to be interpreted by the relevant actors. The social process involves representatives from various departments such as information systems, finance, operations, compliance and sales.

In applying an evaluation methodology, they may subtly change it (Smithson and Tsiavos, 2004) as the actors carry out their various roles within the organisation (Introna and Whittaker, 2002). The above discussion shows the flexibility of financial tools, such as ROI, and there is clearly scope for allocating financial costs and benefits in ways that are favourable or unfavourable to the proposed investment. Similarly, future tangible and intangible costs and benefits, in terms of employee job satisfaction, organisational learning, and availability of information, market share, competitive advantage and profitability are all open to considerable manipulation. Accounting practices that support the classification of computer hardware, communications equipment and software as capital expenditure are equally malleable.

Organisational change and related training costs are treated as operating expenses. The increasing use of outsourcing tends to shift items of capital expenditure into the operating budget. It is not clear how these issues, and their consequences for companies' balance sheets, are interpreted during IT investment appraisal. Political factors (Wilson and Howcroft, 2000) are also important, as well as previous implementations of systems. This conception of IS evaluation as a social construction also fits with the ideas of writers concerning the social construction of technology (MacKenzie and Wajcman, 1985; Pinch and Bijker, 1987).

2.3 What is Value?

The most common meaning of value is monetary worth; in the marketplace buyers and sellers place a value on goods and services that is measured in various currencies such as Euros or U.S. dollars. When an investor seeks a return on capital, it is expressed as a percentage of the original investment. However, the term "value" sometimes has a very remote connection with money; for example, a manager describes an employee who makes a valuable contribution to the firm. It might be possible to trace this contribution to the company's profits, but that is not the intent of the comment. Because information technology is woven into the fabric of business, this thesis adopts a broad definition of the value of IT investments:

> "A good example is investing in IT infrastructure; a company might invest heavily to build a network of computers the return from that network comes in literally hundreds of ways, as individual employees use the network to do their jobs better and IT staff members build applications of technology that take advantage of the network infrastructure. At the time the firm decided to invest in the network, it could only guess at the nature of activities the network might stimulate. A few years later, it is possible to study the return on the projects the network enabled, but it is a rare company that would devote the time and resources to such a post hoc analysis" (Lucas, 1999, page 4).

2.3.1 What is Evaluation?

If we look at the concept of evaluation in a broader context, we will be able to understand information systems evaluation. Walsham (1993) states there are a 'multiplicity of private rationalities' which influence an evaluation. The Shorter Oxford Dictionary gives the following definition: 'the action of working out the value of something'. Evaluation is a weighing up process to assess the value of an object or the merit of a situation and it is on this basis that the definition used in this research is developed. The evaluation analysed and discussed here should support the management and maximise the benefits from an information systems investment.

To evaluate an information system it is necessary to understand what the organisation is attempting to achieve through the use of the information system. Evaluation is a process,

which starts at the project initialisation. A process is a series of structured activities. The process starts at IS project initialisation. Each activity is described and should lead on to the next activity.

The evaluator's approach should be to understand the context in which he or she is within the environment. An evaluation is a complex information processing exercise. Therefore the evaluator will be able to choose the appropriate evaluation method. The basis of the evaluation system is clarification of, and agreement on, the important measurable properties of the information system to be evaluated.

2.3.2 Importance of IS Evaluation

IS evaluation's importance can be seen in the increasing size of organisations' IT budgets, the frequency of IS failures (McManus and Wood-Harper, 2007) and a widespread concern with cost containment across the IT function (Smithson and Hirschheim, 1998). Evaluation can have significant implications for both individuals and groups within the organisation (Cornford and Klecun-Dabrowska, 2000; Wilson and Howcroft, 2000). At a more basic level, Hirschheim and Smithson (1988) argue that such evaluation is "endemic to human existence", and hence an automatic response to a changing situation, while Angell and Smithson (1991) see evaluation as providing the basic feedback function to management. Researchers have identified evaluation's multi-layered nature and its increasing importance in a constantly changing environment (Avgerou, 1995; Cornford, Doukidis and Forster, 1994). Organisational change in conjunction with new IS can cause significant and unexpected changes that should be assessed and captured at some point; see for example the discussion of Orlikowski and Hofman's improvisational model (1997).

The pervasive nature of IT, with its widespread applicability across functions, processes, products and services, increases both the importance of IS evaluation and the difficulty, as it often becomes impossible to separate the technological aspect from the underlying business process. IS evaluation can also add value in terms of diagnosis, planning and the reduction of uncertainty, as well as organisational learning. The IS literature demands that evaluation should be considered as an integral part of project design, implementation and redesign, and understood as a continuous learning process going beyond a single project. Poor evaluation procedures can cause problems in the selection of specific projects for

investment such as in a hospital (Heathfield et al., 1999). Relatively few organisations appear to be confident with their evaluation procedures (Farbey, Land and Targett, 1999).

Most commentators, especially those working at the national level, argue that investment in ICTs is very worthwhile in terms of increased output, growth and productivity. For example:

- IT is pervasive, with a multitude of uses; it is applicable across many industries and all countries.
- IT is complementary to other new technologies (e.g. bio tech, robotics).
- The potential of IT is huge, "probably beyond our imaginations" (Coyle and Quah, 2002).
- IT speeds up innovation.
- By increasing access to information, IT can make markets more efficient.
- Internet allows consumers to seek lowest price, reduces transaction costs & barriers to entry.
- IT has improved many aspects of the quality of life.

However, what constitutes IT/ICT investment is very hard to define. Computer hardware is always included, software and communications equipment less often and 'services' rarely. For example, call centres, mobile phones and personal digital assistants (palm tops) are not easy to categorise. Differences in categorisation and definitions of ICTs between countries (and probably companies), as well as different methodologies and lack of data make it difficult to estimate the UK's performance in using ICTs, both absolutely and relatively to other countries (London Business School, 2002). For example, US statistics normally include communications equipment whereas those for Australia do not.

Furthermore, at the firm level, little 'real' data is available:

- Some researchers have used company financial reports as data sources for IT investment figures but these are unlikely to be reliable.
- Companies may record hardware (and perhaps software) expenditure as a capital investment but other costs (e.g. consultancy, training, adjustment) are probably recorded elsewhere as current expenses. Some researchers believe that hardware and software only account for 10% of true IT investment, leaving 90% of the true

investment as not capitalised or depreciated, nor appearing in company or national accounts as IT investment.

- The burgeoning outsourcing of IT development and operation exacerbates this situation. Client companies, instead of making their own investments (visible in the balance sheet) may pay a monthly charge to the vendors, shown as an expense in the accounts.

2.4 Definition and Scope

According to Farbey et al. (1999):

> "the term 'IT evaluation' is often used imprecisely. Sometimes it is referred to as an event-taking place at the commencement of a project in order to decide whether the project should go ahead. At other times this decision point is called 'appraisal', reserving 'evaluation' for a post-implementation review of achieved benefits. IS evaluation is: "A process, or group of parallel processes, which take place at different points in time or continuously, for searching and for making explicit, quantitatively or qualitatively, all the impacts of an IT project and the programme and strategy of which it is a part" (Farbey et al., 1999, p.190).

The concept of evaluation can be defined as "a study designed and conducted to assist some audience to assess an object's merit and worth" (Stufflebeam, 2000, p. 35). It often refers to programme evaluation. Rossi et al. (2004, p.29) define this as an "organised, planned, and usually ongoing effort designed to ameliorate a social problem or improve social conditions". Scott (2003) believes that the literature on organisational effectiveness focuses on the efforts of organisations and can be directed to private and public organisations. During the last few years the focus has shifted towards how the generic tradition can be adapted and further developed in order to understand the notion of effectiveness in relation to public organisations (Klecun and Cornford, 2005). The two main traditions are programme evaluation (Stufflebeam, 2000) and organisation evaluation, which assesses organisational effectiveness (Scott, 2003). According to Hansen (2005) the two main academic traditions should be included in a discussion about evaluation design because both traditions look at ways to conduct assessments. Additionally the programme evaluation literature is increasingly recognizing that its evaluation models are also applicable to organisations (e.g. Owen and Rogers, 1999, p. 33).

However, the basic evaluation models employed within the two traditions overlap significantly. In order to overcome the problem of definition, this research focuses on IT investment appraisals (ex-ante evaluation), which normally take place early on in the development process. Here, proposals are evaluated and decisions taken to proceed with halt or reformulate the proposal. I have selected this type of evaluation because it is widely carried out within organisations, unlike post-implementation evaluations (Kumar, 1990).

The purpose of ex-ante evaluation is to support systems justification. The ex-post evaluations analyse the existing systems in use compared to other emerging systems suggested by clients, vendors or simply implemented by the competitors. Ex-post evaluations are rarely conducted consequently. Due to the fact that non-tangible evaluations exist, whether those are ex-post or ex-ante, the evaluation as such becomes very complex and has for many years been an ongoing topic for academics and also recently very important for the industry. Competition became so intense that larger and even smaller organisations simply cannot afford to ignore professionally organised and professionally implemented evaluation methods or processes. As described, ex-ante or predictive evaluations are very complex. The evaluator has to understand the existing system in order to predict and understand the future system, as well as be able to estimate the potential impact of the future system to the employer, employee, shareholders or any client.

Hansen (2005) argues:

> "An evaluation model stipulates the question that a given type of evaluation seeks to answer, as well as specifies how to set up the criteria for assessment. Both the literature on programme evaluation and that on organisational effectiveness offer several typologies of evaluation models" (Hansen, 2005, p. 448).

Hansen, 2005, page 3: Choosing Evaluation Models

Table: A Typology of Evaluation Models

Evaluation Models	*Questions*	*Criteria for Evaluation*
Result models		
a) Goal – attainment model	a) To what degree has the	a) Derived from goal(s)
	goal(s) been realised?	
b) Effects model	b) Which effects can be	b) Open, all consequences should
	uncovered?	be uncovered
Explanatory process model	Is the level of activity satisfactory?	Performance is analysed from idea to
	Are there implementation problems?	decision and implementation and to the
		reaction of the addressees
System model	How has performance functioned	Realised input, process, structure and
	as a whole?	Outcome assessed in same dimensions
		or comparatively
Economic model		
a) Cost-efficiency	a) Is productivity satisfactory?	a) Output measured in relation to expenses
b) Cost-effectiveness	b) Is effectiveness satisfactory?	b) Effect measured in relation to expenses
c) Cost-benefit	c) Is utility satisfactory?	c) Utility measured in relation to expenses
Actor model		
a) Client-oriented model	a) Are clients satisfied?	a) Formulated by clients
b) Stakeholder model	b) Are stakeholders satisfied?	b) Formulated by stakeholders
c) Peer review model	c) Is professional quality in order?	c) Formulated by peers
Program theory model		
(theory-based evaluation)	What works for whom in which context?	Program theory is reconstructed and
	Is it possible to ascertain errors in	assessed via empirical analysis
	program theory?	

We can broadly divide evaluation models into six categories: actor models, economic models, results models, system models, process models and programme theory models. Actor models are based on the actors' own criteria for assessment. The economic models focus on the system perspective. However, these models differ somewhat from ordinary system models in that they consider the object of evaluation as a 'black-box' by relating the assessment of results (output) to the expenses involved (input). The results models describe, as the term suggests, evaluation based on results.

The system models analyse input, structure, process and outcome in terms of results. The assessment can be made on a benchmarking basis, by comparing the results with other similar systems.

The process models focus on the ongoing processes and efforts on a real-time basis instead of ex-post analysis. And the programme theory model focuses on assessing the validity of

the programme theory. Programme theory is either reconstructed, and compared with empirical analysis of problems, or empirical observation is used to analyse the causal relation between context, mechanism and outcome.

2.4.1 Formative and Summative Evaluation

Farbey et al. (1999) distinguish between summative and formative evaluation, where the former is oriented towards the past and the latter towards the future. Formative evaluation has its roots in the 19th century in Great Britain and the US (Chelimsky, 1985). It is not often used in the information systems field. Originally formative evaluation was a technique developed to help improve the performance of government and social initiatives such as in the field of health care (Scriven, 1967; Patton, 1986).

The concept of formative evaluation is important, since it acts between various stakeholders in a given timeframe and given framework. Generally formative evaluation can be described as a process whereby the involved stakeholders can contribute their values and ideas in a way in which will influence the outcome of the system. The process of discussions emerges on an ongoing basis in order to 'inhale' the emerging IS. Formative evaluation can be seen as a learning evaluation. A post-modern approach to information systems development should be seen as an approach to deliver business value including intangible benefits. Simple quantitative analysis is not the intention of the author and also not the idea of a post-modern approach.

According to Bhola (1990), formative evaluation is a method of judging the worth of a programme while the programme activities are forming or happening. Formative evaluation focuses on the process. Formative evaluation can be seen as an iterative evaluation and decision- making process. It has an impact on the social programme and also an impact on the involved. Summative evaluation is a method of judging the worth of a programme at the end of the programme activities. The focus here lies on the outcome (Bhola, 1990). Summative evaluation is derived from the word sum. It is seen as an act of evaluation assessing the "sum" impact of the social programme.

In systems design both formative and summative evaluation takes place. Whether to choose summative or formative evaluation approaches depends on the preferences and needs of those performing the evaluation of the information system.

Four types of evaluation levels can be followed and seen as a framework for the evaluator:

- Exploration level
- Planning and analysing level
- Decision making level
- Compliance and control level

Exploration level, planning and analysing level and decision making level can be seen as formative because they support the design process. The compliance and control level should be seen as summative evaluation. However, the exploration level can also be seen as summative because it evaluates the current environment the organisation is in at that time. Formative evaluation also includes the stakeholders' expectations of the management of the organisation.

Most studies have been primarily summative in nature. Finne et al. (1995) suggest that such summative evaluations may be used conceptually, instrumentally or persuasively. This means that the results of the evaluation may be used to reconsider an investment proposal. Different types of measurement tools may be used in different evaluation activities. The measurement tools are based on different contingency variables such as organisational strategy, structure, size of the organisation, and individual characteristics of the system under investigation. No single instrument has been universally accepted as providing a valid and reliable summative measure of the information system being evaluated.

According to Love (1991) summative evaluation, which frequently is only performed once, is not appropriate for the purposes of improving the management of an investment. He argues that a summative evaluation and the reliance on positivistic approaches cannot discover the whole picture of the management of an investment, since it is not iterative.

According to Hewett (1986), an implicit formative evaluation activity can be seen in IS development. The systems analyst's/evaluator's engagement with the client is a formative process. The creation of the system is an iterative process. The formative evaluation process is also influenced by the objectives of the information systems development project. Evaluation is seen in the context of objectives and is undertaken regularly.

Formative evaluation has three main characteristics. The first is the frequency of the evaluation. The second characteristic is that an evaluator's perception of what is being

evaluated can change. In due course perceptions can be influenced in conjunction with the evaluator's understanding of the business objectives. The third characteristic is that the business environment changes over the life of a development project. The purpose of the information system investment may evolve by the formative evaluation process. This is identified as the double-loop learning aspect of the proposed formative evaluation process. The basic business objectives which are driving the IS investment are challenged and changed if necessary in this double-loop learning process. The double-loop learning process can support any adjustment.

Here, evaluation can be seen in a context and depends on the people and stakeholders' involvement. Technology has to be embedded in the business and organisational environment. It is always unique from organisation to organisation and therefore needs to be participative as mentioned.

Formative evaluation takes place at each stage in the development cycle. IS investment should be an iterative process. Hewett (1986) emphasises the role of iterative evaluation in designing systems for usability:

> "Just as the system changes with each evaluation/ design iteration, so too the nature or goals of system evaluation can change with each evaluation/design iteration. Another reason for treating the evaluation process as an iterative process is that evaluation procedures themselves often need to be designed, and redesigned." (Hewitt, 1986, p. 277).

The culminating steps of the evaluation start with negotiation. Individual opinions are expressed at any evaluation situation. An agreement on the course of action is required through negotiation within the group. Participatory evaluation includes a negotiation activity among the participants. Through negotiation, the interpretevist bias can be "neutralised". The value of the information system investment is continuously agreed verbally or ideally also in writing. This view of the evaluation process as a negotiation is mirrored by Walsham (1993), who refers to the process of IS evaluation as "a discourse that is often mediated by formal techniques and procedures".

Participatory evaluation is by nature complex during the interaction and negotiation process. Participatory evaluation in investment in information systems is a social process, causing dissent until consensus is achieved. Evaluation must be approached systematically.

The evaluation process must involve the management. The process of evaluation and the relevant information used in evaluation have to be filtered, controlled and formalised.

2.4.2 IS Evaluation in Practice

The topic of IS investment has attracted many researchers. We can find a substantial body of literature on the problems of measurement and also the problems that occur using traditional investment appraisal methods. The problems organisations face when considering planning an IS evaluation exercise are immense. Most organisations do not exercise an IS evaluation beyond the standard traditional evaluation methods, which are quantitative in nature. Brown (2005) highlights:

> "Nonetheless one of the most persistent results of field work on evaluation practice, whatever the original aim of the study, is the continuing relatively unsophisticated and low level of evaluation activity in all types of organisations" (Brown, 2005, p. 169).

As we know, different organisations have different methods and routines. Brown (2005) continues:

> "[…] at any point in time organisations will have methods and routines that are accepted as the standard for evaluating IS. The tools and methods discussed above will find little support if they are not aligned to existing culture and organisational aims" (Brown, 2005, p. 172).

We can imagine that e.g. an association of IS evaluation can be implemented and can help to discuss, develop and implement standard methodologies in line with local governments expectations. Examples of these trends could be found in Germany, where the Association of Alternative Investment has discussed various evaluation methods in this area in small groups for many years. The head of this association has been extremely busy after the industry became ready to discuss various methodologies in line with the change of the German legislation in 2004. Within a year after implementing a new legislation, the number of members of this association doubled and during various discussions a common methodology has been accepted.

Land (1999, p.2) talks about the socio-technical dilemma. The socio-technical philosophy is based on two perhaps contradictory premises. The first can be called 'the Humanistic

Welfare Paradigm' and the second 'the Managerial Paradigm'. Socio-technical methods generally focus on design of work systems to improve the welfare of employees. The prime aim of redesigning work systems is the improvement of the quality of working life (Cherns, 1976). Focus is mainly on concepts such as 'autonomy', 'empowerment', 'self-regulating teams' and 'reducing stress at the work place' (Land, 1999, p.2). Land (1999) continues:

> "[…] diagnostic analysis of existing work situations by socio-technical researchers found evidence which linked productivity and performance failures to the neglect of many of the attributes listed above. There is much anecdotal and case study evidence demonstrating that there is a link between concern for employee welfare and the effective operation of the organisation including the smooth implementation" (Land, 1999, p. 2).

As mentioned by Land (1999), the changes within the second, so-called Managerial Paradigm are instrumental and should deliver an improved performance of the organisation, hence increasing shareholder value. We witness in the general press that this is important for most private and also in some cases for public organisations such as the NHS.

Land (1999) suggests that the general problem of evaluation

> "[…] can be illustrated by the difficulties encountered by researchers and practitioners in accounting ex-post for the benefits accruing to the organisation from the deployment of information systems based on computer and communication technology" (Land, 1999, p. 2).

Researchers such as Brynjolfsson and Hitt (1996) provide evidence though that investments in information and communication technology (ICT) increase productivity. Evidence can also be found on macro-level productivity gains. Researchers such as Garrity and Sanders (1998) assess user satisfaction in relation to the implemented system.

"However, user satisfaction is not an output measure and it is doubtful whether it would convince hard-nosed accountants that it proves the value of an investment" (Land, 1999, p. 3).

Hirschheim and Smithson (1988) categorise IS evaluation approaches into three zones: efficiency (concerned largely with technical performance), effectiveness (mostly concerned with costs and benefits) and understanding (more interpretive approaches). They found that

efficiency and effectiveness approaches dominated practice through the 1980s and 1990s (Smithson and Hirschheim, 1998). Proposals for interpretive approaches are reviewed below but one of the few approaches to incorporate intangible factors that have been implemented at all widely is the balanced scorecard (Kaplan and Norton, 1992; Singh and Wood-Harper, 2011). Even this approach attempts to quantify such factors at an early stage.

These effectiveness approaches rely on variations of traditional cost benefit analysis (Willcocks and Lester, 1994; Ballantine et al., 1994) and offer certain benefits (Earl, 1992; Farbey et al., 1993; Parker et al., 1988) such as:

- Approval by senior management
- Relation with specific business goals
- Consideration of intangible benefits

Against these are set various problems (Farbey et al., 1993; Galliers, 1991; Remenyi et al., 1999; Smithson and Hirschheim, 1998; Walsham, 1995b; Ward, 1990; Willcocks and Lester, 1994):

- Complex projects are implemented over a long period of time and it is not clear when to carry out an evaluation. This also applies to varying learning curves.
- Lack of defined objectives or changing objectives
- Lack of knowledge regarding the possible impact of IS
- Disadvantages of considering individual investments rather than synergistic bundles or portfolios of investments
- Many changes are so radical and wide ranging that they are increasingly difficult to justify in advance in accounting terms and have to be made on the basis of acts of faith.
- Organisations may want to evaluate these major changes, either in advance or after the event, but either the tools and techniques are inadequate or the necessary data is not available.
- Infrastructure and inter-organisational projects are particularly difficult to evaluate, both before and after implementation
- Lack of understanding of the involved human and organisational costs, the danger of over- and understating costs, the neglect of intangible benefits and risks and the use of inappropriate measures
- Political problems between stakeholder groups.

Most of these problems apply to investment appraisals and post-implementation evaluations to a greater or lesser extent. Focusing on investment appraisals, Wen and Sylla (1999) describe the following commonly used techniques, most of which originated in the 1970s or 1980s:

Tangible costs and benefits:

- Return on investment (ROI) (Radcliffe, 1982; Farbey et al., 1993), based on the accounting techniques of net present value, discounted cash flow and/or payback period. These compare future financial returns against the cost of the investment, taking into account prevalent interest rates. Intangible costs and benefits are not included.
- Cost benefit analysis (King & Schrems, 1978), which does attempt to value intangibles.
- Return on management (Strassmann, 1985) attempts to calculate the changes in the value added by management but tends to (incorrectly) attribute residual costs and benefits to the management process.
- Information economics (Parker et al., 1988) retains ROI for financial costs and benefits but tries to deal with intangibles and risk factors through surrogate scoring techniques. Wen and Sylla (1999) find it only appropriate for simple, easily modelled proposals.

Intangible costs and benefits

- Multi-objective, multi-criteria (MOMC) (Chandler, 1982) attempts to incorporate the views of multiple stakeholders in terms of relative preferences and statistical weighting but does not contribute to any ROI calculations.
- Value analysis (Keen, 1981) emphasises the notion of value, rather than cost but such values are hard to ascertain in practice.
- Critical success factors (Rockart, 1979) attempts to focus on key business objectives at the expense of realistic figures.

Of the above, ROI techniques are still widely used, sometimes augmented by ad hoc techniques to deal with intangibles. However, an editorial in a practitioner publication (CIO Insight, 2003) found that ROI:

- Produced an illusion of objectivity and accuracy,
- Lacked a universal definition but at the same time failed to take account of the particular context,
- Was rarely checked by managers.

These above-mentioned approaches can be seen as incomplete or just 'touching the surface' (Smithson & Hirschheim, 1998; Farbey et al., 1999). During the original way of conducting evaluation there was an emphasis towards technical aspects of systems, reliability, cost benefit and security. For some time, IS evaluation activity has become more complex and influenced by political, organisational and cultural aspects (Walsham, 1993). Ethical questions seem to be raised more and more (Cornford & Klecun-Dabrowska, 2001). Many authors highlight that, in practice, IS projects are often not evaluated or only half-heartedly evaluated (Anderson & Aydin, 1994; Smithson & Hirschheim, 1998; Willcocks & Lester, 1999; Wyatt & Wyatt, 2003).

Klecun and Cornford (2005) argue:

> "In response to such critiques the scope and content of evaluative activity, as seen in the IS literature, has begun to change. The application of rigorous 'scientific' methods, for example, cost and benefit analysis, or return on investment, have been often questioned, although such questioning has been equally robustly refuted (Farbey et al., 1993, 1999; Smithson & Hirschheim, 1998; Bannister, 1999; Land, 2000; Wilson & Howcroft, 2000. The result has been the emergence of a number of alternative or complementary methods, including critical success factors, value analysis, and other 'subjective' multi-objective, multi-criteria methods "(Klecun and Cornford, 2005, p.230).

Anderson & Aydin (1994) believe that evaluation activities are a learning process, and it is not sufficient to evaluate selected and isolated criteria. Also Kaplan (1998) supports the idea that it is necessary to pursue the complex processes that contribute to outcomes. Drawing upon both the IS and health informatics traditions, Cornford et al. (1994) provide an evaluation framework in the shape of a matrix, comprising structure, process and outcome on one axis, and system functions, human perspectives (customer, actor, owner)

and organisational context on the other. This matrix adapts a framework developed by Donabedian (1978) for evaluating quality of care, and is similar to a U.K. Department of Health framework for evaluating IS projects.

Klecun and Cornford (2005) continue:

> "[…] this framework not only encompasses technical, individual and organisational characteristics, as well as a societal perspective ('effect in the wider world'), but also offers a rich template for generating measures and data sources when evaluating IS in many settings. It seeks to address the long-term prospects of a project, that is, its sustainability, as well as changes to work practices. It also implies an ethical dimension, through human perspective as well as organisational context" (Klecun and Cornford, 2005, p. 231).

System Functions	Human Perspectives	Organisational Context
Sustainability,	opportunity costs,	
Structure	Technical detail	Work conditions and management needs,
Skill requirements	implied requirements	
Process	Information processing;	Human participation in
		Altered delivery and practice
	Correct and valid tasks,	social interaction
Outcome	Relevant, applicable,	Quality of service,
	Effects in the wider world	reliable and outcomes

Figure: Evaluation framework (Cornford et al., 1994, Figure 3, p. 499).

2.5 The Interpretive Literature

Hirschheim and Smithson (1988) criticise the overly positivistic direction of the efficiency and effectiveness literature of the 1970s and 1980s. They argue that the adoption of the scientific paradigm by both researchers and practitioners represents an inappropriate application of positivism and determinism to the description of inherently social systems. They find that an excessive concentration on tools and techniques has led to an increased formalisation and quantification, resulting in an increased concern for measurement instead of understanding. This serves to ignore the inherent subjectivity of evaluation and its political and social aspects. Their comments echo those of Legge (1984) who found that positivistic evaluation concerning social projects (such as hospitals) was merely rhetoric to justify the lack of rationality in decision-making. The scope for subjectivity in the apparently scientific practice of measurement is based on the work of Mason and Swanson (1981).

During the 1990s, various interpretive (or quasi-interpretive) approaches to IS evaluation were proposed in the literature. Farbey et al. (1993) argue for a contingency approach that different types of information system require different evaluation approaches. Gregory and Jackson (1992) focus on the make-up of the evaluation team while Serafeimidis and Smithson (2003) analyse evaluation in terms of the roles of the participants. Symons (1990) notes the potential role of evaluation in organisational learning. Symons (1991) and Walsham (1993) propose the use of contextualism, based on Pettigrew (1985). Lyytinen et al. (1991) derive effectiveness measures from a social action perspective. Interpretive evaluation has been advocated by other authors, such as Land (1999), Hochstrasser (1990), Symons and Walsham (1991), Willcocks (1994). Smithson and Tsiavos (2004) explore the use of actor network theory in the context of IS evaluation while Introna and Whittaker (2002) advocate viewing evaluation from a phenomenological perspective.

Land (1999) argues that:

> "[…] the evaluation process is ideally a socio-technical one. That is, it is an iterative process of discovery involving all classes of stakeholders. Technical and social considerations are equally acceptable. Evaluation is regarded as a mutual exploration of the issues, not as a mere recording of technical data. It is recognised that evaluation is a political process (Hawgood and Land, 1988), and is seen as an

> arena for fighting for cherished objectives or alternatively for denying other's objectives which are seen as harmful to one's own interests" (Land, 1999, p. 5).

There has been reluctance by practitioners to accept the proposed interpretive approaches (Smithson and Hirschheim, 1998). It seems that managers and organisations are not ready for the necessary 'paradigm shift' (Hirschheim and Smithson, 1988; Kallinikos, 2001). Walsham (1993) argues that interpretative methods of research begin from the position that our knowledge of reality and human action is a social construction caused by human actors. Geertz (1973) concluded that the interpretive view of the data we collect during our research could be seen as:

> "[…] what we call our data are really our own constructions of other people's constructions of what they and their compatriots are up to" (Geertz, 1973, p. 9).

Compared to the early 1990s, when Orlikowski and Baroudi (1991) highlighted that interpretivism represents a small proportion of the US IS literature, it is now much more common and important (Walsham, 2006). According to Mingers (2003), 17% of papers in six US and European based journals during the period of 1993-2000 were interpretive.

Walsham, (2006, p. 321) argues that the setting up and carrying out of fieldwork is the fundamental basis of any interpretative study. He divides interpretive research into four elements, namely choosing a style of involvement; gaining and maintaining access; collecting field data and working in different countries.

Theorists of socio-technical school were among the first to highlight the social as well as technical nature of IS and to advocate the design of IS that would enhance job satisfaction (Mumford, 1983). Working within the tradition, Land (2000) argues for methods capable of valuing both social and techno-economic goals. He suggests, for example, the use of a modified version of the balanced scorecard (Kaplan & Norton, 1992). It would include customer, internal and external communication, and employee perspective related to improving the quality of working life.

The socio-technical approach has evolved considerably in the past decade (Avison et al., 2004; Horton and Wood-Harper, 2006) and IS researchers emerging from this tradition have reached out to different social theories, including social shaping of technology (SST), social constructivism and actor-network theory (ANT), seeking a better fundamental

understanding of the nature of IS innovations within organisational settings. Wilson and Howcroft (2000) propose an approach to evaluation based on SST. They argue that technology is a product of a society, influenced by the conditions of its creation and use. Wilson and Howcroft (2000) also argue that evaluation is interpreted by engaged social groups.

Klecun and Cornford (2005) highlight the hermeneutic tradition:

> "Evaluation approaches drawing on the hermeneutic tradition shift the focus – to meanings rather than interests – emphasising the historical dimension of meaning and the role of an interpreter (reader of the text) in the process of understanding. This draws on Gadamer (1976), who suggests that a text can have many meanings depending on the context in which it is read, and that understanding is in this sense situated, both historically and culturally. If we consider an IS as a text, and an evaluation as an interpreting process, then we see that an IS may have many meanings – meanings created by (read by) the various interpreters and other 'readers', that is, participants in the formal evaluation process but also in the every-day work situation that a system is embedded in" (Klecun and Cornford, 2005, p. 234).

Jones and Hughes (2001) argue for the use of 'situated hermeneutic evaluation' as people are 'active makers' of 'physical reality' through evaluating (important) things in course of their everyday life. Davis et al. (1992) also use the concept of Gadamer's (1976) hermeneutic circle of understanding through the interaction of understanding the parts and the whole.

2.6 Summary

Over the years, a large volume of literature has accumulated concerning the topic of information systems evaluation. It is clearly an important yet slippery concept. Much of this literature is of a theoretical nature that has explored this complexity in detail but the basic divide between positivistic and interpretive studies remains. Of the two streams, the interpretivist one seems to be the more interesting and the one where IS research can further progress.

Furthermore, much of the literature appears to be divorced from practical contexts and there is a pressing need for studies, such as this one, that are firmly rooted in practice. More specifically, there are very few 'academic' studies that examine how IT investment is evaluated in the financial services industry, despite the importance of the industry and its dependence on IT. This sophisticated industry, with its emphasis on short-term profits, is unlike, say, general administration or manufacturing and deserves more attention.

Hence, this study will take an interpretivist approach to IT investment appraisal in financial services.

Chapter 3 - Conceptual Framework

3.1 Introduction

This chapter outlines the theoretical approach adopted in this thesis including a discussion of its strengths and weaknesses. It is strongly influenced by the work of Callon and Latour (1986, 1999) such that actor-network theory forms the theoretical backbone of the study.

Globalisation of financial markets has increased rapidly in the last few years due to a combination of deregulation and dramatic advances in information technology (Beck, 2000; Giddens, 1998; Kapstein, 1997; Young & Theys, 1999). Increasingly, financial institutions conduct their trades through electronic markets. Electronic trading markets like the German/Swiss European Exchange (Eurex) have had a major impact on the participants (e.g. banks and brokers) on the one hand, and on the markets (e.g. different exchanges) on the other hand. Electronic trading has been globally successful since 1997. Most financial products are now traded electronically on a relatively few electronic trading systems such as Pats Systems and Trading Technologies (TT).

The objective of this research is to explore the interaction of new communication and information technologies and the role of actors. Interaction between actors is not comprehensively understood. Participant observation research was conducted because it allows for a rich study of phenomena in Refco's organisational and market contexts. Two years of extensive interviewing and observations were conducted. Refco's actors' interpretations were influenced by their constructs. Certain concepts had different meanings within the specific social group. The phenomenon of 'change' cannot be studied in isolation from the particular environment where the change takes place. In order to create the context of the derivatives broking market this research set out to investigate the technology and the way it is used to communicate.

The nature of information systems is often complex and involves both human and non-human components. This is particularly true in an electronic market. ANT can be used in general to describe the actors, intermediaries, framing and power that are the most important components of such an electronic market, which we call a network. This chapter explores whether ANT can help to analyse electronic trading markets. It highlights how

ANT is useful to define the various components involved within an electronic market. Moreover, the chapter analyses ANT's limitations in modelling computer-trading systems. This chapter concludes that ANT is useful to analyse an electronic market such as EuronextLIFFE or Eurex.

ANT is introduced to describe with a specific vocabulary to what extent technology influences human behaviour. ANT shows that the use and development of an information infrastructure is a socio-technical process of negotiation. ANT has been widely adopted in the social science literature and also in the information systems literature. It can provide a framework to describe global networks. ANT will help us to understand the electronic markets and, in particular, it can tell us about Eurex's success (Smithson and Baygeldi, 2004). ANT has its origins in studies of the networks of social practices within science and technology. Latour (1996) recognises that both human actors and non-human participants are equally actants. The neologism actant is often used as a neutral way to refer to human and nonhuman actors, thus eliminating the human touch in the word actor. They are defined by how they act within the networks.

In this chapter, Eurex and its direct member Refco is used as a case study to analyse how a market can be interpreted as a heterogeneous network. Financial products traded on the German/Swiss electronic exchange Eurex are accessible from any location in the world via companies such as Refco. In order to understand an electronic market like Eurex, I discuss the role of an actor network. Heterogeneous actor networks will be described. A network consists of different components. Analysing such networks gives us a broader perspective and provides insight into markets based on electronic exchanges. It also allows us to explore the differing interests of actors within a market. A market can also be seen as an exchange. Direct accesses from actors like institutional or private market participants to an electronic market are an important factor for the network. Without this direct access, electronic trading systems like Eurex would not exist.

My aim is to analyse whether ANT can help to understand the "components" involved in the "actor network" of Refco and Eurex. Relatively little literature is available on the application of ANT to new electronic markets/exchanges like Eurex, which emerged fairly recently. The aim of actors is to buy and/or sell financial products within the actor network of Refco and Eurex. Humans and artefacts are involved in this process in order to perform a transaction. Both roles within the network will be described in more detail. However, it is

necessary to explain concepts like actor, black box, framing, power and intermediary in order to understand and interpret Refco and the relevant exchanges.

It will be explained what an electronic market such as Eurex and the intermediary such as Refco means. Callon (1998) concludes that framing and the construction of calculative actors are essential for a market. To analyse Eurex's components, we need to describe what framing means. Aspects of power will also be mentioned for the purpose of distinguishing between actors. The main components of a network are discussed after defining the basic concept of ANT. The question, "What is an actor network?" will be discussed. The framing of actors within a market will also be analysed, before highlighting implications for theory and practice. Finally, conclusions are laid out in the last section together with areas for further research.

3.2 Main Arguments

The issue of information systems evaluation suffers from scarce and scattered theoretical background as well as measurement problems (Berghout and Remenyi, 2003). Some authors argue that, if the measurement problems were to a certain degree solved, there would be sufficient methods of evaluation available. The question "What is the value of the company's investment in information systems" should be answered systematically. One of the issues, in the ongoing 'process' is placing dollar amounts on intangible benefits. The author believes that some evaluation processes must be used if the primary question of value is ever to be answered adequately. The application of the methods and techniques implemented in this research can lead to a clearer understanding of the information system investment.

Brown (2005) concludes:

> "IS evaluation exercises involve several elements, all of which must complement each other if the exercise is to be a success in terms of creating greater understanding of the implications of ICT investment to an organisation. An ICT project has two key factors to assess and manage; the hard ones on the nature of the technology and what it can do and soft ones associated with the social and organisational consequences of implementing and using the technology. Success requires a high level of project management skills to ensure that all stages are completed to specification and time. IS evaluation exercises can also be viewed as

> projects that involve both the hard factors of evaluation and soft factors like evaluation of the technology and soft factors like evaluation of the organisational impact of the technology and organisational processes for decisions. These exercises require as high a level of project management skills as for ICT projects" (Brown, 2005, p. 174).

In relation to data processing, most information systems provide operational benefits such as proximity, accuracy or reduction of staff that have tangible dollar values to the company.

For Latour (1993), ANT attempts to overcome what he sees as the major shortfall of postmodernism. According to him, the epistemology of postmodernism divides nature and society into two incommensurable poles. Nature is only observed, never man-made. Humans only make society. The two poles are connected by language in order to refer to one of them. Postmodernism separates language and declares it as autonomous. The autonomous concept introduced by postmodernism and extended by postmodernism is criticised by Latour (1993). He argues that the separation highlighted by postmodernism is artificial. He is convinced that we have never been modern.

ANT integrates society, language and nature. It delivers a result, which leads to the integration of humans and non-human actors into networks. Networks can be seen through the inscription of intermediaries. Intermediaries are a part of heterogeneous networks. For Law and Hassard (1999), an actor network "is a name, a term which embodies a tension": a tension, which lies between the centred actors on the one hand and the 'decentralised network' on the other. The actor network insists on the *achievement-focused* character of relations (Law and Hassard, 1999). This 'translation' does not tell us how links are made. Similarity and difference are unclear. If we assume that ANT is alive, then we can also assume that it transforms itself. So there should be no identity or any fixed point. We can assume that relations are in general uncertain and can be reversed by actors constantly.

If we believe that the last few years have been years of describing and evaluating IS/IT investment in a way that has not done much to move to the next level, I would agree to go back to the origin as Latour (1999) suggests. I would like to use the following example: If we assume that somebody is in love with a woman and does not know why the aim to become a couple and being together is difficult to achieve. Wouldn't it be a good idea to find out "where" (historically) my background is from? Her childhood, religion etc. may

also help to find out more about her-/myself and her/my childhood or in other words about the "social influence" in the past influences my live today? Social and cultural background may help to understand current human actions and the networks I am part. The author of this thesis acknowledges that this example is very simplified.

The author of this thesis believes that it is time to go back to the roots as mentioned in the example above. I also agree with Latour that it is necessary to scrutinise more thoroughly the content of what is 'assembled' under the umbrella of society. Latour (2006) argues:

> "It is no longer clear whether there exist relations that are specific enough to be called 'social' and that could be grouped together in making up a special domain that could function as 'a society'. The social seems to be diluted everywhere and yet nowhere in particular. So, neither science nor society has remained stable enough to deliver the promises of a strong 'socio-logy'. In spite of this double metamorphosis, few social scientists have drawn the extreme conclusion that the object as well as the methodology of the social sciences should be modified accordingly. After having been so often disappointed, they still hope to reach one day the promised land of a true science of a real social world.
>
> No scholars are more aware of this painful hesitation than those who, like me, have spent many years practising this oxymoron: 'sociology of science'. Because of the many paradoxes triggered by this lively but more than slightly perverse sub-field and the numerous changes in the meaning of 'science', I think time has come to modify what is meant by 'social'" (Latour, 2006, p. 2).

3.2.1 Why Use This Theory?

After a long time of studying, I found a theoretical approach which comes closer to helping me translate and understand electronic markets and the complexity of the notion of evaluation. ANT is a very interesting and exciting theory, on the one hand, but has, on the other hand, its limitations (Richard and Whitley, 2000; Walsham, 1995). ANT can be seen both as a methodology and as a theory. The users of IT have in many cases ignored related social issues within these "heterogeneous networks" (Latour, 1991, 1992, 1993, 1996). Bijker (1992) describes a society of humans and non-humans as equal actors tied together into networks. Language connects both poles. The products of these networks can be nature in the form of scientific facts (Latour, 1987) or it can be society (Castilla, Hwang and

Granovetter, 2000; Fenwick and Edwards, 2010; Granovetter, 1992; Rosen, 1993) or technology (Bijker, 1992; Law and Callon, 1992; Latour, 1991).

My hypothesis is that human behaviour (social aspects) is important for the emergence and sustainability of IT investment within organisations. The intention of the research is to extend existing research by expanding the social element further and to provide a convincing analysis with the aim to animate further research into the relevant areas.

3.2.2 What is an Electronic Market?

Following O'Brien (1992), Gosh and Ortiz (1994) hold that the changes of the global structure of financial markets are the result of the rapidly changing environment. The trend towards a global electronic trading platform has become a new reality for most markets or exchanges around the world (Clemons & Weber, 1996; Fan & Stallaert, 1999). I focus on Eurex, which is one of the largest electronic markets in the world and is slightly different from other electronic exchanges. Eurex was formed as a result of the merger of the German and Swiss electronic exchanges.

Cunningham and Tynan (1993) try to define electronic trading (markets) in a way that the definition needs to be sufficiently adaptable to avoid becoming obsolete because of rapidly changing technology. One of the solutions they suggest is to take perceptions of the systems in use as the starting point. As a result, it would be possible to refer to "electronic trading," rather than specific communication technologies. They define electronic trading as any trading relationship that relies upon the use of computer technology for inter-organisational communications, normally involving telecommunication links.

Electronic trading systems exploit information technology capabilities to improve the efficiency of communications and alter the nature of inter-organisational transactions. It can be seen as an automated process of trading financial products in a market. Trading on Eurex can be seen as the matching of bid and offer prices from different actors through translation. Eurex members can conduct trades directly through a computer link to the market or they can simply transact via the Internet. In this context, the most frequent confusion is with respect to the meaning of the term transaction. The relevant broker calculates how many financial products the actor can buy or sell, depending on the financial strength of the end client.

When discussing transaction limits, the term transaction does not refer to the number of financial products that a given actant may trade, but rather to a processing activity within the Eurex system. From a technical point of view, a distinction is made between synchronous and asynchronous system transactions. Transactions are termed synchronous whenever an exchange participant, triggering an immediate response by the Eurex system, initiates them. Participants who have initiated such a transaction await a direct (synchronous) system response on their screen. Asynchronous system transactions are all those which cannot be directly attributed to an activity by a participant. Predominantly, this includes subsequent Eurex system processes carried out as a result of actants' activities, such as the posting of positions after the conclusion of trades or the broadcast of price information to all participants. Some authors describe an electronic market as a single or joint action of a variety of actors who are always present in a market. In the next section, I will mention two different examples of computer markets or "networks."

3.2.3 Eurex and other Exchanges Electronic Networks

Exchanges such as Eurex provide customers such as Refco with access to the world's most liquid financial markets. Eurex was launched in 1989 with the aim of competing against other financial markets. In order to distinguish itself from the long-established competing financial markets, Eurex decided to link actors electronically to their local network in Frankfurt. This was possible after the German government changed its financial market legislation in 1988. The new legislation allowed financial institutions to launch electronic markets almost independently of the influence of the German government.

Trading on the fully computerised Eurex platform is distinctively different from trading on traditional open-outcry markets. It transcends borders and offers actors technical access from any location, thereby creating a unique global liquidity network. Members are linked to the Eurex system via a dedicated wide-area communications network (WAN). To facilitate access to Eurex outside of Switzerland and Germany, access points have so far been installed in Amsterdam, Chicago, New York, Helsinki, London, Madrid, Paris, Hong Kong and Tokyo.

Time and space limited the expansion of the major traditional open-outcry markets. Eurex could expand with the help of technology and provide direct electronic access to a full

range of products. The powerful German banks forced other participants to join the electronic exchange. They also offered their clients "fee holidays" (Franke, 1993). In other words clients did not have to pay any transaction fees for selected financial products. The success is sustainable because the banks support the system and are at the same time major shareholders. One of Eurex's other initiatives is expanding its already broad product range, either by listing innovative financial products or entering into strategic alliances. It facilitates trading of many of the world's benchmark financial products between the entire range of direct exchange users, institutional and retail investors.

For Shaw and Kauser (2000) a strategic alliance is regarded as a term that is applied to independent firms cooperating and forming alliances. Those alliances can also be seen as new "networks." The Chicago Board of Trade (CBOT) and Eurex formed a business and technology partnership in the U.S. that has resulted in a joint venture company: a/c/e – alliance/cbot/eurex. This alliance was created and launched on August 27, 2000 as one global platform. The global platform can also be seen as a "new network" or market. The CBOT exchange is modelled on open-outcry. CBOT realised that their actor network had become "unstable." More and more actors were joining the fully computerised market. Eurex realised the opportunity to extend their established and stable network through partnership. Eurex formed an alliance with CBOT to implement and operate the Eurex electronic trading platform in the United States. CBOT and Eurex members can obtain direct access to CBOT's and Eurex's trading platforms. Every exchange participant admitted to trading is required to participate in the clearing process of Eurex Clearing AG. The participant can choose to participate as a general clearing member (GCM), direct clearing member (DCM) or non-clearing member (NCM). GCMs can participate without any limits or restrictions. The system is based on a common trading platform. The alliance is open to other electronic exchanges. CBOT tried to re-stabilise their actor network through the transformation of the open-outcry exchange to a computerised exchange. Many financial firms have different network connections. The problems of different network connections are not addressed sufficiently in the literature. CBOT/Eurex decided to link participating firms to the common platform via a wide-area communication network (WAN).

3.2.4 Integration of New Electronic Trading Systems

One of the bases of success for these networks is the global accessibility and low transaction costs. Transaction cost is the price a member has to pay for a matched trade. It is also called "the exchange fee." The exchange fee dropped dramatically due to lower head counts. Lower costs lead to more members or actors stimulating rising volumes. Liquidity is typically defined as the ability to convert an asset into cash equal to its current market value. In this paper liquidity is something that is easily sold in the market at current market prices. In a liquid market, an actor can sell large blocks of financial products rapidly without significantly affecting market prices. Before the integration, the CBOT open-outcry exchange network was criticised as expensive and "old-fashioned."

Many market participants refused to continue trading on the open-outcry exchange. Liquidity declined in conjunction with the destabilisation of the network. The open-outcry network was and still is close to a "breakdown." CBOT decided to transform their network to a computerised market. The electronic trading system is identical to the Eurex trading system. Actors can electronically transact from all over the world now. The new Eurex/CBOT global electronic system is linked to the markets in Frankfurt and Chicago. Both networks are integrated and actors have access to financial products from both exchanges. CBOT is thinking about a new alliance with different electronic exchanges such as Euronext/LIFFE.

3.4 Actor-Network Theory (ANT)

Actor-Network Theory evolved mainly from the authors Latour (1992), Callon (1991) and Law (1991, 2009) who were searching for an explanation for the social interaction between "us," the humans and, for example, technology, the non-humans. Within the interaction, the actors are defined as entities that create things. Humans include all natural creatures. Non-humans include technology, artefacts or also naturalised constructs. All of these components should be seen together in a network. Latour (1993) stresses the need for a new interpretation of our modern constitution. He is convinced that nature and culture should be treated symmetrically. The traditional view interprets nature and culture as completely opposite poles. Which view is correct, the traditional view or the view of Latour and Callon? According to Latour (1992), nature, culture and society are constructed

simultaneously. These three factors should be seen as interrelated. For Callon (1991), the acceptance of a clear distinction between technical and scientific approaches should not be taken for granted. Callon (1998) focuses on the market to explain, as economists have done in a different context, "the coordination mechanism between humans, goods and technologies." Conflicts of interest are resolved by transactions. The actors are involved in transactions within the market. Callon's (1991) approach is based on the assumption that products and technology are as important as human beings in a market.

Rhodes (2009) provides us with a useful summary of the ANT approach:

> "The methodological cornerstone of the ANT approach is to follow actors to see how they attempt to impose worlds upon another, and to describe the dynamics and internal structures of actor worlds. It tries to trace and explain the processes whereby stable networks of aligned interests are created and maintained" (Rhodes, 2009, p. 4).

I would also like to draw attention to Callon, as he is one of the few academics that are willing to answer the question, "What is a market?" in conjunction with ANT. Social aspects within economics influence theories more than many authors assumed a long time ago. This sociological aspect gives economics and information systems a more complete character. He discusses cognitive psychology and presumes that individual economic actors are capable of constant mental calculation. Calculation is in Callon's opinion a "complex collective practice that involves more than the capabilities granted to actors by epistemologists and some economists" (Callon, 1998). Culture, as he explains, "is frequently used to explain the appearance of rational actors." He describes it as the atom of the market economy. Actors differ in their behaviour within different societies. They pursue their own interests and perform economic calculations.

Optimisation and maximisation of an operation can then be achieved. Actors generally have divergent interests, which lead them to engage in transactions, which resolve the conflict by defining a price. Actors are defined as calculating actors. As Akerlof states, "I would like to ask how precisely do actors define a price?" Akerlof's idea is that if "buyers cannot tell the difference between second-hand cars by looking at them, kicking the tyres or taking them for a test drive, then the price in the market will reflect the average quality of the cars on offer" (Akerlof, 1984). In order to be calculative, actors must be open to the environment. As Callon (1998) points out, actors will be calculative according to social network analysis.

Actors enter and leave the exchange network like strangers after the transaction has been concluded. It is significant that he says that the actor with the greatest power of calculation is the actor whose tools enable it to have the greatest number of relations. Unfortunately, Callon (1998) does not explain the power of an actor more precisely. General clearing members in Eurex have the greatest number of relations and power. They can act in an unlimited fashion within the Eurex framework.

Human and non-human elements are both actors (actants). An actant should be seen as superior to just an actor. An actor network consists of and links together both technical and non-technical elements. This can be easily explained from our activities, for example conducting a trade on Eurex; the buyer or seller is hereby the non-technical element, the electronic trading system Eurex can be seen as the technical element. "Network" means the interaction between all actors, objects and subjects, that together determine our behaviour, or in this case the market.

For example, I am using a PC linked to Eurex and all the technicalities it offers in order to be able to conduct a trade. My previous experience allows me to exploit the electronic trading system Eurex in more depth and continuously develop my own skills. All these surrounding factors: myself as the user, the PC, the advancing technology, my experience, are related or connected to how I act now. All these influencing components should be interpreted together to produce a framework or "network" as defined in ANT. Networks will be explained in more detail within the next sections.

Actors share the scene in the reconstruction of the network of interactions. This leads to the stabilisation of the system. Only actors are able to put actants in circulation within the system, although uncertainty about the stability of a network does exist. A possible solution to reduce uncertainty "is provided by the network, a network that configures anthologies" (Granovetter, 1992). The actors, their dimensions, and what they perform, depend on the morphology of the relations in which they are involved. The number of connections that an actor has with different networks determines what the actor is.

3.4.1 Actors and Black Boxes

Callon and Law (1986) define an actor as an element, which bends space around itself and makes other elements dependent upon it. The aim of an actor is to translate its will into a

language of its own. In another definition, Latour (1992) sees actors as entities that do things. Accordingly, he emphasises that what an actor is not as important as the action itself and the competences it performs within the chain. An actor is also defined as an element, which performs through trial and error (Akrich and Latour, 1992).

Actors represented in a text perform an act and do certain things. Outside the text, the actors have an independent reality. Inside the text, they become actors within the network. The more heterogeneous elements a text or an object is able to align, the more likely it is that it will become 'stable'. It contains a sealed network of humans and non-humans.

For example, a coin is an actor and performs as a mechanism for exchange. The coin is acting and is being represented. Actors show that the elements represented in a market do act. A computerised market can be seen as a network. The coin as an exchange mechanism depends on the strengths of the network. In other words, its performance and success as an accepted exchange mechanism depend on the strength of the network. A coin in this sense can also be seen as a "black box." Thus, it is not possible to break up the world into discrete objects, events or persons (Introna and Whitley, 1999).

Electronic trading participants in offices and the actions they perform confirm that the technology is well advanced and that human-actors such as traders or stakeholders decide which system they use and support. An example of two different electronic trading systems clearly supports the idea that human actors use their power unexpectedly. LIFFE (London International Financial Futures Exchange) used to trade all derivative products (options and futures) on the open-outcry market. If we look more specifically to the short-term three-month interest rate futures we observe a very interesting behaviour of human actors. In spite of the immense success of the electronic trading system Eurex, one specific product remained in "London," the Euronext/LIFFE Connect system, namely the three-month Euribor futures and options. The social relationship between the actors including the pit traders was so robust that the transformation has been to the electronic trading system of Euronext/LIFFE instead of Eurex. The "leading" actors and social environment animated them to switch to LIFFE Connect. Pit traders, for example, socialise on a regular basis and often make their decisions during a dinner or a drink after work. The network in this case was still intact and difficult to change. As we know, all fixed income and equity derivative products are traded on the LIFFE-electronic trading system Connect. Actors trading the short-term interest rate sterling futures on the pit simply supported the LIFFE electronic

trading system and switched over and continued conducting trades via this new heterogeneous electronic network. The German electronic exchange Eurex "took over" the five-year Government Futures and Options (BOBL) and also the ten-year Government Futures and Options (BUND). All actors moved from the LIFFE pit to the German electronic trading system in a very short time. The actors now act differently and translate their activities in an electronic environment.

The reasons for using an electronic trading system rather than an open-outcry exchange are mostly costs, time and transparency. Now, back to the unexpected and unusual behaviour of the actors in one specific area. The three-month Euribor futures can be traded on both the LIFFE electronic trading system/exchange and the German electronic trading system/exchange. There are no major differences between those two exchanges, except for the difference of clearinghouses. The German clearinghouse gives the actor some advantages because it is integrated with the exchange. But the actors do trade Euribor products via the LIFFE trading system. It is important to mention that the German electronic exchange did offer the service - trading three-month Euribor derivatives - long before LIFFE on their electronic exchange. The actors did not support the German electronic trading system for one specific product, namely the Euribor products. This finding supports our hypothesis that human actors have the power to support or reject existing trading systems. The explanation can only be found if we analyse social issues, which influence actors' activities.

A black box can be treated as a fact where only the input and output counts. A black box contains what no longer needs to be considered, those things whose contents have become a matter of indifference (Callon and Latour, 1986). Law (1999) states:

> "ANT removes the productive non-coherence even further from view. The black boxing and punctualizing that we have witnessed as we have named it made it easily transportable. They have made a simple space through which it may be transported. But the cost has been heavy. We have lost the capacity to apprehend complexity. What we are trying to do is to argue against simplicity-and a notion of theory that says that it is or should necessarily be simple, clear, and transparent" (Law, 1999, p. 10).

3.4.2 Emergence of Intermediaries

Networks are created by or through actors. In some cases, a sustainable development is interrupted by new developments like new inventions (e.g. open-outcry market versus computer market). A new invention can result in new networks. These new networks develop out of existing networks. Another example is the failed electronic market Jiway (Financial Times, October 2001).

As soon as an actor tries to increase power (Introna, 1997; Foucault, 1983), a starting point of a different network can emerge. If actors follow the "leader," it is likely that a new network can emerge. The stability of the network depends on the number and commitment of each actor. If the actor is very active he can become very powerful. Two aspects of power should be mentioned: the micro politics of power and the semiotic power structure. In the micro politics of power, technologies can be used as instruments to build up networks of influence (Kapstein, 1997; Walsham, 1993). Walsham also uses the term domination. The semiotic power is a result of the "fixity" of meanings. It is built-up during the creation of a technological frame. After spending a lot of time on the key technology, the technology's meaning becomes settled or fixed. It is not easy to revert to a new technological frame. Framing will be further analysed in the next section.

Intermediaries are not always accepted in markets, because they can slow down the process between two transactions, although intermediaries may be necessary to create a network. An intermediary connects actors into a network and defines the network itself. Actors create networks by implementing intermediaries between each other. An intermediary is anything that "passes between actors in the course of relatively stable transactions" (Bijker & Law, 1992). Intermediaries are the language of the network. Through intermediaries, actors communicate with each other within the network. For example, one bank employee communicates with a broker and asks him to find a buyer for the product within the "network." The financial institution employee prefers to conduct the trade via an intermediary due to his or her limited time.

3.4.3 Networks and 'Moments of Translation'

A network can be described as a dynamic system of communication, cooperation and partnership.

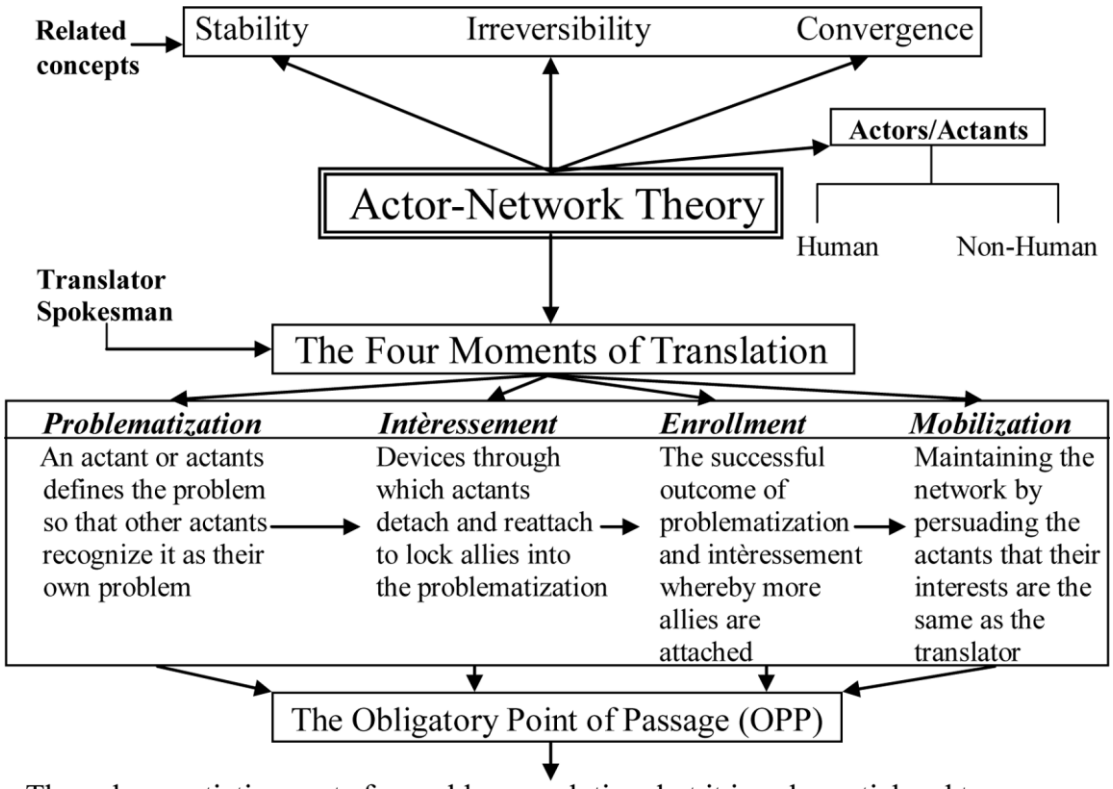
An actor cannot act without a network, since networks consist of actors (Callon, 1987). Actor and network redefine each other permanently. The size or the power of an actor is not necessary dependent on the size of the network. For example, the Jiway electronic market is very small compared to Eurex. But an actor within the smaller electronic market can be more powerful. The power of an actor is defined by the position within the network. Actors are not necessarily equal (Latour, 1992). It can be criticised that he also says that there is no structural difference between large and small actors.

Benjamin and Wigand (1995) discuss the unspecified relationship between things and people within a network. They are convinced that networking technologies can reduce the costs in exchange transactions. With the decline of costs, business activities previously carried out within vertically integrated firms will be shifted to the marketplace. Some authors claim that transaction costs can be crucial for ANT. The market structure depends on network characteristics and the economies of the network. Part of the development within a network is the process of translation. It is possible to have two directions within the network. The first one is leading to convergence and the other one to divergence. New actors within a network can lead to higher divergence. Those new actors are already involved in other networks. Translation is a process that is performed by at least two different actors. Actors are, as mentioned, engaged in other networks. This engagement can lead to different translations between actors and can lead to various results. It is not clear enough in the literature, which role intermediaries have in networks in terms of increasing the success rate of translation in networks.

Translation happens if actors use the technology in a specific way with the aim to help them. This specific translation potentially leads to resistance to other potential competing translations. Actors translate between each other and show interest and develop strategies. According to Callon (1991), conventions regulate the translation process. The end result of IT investment might be different to the original plan during the translation process. Actors influence each stage of the project. In many cases, the project causes unintended and unforeseeable results not related to the original plan.

Callon (1986) described the construction and deconstruction of actor networks in terms of four 'moments of translation' (or phases): problematization, interessement, enrolment and mobilisation. These may overlap but can be considered separately for analytical purposes. The first moment, problematization, is the phase when the actors and their identities are defined. It is the first level of inscription, where the roles are defined and the rules of the game are set. In this phase the actors attempt to define the roles of the other actors. In the second, interessement phase, actors try to cut off other actors from certain alternatives that could alter the role they were allocated during problematization. Enrolment, the third phase, is the result of a successful interessement process, which suggests that all the necessary actors have been 'brought on board'. Things can really start happening in the fourth phase, mobilisation.

'Moments of translation' describe the means by which networks emerge. Allies work together in order to solve their problems through the network. According to Callon (1991), the notion of problematization is used when an actor highlights that it has specific skills enabling him to solve his/her problem. A problem is translated, as the allies become actors in the selected network defined by their common ownership of the original problem. For Callon (1991), the notion of interessement is an act of persuasion of other potential allies by those being able to find a solution to the initial problem. An actor makes itself indispensable by translating their interests and enrolling them by technology. A successful negotiation is a condition of network stabilisation (Latour, 1987). Social investment becomes most effective when actors commit themselves as members of the network as described in the diagram below:



Source: *Figure: Rhodes, J. (2009), 'Using Actor-Network Theory to Trace an ICT Implementation Trajectory in an African Women's Micro-Enterprise Development Orgnaization, page 6. ANT Key Concepts and Translation Moments, Adapted from Hassard, Law, & Lee, 1999; Callon, 1991, 1999; Latour, 1987.*

A good summary of 'Four Moments of Translation' is provided by Rhodes, J. (2009, page 6):

- ***Problematization***

  This is the first moment of translation, during which a macro-actor defines the identities and interests of other actors that are consistent with its own interests. In this way, it establishes an obligatory passage point (OPP) and renders itself indispensable. Other actors are then approached to join in solving the problem through forming an alliance with the macro-actor by persuading, cajoling, and even frightening others into believing that he or she has the solution.

- ***Intéressement***

  The second moment of translation is a process

where the actors convene around an issue to strengthen their determination toward moving through the OPP, all while excluding voices of dissuasion from without or dissenting voices from within. It is a process of convincing actors to accept the definition of the macro-actor by using devices to detach actants from elsewhere and attach them to this point of view. It also involves translating, strategic compromise, and persuasion to lock allies into the proposed roles.

- ***Enrolment***

The third moment of translation is a successful outcome of the problematization and intéressement processes. Actor-networks grow by enrolling other entities through the following steps:

• translating the purposes of entities and establishing themselves as the spokesperson to those who are being associated;

• strengthening connections through political persuasion to infuence enrollment strategies;

• maintaining stability and alignment through constant attention; and

• using humans and machines to enroll actants- Internet technology, fax, telephones, TV, and radio can be just as seductive as actant "enrollers."

- ***Mobilisation***

The fourth moment of translation maintains commitment to the problematised cause of action and ensures the continued position of the OPP. Of importance in this step is establishing the legitimacy of the spokesperson.

3.4.4 Market as a Network

The motivation behind an actor's actions is not predetermined (Callon, 1998). To show the strength of ANT and one of the reasons why it was created we use the example of the "market" which mixes humans and nonhumans and controls their relations. Actors are active and able to make difficult decisions to achieve their objective. As mentioned earlier in this paper, actors are calculative, pursue their own interests, and make informed decisions. Their roles are defined in the computer market Eurex. We can use ANT to understand micro-processes of this market. Actors are interested in the outcome of their economic calculations. This is caused by the fact that a discord regarding a price during a transaction between actors can generally be transformed into consensus.

The ideal situation to be able to calculate is an environment with low uncertainty. Callon (1998) uses the term contingent contract to solve the problem of uncertainty in a market. In this context contingent means contingent to the precise market situation. For example: I am offering a product A in the Eurex network for a price of X1, contingent to Y. If the price of Y changes to Y1, I will ask the actor to cancel the order to sell X1. Here the actor can be seen as an artefact and/or as a human being. The contracts offered between actors are constantly revisable during the social interaction. Shared culture, rules, procedures and routines can reduce uncertainties for actors and increase the predictability of electronic markets. Unfortunately, behaviour is not always predictable, although interaction and negotiation can help to reduce misleading interpretations.

One solution to the question of coordination would be the notion of embeddedness (Granovetter, 1985). Actors can calculate their decisions because they are entangled in relations. For Granovetter the solution that is provided by the network is a network that configures ontology. The actors, their dimensions and their actions depend upon the morphology of the relations in which they are involved. An actor's power rises with the number of relations within different networks. General Clearing Members (GCM) have more power than Non-Clearing Members (NCM) in Eurex. Teamwork and trust lead to a network, which can improve performance (Luhmann, 1988). We have seen this behaviour of locals switching to the LIFFE electronic trading system rather the German Eurex system. EuronextLIFFE has got a fully functional electronic futures spread matrix. Many networks become entangled in relations. But it takes time and the rejection of many human actors with different power structures before a heterogeneous already established network

becomes vulnerable. The global financial system can become vulnerable over time. As soon as an actor's activities change, their power supporting existing infrastructures becomes uncontrollable and not stoppable. Those human actors will — after an unknown time — support a different heterogeneous network or heterogeneous networks which have different actors and which are possibly in place already. Those networks consist of actors and behave like atoms which always remain but which appear in various locations.

3.4.5 Framing of Actors

Actors and goods conducting calculations should be framed and disentangled. Therefore, it is necessary to implement boundaries. Actors' activities are within these boundaries. The notion of externality has been developed in economic theory to show one of the shortcomings of the market (Aumann, Hart and Neyman, 1995). Callon (1998) uses the notions of framing and overflowing to explain what he means by constructing a market. According to Callon, framing is an operation that helps to define actors. He distinguishes actors from other actors and goods from other goods. Framing is a tool to create a market. Rules and regulations helped Eurex to frame relations. Relations outside the frame are externalities. Framing is a continuous procedure. Calculations are not possible without framing as explained by Garcia (1986). Garcia's study of the transformation of the strawberry market in the Sologne region of France explains the development of framing and the construction of calculative actors very well and is a good example of how an electronic market can be framed. This framing allows actors belonging to the Eurex network to calculate. Transactions within this newly created market started in line with the existence of the product (strawberries) and a sustainable supply and demand (bid and ask) between actors. The different components help framing and lead to transactions within Eurex. The strawberry market can also be created electronically and is similar to the electronic market Eurex.

Ciborra (1996) emphasises that the modern form of economic organisations as alliances or networked or federated firms is considered to be at the forefront in terms of combinations of routines and transactions. The actors' intention is to stabilise the network in order to reduce uncertainty. Stabilisation or closure means that the interpretive flexibility diminishes (Callon, 1992). A stable network is able to resist competing translations. It is also able to avoid further possible future translations because it is already "settled" (Star, 1995). Latour (1992) sees the description of a network as finished when it is "saturated" and an

explanation emerges. But how can we measure a saturated market? Is Eurex the electronic market saturated and not vulnerable to a breakdown?

3.4.6 Critiques of Actor-Network Theory

Monteiro (2004) provides a good summary of the various critiques of ANT. He believes that the aim of ANT is to provide a vocabulary to trace out how plans, goals, and intentions are translated and inscribed into alternative choices such as alternative of words. The question is whether those choices are relevant to be mentioned or substantial enough to be recognised.

Various authors believe that ANT was popular as a theory for only a short period of time and is less recognised now. Even in our IS department at LSE I recognise that not many students use ANT anymore compared to when I started working on the PhD thesis.

Some authors do not like the term symmetry as used by ANT. Here, with symmetry it is meant that technical equals non-technical. In other words humans are equal to non-humans. People can easily say: how can a computer and a student be equally treated in the network? Also, various people struggle to decide whether ANT can be treated as a theory, or as a perspective, or as a methodology.

Latour himself highlights that ANT is not perfect and needs to be discussed in a specific context and developed further. Projects are concluded through various steps of translations. According to Monteiro (2004, p. 131), "there is a danger in ANT of emphasizing this goal-directedness too much". ANT has been said to produce actants that are 'flat'; they are without much blood and tears-or 'hairy gorilla-like' as Latour (1999a, p. 16) expresses it.

In order to illustrate ANT weaknesses, Monteiro (2004, page 133) uses the example of the McDonalds fast-food chain. He refers to Star's (1991, page 28) example:

> "In ANT terms, the practices of producing and serving McDonalds' hamburgers is a well-aligned, heterogeneous network of technology and routines, which, in total, produce the hamburger. Star's point is to think systematically about what it would take to request something that falls outside the robust actor-network, for example an order for no onions on a hamburger for someone with an allergy. In ANT terms, this would require an alternative, competing network to be viable. More generally,

this reminds us not to focus on the existing networks only (e.g. McDonalds) but also to make visible the conditions for alternative networks" (Star, 1991, p. 28).

It is assumed that ANT does not account for pre-existing structures, such as power, but rather sees these structures as emerging from the actions of actors within the network. ANT has been criticised as overly managerial in focus. Other authors argue that ANT does not take detailed social processes into account and only touches the surface by being descriptive. Actors are seen as part of networks and are not able to exist without networks. It could be asked why, for example, activity theory cannot be used instead. Latour (2005) said that he had been reminded that the ANT acronym "was perfectly fit for a blind, myopic, workaholic, trail-sniffing, and collective traveller."

3.5 Information Systems Evaluation and Actor-Network Theory

For many years, researchers have been highlighting the multidisciplinary nature of IS evaluation (Serafeimidis and Smithson, 1994). Berghout and Remenyi (2003, p. 46) argue:

> "Evaluation is a multidisciplinary topic and many theoretical approaches have been applied to study evaluation practices and explain the various phenomena. Examples of theory-based approaches are:

- Economics/accounting theory (Dirks and Lent, 1997; Bannister and McCabe, 1999; Maanen and Berghout, 2001; Svavarsson, 2002);
- Interpretative approach (Serafeimidis and Smithson, 1994; McBride and Fidler, 1994; Abu-Samaha, 2000);
- Critical approach (Nijland, 2001; O'Donnel and Hendriksen, 2001; Jones and Basden, 2002);
- Structuration theory (Vaujany, 2001, Jansen and Nes, 2004)
- Grounded theory (Jones and Hughes, 2001);
- Contingency approach (Turk, 2000);
- Soft Systems Methodology and process theory (Bennetts and Wood-Harper, 2003; Kefi, 2002; Stansfield et al., 2000; Wood-Harper and Basden, 2006).
- Cognitive mapping (Newman and Hang, 2002);
- Option theory (Black and Scholes (1973); Cox Rubinstein, 1979; Jong et al., 1997; Clare and Lichtenstein, 2000; Mehler-Bichler, 2001; Svavarsson, 2002);
- Social theory (Berghout et al., 1996);

- Post-modernism (Remenyi and Sherwood-Smith, 1996).”

Unfortunately, so far we have no common understanding regarding the necessary methodology to understand this multidisciplinary field of study that is IS evaluation. In my view, it is unavoidable to put IT investment in a social and historical context in order to see the whole picture. ANT offers the notion of heterogeneity in order to describe heterogeneous networks. The mentioned concepts of ANT such as heterogeneous networks (Akrich and Latour, 1992) and translation (Latour, 1987; Callon, 1991) are useful for this research. The heterogeneous networks consist of a number of actors. Therefore it supplies a method to study the relationship and interaction of various actors.

Technology is socially shaped. It is not an autonomously developing force in our society (Backhouse, 2001). The concept of *technological frame* (Kapstein, 1997; Walsham, 1993) is proposed to explain the development of heterogeneous socio-technical ensembles. A technological frame structures the interactions between the actors of a relevant social group. One of the main characteristics of the concept is that it is applicable to relevant social groups. The concept of technological frame sets the way in which technology influences interaction. It also explains how a new technology is constructed by a combination of enabling and constraining interactions within relevant social groups in an organisation. The stabilization of an artefact is a social process. It depends on our interests and personal value judgements.

3.5.1 Heterogeneous Networks

A network can be described as a dynamic system of communication, co-operation and partnership between individuals and groups. The concept of the network is found in e.g. sociology, business, biology and politics. Callon (1993) defines the term network as a "group of unspecified relationships among entities of which the nature itself is undetermined". A network can be seen as two systems of alliances (Wasserman and Faust, 1994): “Firstly, people who are involved in the usage, construction, distribution and implementation of an artefact. And secondly things (non-humans) like coins or computers”. People and things are interconnected (Latour, 1987). An actor cannot act without a network, since networks consist of actors (Callon, 1987). Actor and network redefine each other permanently. Actors are not necessarily equal (Latour, 1992). One of the weaknesses is that the literature does not clearly distinguish between “small” and “large” actors. We

need to know not only that there is interaction between human and non-human behaviour, but also how it works. ANT has been used in various interpretative case studies (Monteiro, 2000). A useful definition of information systems is suggested by Cornford and Smithson (1996):

> "Information systems are social systems whose behaviour is heavily influenced by the goals, values and beliefs of individuals and groups, as well as the performance of the technology. As such, the behaviour of information systems is not deterministic and does not fit into any formal algorithmic representation" (Cornford and Smithson, 1996, p.7).

The importance of enrolling the various actors into the heterogeneous network, including the influence of non-human actors leads us to adopt actor-network theory. In adopting ANT, we are mindful of some of the basic tenets:

- People and things are interconnected (Latour, 1987).
- An actor cannot act without a network, since networks consist of actors (Callon, 1986).
- Actor and network redefine each other permanently.
- Actors are not necessarily equal (Latour, 1992).

Callon (1986) is convinced that actors are defined as calculating actors. An actant should be seen as superior to a simple actor. "It can be seen as an automatic door opener" (Latour, 1988) or "it can be scallops in the sea" (Callon, 1986). An actor network consists of and links together both technical and non-technical elements. Optimisation of an operation within the organisation can then be achieved. The surrounding factors, the Refco employee, the Refco PC, the advancing technology, his/her experience, are related or connected to how he/she acts now. All these influencing components should be interpreted together to produce a framework or 'network' as defined in ANT.

The emergence and dynamics of heterogeneous networks and the stabilisation procedure is an important part of this research proposal. The socio-technical approach to organisational change has been discussed for many years. "It has offered so much and produced so little and we need to know why" (Land, 1999, p. 7). Analysing such networks in this case study gives us a broader perspective and provides insight into the evaluation of IT investments. It also allows us to explore the differing interests of actors within Refco and other organisations. Similarity and difference are unclear. Benefits are not automatic: "If you

automate a mess, you get a faster mess." (Strassman, 1997, p. 39). In most cases, to make significant improvements, IT requires something else ('**X**') in terms of organisational change, industry restructuring, process improvement etc. (the list is long if not endless, Smithson, 2004).

Much concern has been voiced about the lack of a unifying theoretical perspective in human computer interaction. Although ANT has various weaknesses, it complements and is helpful to involve the researcher in different aspects of the fieldwork process. ANT's nature shows us that we need to find ways to diagnose the problem of evaluation.

Latour's and Strum's work on the 'Performative Model of Society' (1987) has provided a basis for fieldwork design and the collection of empirical materials. The part of the performative model is derived from Garfinkel's Ethnomethodology (1967). According to Garfinkel, society is achieved through interaction. The performative model is used as mentioned by Latour as perspective frames through which activities taking place can be monitored. By understanding the actors, the evaluator will be able to understand how and why translations and associations are evolving. Alliances are constantly formed and are a dynamic procedure within organisations.

Latour argues that ANT is 'relationist' rather than relativist. What is included in the network needs to be analysed, if ANT is used to support data collection.

> "Substantiation takes place through processes of alliance forming where other actors enroll people, resources, symbols and infrastructures. Latour highlights that when enrolment, associations and agency are described the lines between 'in there' subjective truth and 'out there' objective reality can disappear" (Latour, 1991, p. 129).

Framing is a continuous procedure and relations outside the frame are externalities. Calculations are not possible without framing as explained by Garcia (1986). Garcia's study of the transformation of the strawberry market in the Sologne region of France explains the development of framing and the construction of calculative actors or evaluator well and is a good example of how e.g. an electronic market can be framed. Callon places emphasis on the actor and introduces the term agency. Association leads to translations (Callon, 1986). For Callon it is crucial that during translations the concept of the actor

affords attribution of agency. Understanding actors and intermediaries helps to understand certain constructions.

3.5.2 Re-Constructing Information Systems Evaluation

Smithson and Tsiavos (2004) suggest 'deconstructing' the evaluation process with the aim to

> "[…] clarify the importance of both human and non-human actors. These arguments lead to the introduction of the notion of evaluation as a *time gateway*. We explore how evaluation is used by managers as a means for managing selected aspects of information systems at a particular time and in a particular situation as well as the inherent limitations of such an effort. Finally, we approach evaluation as a series of open episodes, as a process that comes from the past but looks towards the future. Evaluation may sometimes seem rational, orderly and stabilizing but we argue that it is never static; rather it is a dynamic process that is always changing" (Smithson and Tsiavos, 2004, p.1).

They argue that various factors influence groups and stakeholders.

Evaluating can be seen as categorizing and reducing the world to numbers with a 'positivistic touch' leading to rational decision finding. We can assume that the object of evaluation is not the world itself but a reduced version of it, the information system. Smithson and Tsiavos (2004) state that

> "[…] evaluation is mostly used in order to justify future decisions. The assumptions contained in the information system are projected into the future and amplified through the evaluation process. In that sense the evaluation operates as a *time gateway* through which various aspects of the past of the organisation and its information systems are inscribed into future systems" (Smithson and Tsiavos, 2004, p.1).

Thus, evaluation is an activity that takes place within the heterogeneous network. It is an interaction between human and non-human actors. It is just one activity among many activities but it is important for the formation and stabilisation of networks. Where there are problems in this interaction – for example, where human actors conceptualise the

technology as being faulty or ineffective – the whole network is likely to become unstable or perhaps fail to form in the first place.

Based on the work of Smithson and Tsiavos (2004), I use actor-network theory (ANT) as a way of describing the enrolment of the various actors into the investment evaluation. This seems highly appropriate given the social construction of evaluation. ANT is also useful because it accepts the notion of non-human actors, which in this case could include evaluation methods, accounting conventions, budgets and documents such as an IT strategy and black boxes.

3.6. Summary

Financial products are either traded on open outcry exchanges or on electronic exchanges. Both markets can be seen as different heterogeneous actor networks. The shift from traditional exchanges towards electronic exchanges can result in uncontrollable networks. Risks are involved because many questions regarding electronic exchanges are not answered. One of the risks involved is a "breakdown" of a network and the appearance of a new one.

ANT has its limitations because it is not seen as a fixed theory. This "theory," a very interesting and exciting one, is on the other hand also controversial (Richard and Whitley, 2000). Sometimes, it is partly rejected (Walsham, 1995) and can be seen as a methodology rather than a theory. It is very useful to explain markets or networks based on electronic trading systems in order to understand the complexity of a market. Unfortunately, it is also necessary to develop or define the "components" (e.g., actor, power and framing) within ANT further. It is also necessary to know more about how IT shapes and constrains changes within an electronic market.

This chapter has attempted to bring together a range of different literature. The aim was to investigate what an actor network is and conclude what kind of further research is necessary in order to describe networks. The nature of information systems is complex and involves both human and non-human components; no less so than in an electronic market. We explored whether ANT can help to analyse electronic trading systems. An electronic market depends on the outlined components or elements of a network. A market or an electronic exchange can be seen as an "actor network."

ANT can be used as a tool for the analysis of socio-technological development. Intermediaries are passed among the actors to assure a certain degree of convergence among them. This convergence allows the heterogeneous network Eurex to act in an understandable way, which is to translate one actor's objectives through different actors to achieve the goal via a transaction. A goal of an actor within Eurex's network can be seen as the attempt to find a counter party who is willing to buy or to sell. The importance of an actor within the transaction procedure is defined by his/her/its position within the network. Power rises in correlation to the degree of convergence. In a situation where we can see high convergence, the network seems to be stable. In this situation it can be seen as a black box. Black boxes can be seen as artefacts or structures.

There have been various "breakdowns" of networks (Taurus, LIFFE "open-outcry," Jiway). A "breakdown" of a network (market) can be seen as the result of the move of actors to different networks. In many ways, ANT seems to offer a useful approach to studying such breakdowns and, in particular, it seems especially suited to studying the creation of new networks. ANT enables us to go further than traditional socio-economics or analyses in terms of networks proposed by authors like Granovetter (1992).

Eurex as an electronic market is the result of operations of disentanglement, internalisation, externalisation and framing. To understand a market we need to understand the construction of calculative actors. Framing can be possible only if there are connections between actors. Eurex does supply these connections. ANT assumes social relations are "in-forged" into the technology. It can be system-theoretically presumed that there are different types of electronic trading systems. They differ in complexity levels. During a system transformation complexity enlarges (e.g., a/c/e, the new electronic market that resulted from the alliance of Eurex and CBOT).

One particular benefit of the ANT approach is that it offers a relatively straightforward and systematic way of formalising much of the tacit knowledge regarding social behaviour. This type of knowledge is held by all of us, in our particular fields of expertise, but it is not easily formalisable, unlike much of a knowledge-based organisation's low-level data. I have shown how this type of knowledge concerning the formation of Eurex can be captured in a reusable form, using ANT. The nature of ANT analysis is very detailed and comprehensive, which means that an analysis of a large market like Eurex, with all its

traders, operators and regulators, becomes very complex. The number of actors shaping Eurex's network is so high that it is difficult to identify all of them. Furthermore, although ANT provides the tools to track the process of change in networks, it does not seek to explain the behaviour of actors. Thus, the use of ANT alone makes a network change unpredictable and a change to the network causes new changes. Callon (1998) criticises that, "ANT is so tolerant that it ends up presenting an actor, which is anonymous and not well defined." Nevertheless, with further development, or perhaps in combination with other social science theories, the tools of ANT may become the basis of a more effective approach to explaining changes in social and business networks.

From the perspective of this thesis, which focuses on IS evaluation, ANT offers the facility to view evaluation in the context of an actor network, in this case electronic trading. ANT allows the human actors (developers, traders, brokers etc.) and non-human actors (hardware, software) to be considered as part of a whole but it also allows us to look at individual links in the network such as the interaction of particular humans with particular technologies. This interaction takes place across time as technologies are designed, developed and used and part of this interaction necessarily involves various forms of evaluation: from formal cost-benefit studies to informal judgements of users.

Chapter 4 - Research Method and Design

4.1 Introduction

This chapter discusses the chosen approach, the research method and the research design. This requires being aware of methodological choices. It can also help to focus and is important in social science research. By choosing a particular methodology the researcher's analysis will be determined by a specific angle. It requires looking at the methodology from a certain point of view. For over two decades, there has been a growing number of IS publications that advocate the use of alternative approaches to understand the organisational, behavioural and social consequences of information systems investment, planning, development and use; e.g. Hughes and Wood-Harper (1999), Jayaratna et al. (1999), Markus (1994), Orlikowski (1993), Wood-Harper (1992).

While all methods have weaknesses, some are more appropriate than others. The researcher has created a framework, by which it is possible to go through certain levels in order to understand the whole picture. But what is the whole picture and how does it look like? Here, I would like to quote Latour (2005):

> "The argument of this book can be stated very simply: when social scientists add the adjective 'social' to some phenomenon, they designate a stabilised state of affairs, a bundle of ties that, later, may be mobilised to account for some other phenomenon" (Latour, 2005, p. 1).

4.2 Research Approach

In order to look at the social construction of evaluation I have taken an interpretive approach to this research (Klein and Myers, 1999). For me as a researcher, this approach offers the opportunity to observe and also to distinguish from a positivist approach (Yin, 1994). The interpretive approach suggests that knowledge of reality can be gained through social constructions such as language and processes embodied in common meanings (Walsham, 1995).

Actor-network theory (ANT) as a *method* represents a *technique* of data collection in which the researcher studies the subject within the natural environment. The social world can be

studied from the viewpoint of the individual actors. Understanding and interpretation of 'human activity' is highlighted (Norros, 1998, p. 159). The term 'qualitative' refers to qualities of entities, which means that activities are not measured or examined experimentally through quantity, intensity, frequency or amount (Denzin and Lincoln, 1998; Maxwell, 2005). Quantitative research is based around measuring and analysing causal relationships amongst variables. The qualitative researcher (Strauss and Corbin, 1998) on the other hand represents an activity which locates the observer in the world. The world can be turned into representations such as interviews, recordings, field works. A qualitative researcher analyses actors in their natural environment with the intention to interpret the phenomena in the terms of the meaning actors bring to them. The qualitative researcher believes that he/she can obtain a closer perspective of the actor. By contrast, quantitative researchers believe that interpretative research methods lack objectivity.

IS research methodology requires acknowledging that researchers cannot extract themselves from processes of social construction. Researchers are social actors interpreting the world. They are already involved in others' construction of reality. Gadamer (1976) argues that interpretations are based on past experience, perception of the present and the projection of the future. Gadamer also highlights that only some part of lived experience can be separated. Latour has done some work for "me" and the following words are very well summarised; as good, probably better, as they would have been my own words. Although, with all respect, I assume that we both would not be able to find the precise English wording from French, his native language, and German as my "native" educational language in order to describe the following:

"What I want to do in the present work is to show why the social cannot be construed as a kind of material or domain and to dispute the project of providing a 'social explanation' of some other state of affairs. At the present stage of their development, it's no longer possible to inspect the precise ingredients that are entering into the composition of the social domain. What I want to do is to redefine the notion of social by going back to its original meaning and making it able to trace connection again. Then it will be possible to resume the traditional goal of the social sciences but with tools better adjusted to the task" (Latour, 2005, p. 1).

My research approach is qualitative and interpretative or in other words anti-positivistic. Anti-positivism emerged through a critique of positivism. This philosophy supports the

view of individuals involved in a given activity. The social world has been studied from the viewpoint of these individuals that we call actors. Anti-positivists reject the notion of the researcher as an unbiased observer. Instead the research should be capable of seeing the world as it is. Understanding and interpretation of human activity is highlighted.

Nevertheless, I have decided to include pure quantitative data in order to support the findings of the interpretative approach. If other researchers would like to compare the Refco case with other case studies, it is important to concentrate on case studies from the same sector. As an example it would be difficult comparing data from organisations in the service sector with data from the non-service sector. If we assume that computers do contribute positively to e.g. fast execution or productivity growth, than we can assume that the traditional information productivity paradox is largely a measurement problem. This is related to the problem of assessing service sector productivity, because computers are used more in the service sector. Personal computers appear to have a large impact on productivity. Measuring computer inputs accurately is difficult. I interpret data on the number of PCs per employee as a provider of an indication of the extent of usage of computers within the firm. The organisations needed to evaluate their in-house and external IT/IS developments in order to implement a long-term business and IS strategy.

The interpretive approach to this research is compatible with my theory. Walsham (1995) suggests that interpretive research opens doors to the researcher in order to understand humans' thoughts and their actions. I embed my research in the interpretative approach suggested by Walsham (1995) in conjunction with ANT. I have analysed IT and other departments at Refco in two countries and the actions they perform. In order to do this, I analysed and observed their interactions. All the inputs have been precisely recorded and discussed individually and in groups. I observed what kind of input has been conducted and why this specific input has been chosen. Those findings have been discussed within the relevant department within the organisation in order to clarify their activities. This was a daily and continuous procedure and has been repeated regularly for a period of more than two years.

Since the 1980s, sociological and historical studies have developed a constructivist analysis of technology in contrast to the standard image of technology that was largely 'technological determinist.' The idea that technology is socially shaped, rather than an autonomously developing force in society or a primarily cognitive development, is not new.

Angell and Smithson (1991) “choose to take as our point of departure – information systems are social systems”. Land and Hirschheim (1983) also agree “an information system is a social system that uses information technology”. Social shaping models show that technology does not follow its own momentum. Technology is shaped by social factors. Existing social concepts are reinvented and different approaches are introduced in the context of rapid technological and social change. Approaches, which lean toward society, begin with the assumption that technology and its resulting consequences are planned and shaped by social actors. These social actors include large institutional entities. Bijker (1992) also argues that the social construction of technology (SCOT) is socially dominated. Other authors argue that technology develops according to its own internal necessity and out of dynamics with no human control. Is technology constructed by society or society made up of technology?

4.3 Research Method

The applied method is a detailed case study, which allows “an investigation to retain the holistic and meaningful characteristics of real-life events, such as organisational and managerial processes” (Yin, 1994, p.3). I decided to carry out a single embedded in-depth case study as the case is of a revelatory nature (Yin, 1994). A case study allows a rich insight into a particular context, which is important for the whole issue of the meanings and measurement of evaluation. Thus the social construction of these notions takes place and can be observed within one organisation. This makes the empirical aspects of the research much more manageable (Engestroem and Middleton, 1998).

A case study refers to the collection and presentation of detailed information about a particular participant or small group, frequently including the accounts of subjects themselves. A form of qualitative descriptive research, the chosen case study looks intensely at an individual participant pool, drawing conclusions only about that participant or group and only in that specific context. I do not focus on the discovery of a universal, generalisable truth. Emphasis is placed on exploration and description. To obtain as complete a picture of the participants as possible, case study researchers can employ a variety of methods. The methods include interviews, protocol analyses, field studies and participant-observations, which have been applied during the very extensive fieldwork.

I have had good contacts with the senior management of Refco and access to many people within this company. Also, I have worked for Refco during the research period. Subsidiaries in London and Germany have been chosen as the prime location for the fieldwork. The head of IT in London and Germany has been interviewed and further face-to-face meetings have been held in February 2004. The company's main business was broking derivatives and similar financial products. In this type of business, in a highly competitive environment, information is very important and could be seen as the lifeblood of the business. There is considerable information sharing through databases and the Internet. The organisation was a sophisticated user of IT with a comparatively small IT budget.

I started with a small pilot investigation of a small to medium sized IT project, in order to test the research approach and techniques. For this I interviewed everyone involved, not just a few selected people. This pilot expanded and became incorporated into the main research. I also modified my research procedures and treated the pilot as a learning experience. For the main research, the projects needed to have a significant IT content, as well as being large enough to 'tell a good story' but not too large that the empirical part of the research became unmanageable (Cornford and Smithson, 1996). The organisation had various IT-based projects running at any one time and project selection was not a problem.

My intention was to focus on the way the investment appraisal (including ex-ante evaluation) is conducted and how the various actors behave, based on the conceptual framework above, and become enrolled into the project. I also followed the project through to its implementation, taking special note of events that took place in the course of development. This organisation, like many others, did not normally carry out a formal post-implementation evaluation but I interviewed the key actors at an appropriate time after implementation. This should give me some indication as to whether, and how, their views of the evaluation had changed. There was also the possibility of seeing how the fate of this project fed into the next IT investment appraisal. These post-implementation activities were not essential to the research, as the focus was on the initial investment appraisal but they could provide a very interesting account of the dynamics of the social construction of evaluation.

Throughout the research, I combined interviews with the collection of documentary evidence, in terms of investment costs and outcomes. I relied mostly on semi-structured

interviews with managers, developers and users who were closely involved with the project, as well as the heads of the support functions, such as human resources. As my access to the company was good, I attended relevant IT investment and project management meetings to observe the actions taking place. I also collected relevant documentation concerning, for example, accounting standards and investment evaluation criteria.

The chosen fieldwork design and methodology enabled me to capture the flow of activities. I observed the case study firm Refco very carefully over a long period of time. The outcomes of these activities were verbal interviews, fieldwork texts and in contrast also pure figures in order to support the findings. Principles and procedures from social science theory enabled me to analyse the collected data further.

4.3.1 Elements of Action Research

In order to understand and conduct this research, there are elements of action research that have complemented the case study and that have helped to monitor activities within the involved organisation. The work of authors such as Law (1991), Latour (1991, 1992, 1993, and 1996), Walsham (1995), Callon (1998) and Wood-Harper (1985) helped to structure my research.

Action research has been used in social science since the 1940s, with the aim to integrate theory with practice through an iterative process of problem diagnosis. It is still not very well recognised by IS researchers. Hult and Lennung (1978) believe action research can assist in practical problem solving, is performed collaboratively, uses data feedback and is applicable for the understanding of change processes in social systems. In the chosen participatory action research, actors try to overcome potential problems by controlling most of the actions. According to Checkland (1991) one of the strengths of action research is in its iterative process of problem diagnosis, action intervention and reflective learning by the involved parties.

The research process has been in a continuous interaction with the "field". Being in the field and acting within the field physically was important. Practitioners should carry out systematic research on themselves and their own practices. According to the literature, Kurt

Lewin ‘invented’ the term ‘action research’. His main arguments are learning from experience and studying social systems by changing them.

Also, Trevor Wood-Harper has been an advocate for many years and has been recommending using action research since the 1980s (Eardley et al., 2007; Wood-Harper, 1985). According to Baskerville and Myers (2004) and Wood-Harper (1985), IS researchers should aim to make their research in the field more practical and relevant to the industry concerned:

> “Action research aims to solve current practical problems while expanding scientific knowledge” (Baskerville and Myers, 2004, p. 329).

They use the term ‘helping role’ and continue:

> “[…] the essence of action research is a simple two stage process. First, the diagnostic stage involves a collaborative analysis of the social situation by the researchers and the subjects of the research. Theories are formulated concerning the nature of the research domain. Second, the therapeutic stage involves collaborative change” (Baskerville and Myers, 2004, p.329).

However, action research is not a ‘yes/no either/or’ method but rather contains ‘shades of grey’ or shades of involvement (Walsham, 2006). At one extreme, the researcher spends all his working hours for the focal organisation wrestling with the research problem in question. However, this was not my position. I was employed by Refco for most of the study period but I was not directly concerned with IS evaluation. I was certainly an ‘insider’, working for the company, but IS evaluation was ‘someone else’s job’. I did not have responsibility for this evaluation but I was in a position where I could occasionally contribute towards the discussion. Nevertheless, I was conscious of the problems and I used my position within the company to gain access to the main actors in order to interview them or to complete my questionnaires.

I was actively involved in day-to-day business, including internal and external meetings. The research within Refco combined the application of theory to practice. It helped to focus on practical problems, collaboration and was action- and change-oriented at the same time. An important characteristic was the aim to understand a social situation in the IS field and simultaneously assist in practical problem solving.

Walsham, (2006) argues:

> "I made the distinction in Walsham (1994) between an 'outside researcher' and an 'involved researcher'. I saw the former as, for example, a researcher carrying out a study mainly through formal interviews, with no direct involvement in action in the field or in providing significant feedback to field participants. I saw the latter as a participant observer or action researcher. Although the above distinction still seems useful to me, I would view involvement now as more of a spectrum, and as changing often over time. At one end of the spectrum is the 'neutral' observer, but this does not mean unbiased. We are all biased by our own background, knowledge and prejudices to see things in certain ways and not others. I meant by neutral that the people in the field situation do not perceive the researcher as being aligned with a particular individual or group within the organisation, or being concerned with making money as consultants, or having strong prior views of specific people, systems or processes based on previous work in the organisation. At the end of the involvement spectrum is the full action researcher" (Walsham, 2006, p. 321).

Thus, I would suggest that this study has strong elements of action research but is better classified as a case study.

4.4 Research Design - Data Gathering and Access to Refco

During the fieldwork, I was a PhD student at the LSE in the information systems department. Preliminary data collection began in October 2003. I had access to the organisation constantly and was also present within the premises of Refco Germany and London. Fieldwork data could be accessed at any given time, from the offices in London and Düsseldorf, Germany. Further data or interviews have been selected indirectly from offices in New York and Paris. However, I was physically present at the offices in London and Düsseldorf. For the bulk of the time, namely from January 2004 until March 2006, I had direct access to data and was also present in the organisation's office in Düsseldorf.

It was important that the adopted theoretical framework provided a foundation for further discussions and analytical evaluations. During the period mentioned above, the main stakeholders were identified and semi-structured interviews were conducted. Interviewees were asked to describe their background, their current role and their involvement directly or

indirectly with electronic trading systems used by the organisation and its clients. The majority of interviews were tape-recorded and transcribed by the researcher. Interviews have been conducted on an ongoing basis in order to clarify aspects of the project.

During data collection, emphasis was placed on being physically present at meetings, which took place at least once a week. However, some meetings were cancelled and rescheduled. A diary of these interviews has been maintained and was crucial for data collection. Additionally, e-mail correspondence was practised regularly. A business and product development group was implemented in the London office and one person in the German office was part of this group. The direct participation enabled me to monitor any new events or discussions even before other parts of the organisation were involved or enrolled. Data collection continued until March 2006. Finishing data collection was a significant act that had to be carefully planned and sensitively enacted, due to my close involvement at both field sites in London and Germany. Participants were asked to comment on the analysis of that material.

The methodology was chosen carefully and a research plan was constructed before data collection. In the course of collecting data, some hurdles had to be overcome, including the collection of sensitive internal information. It seemed that the company was in particular concerned about possible reputational risks. By using an interpretative approach, it was possible to keep in mind the principles of the adapted research plan and the overall research question: *"How is IS Evaluation Socially Constructed: A Case Study of IT Investment Appraisal"*.

Prior to working in the German office from March 2003 until March 2006 I had been working for six months in the U.K. Head Office, namely from October 2002 until spring 2003. Due to my German language skills I moved to Germany in order to gain access to the local office.

	Interviews	Questionnaire	Total
IT Department	58	45	103
Marketing Department	17	9	26
Sales Department	12	15	27
Product Development Department	41	77	118
HR Department	4	3	7
Management	6	3	9
External Vendors	21	29	50
External Clients	28	14	42
Total	**167**	**195**	**382**

Table: Overall numbers of interviews and questionnaire responses

A total of 167 interviews were conducted with 36 different interviewees, and twenty of the interviewees were interviewed several times. Initial contacts were made on the basis of who was doing what. Interviews varied greatly in length and context, with some conducted in the relatively formal semi-structured manner envisaged at the outset, but with others carried out on a more ad hoc basis as opportunities to ask questions arose within various locations in the organisation. A large amount of documentary evidence was collected during the study such as:

- Minutes of meetings
- Notices
- Email from various local and overseas offices
- Promotional material such as booklets, company brochures and flyers
- Websites, which were different from office to office until 2004
- Internal reports
- Press reports and articles

As discussed in the previous section, conducting fieldwork in these cities enabled me to have direct access to the informants. This section offers the background of the fieldwork, how the informants were selected and how the actual interviews and observations were carried out. Essentially, the company relied on order flow businesses. Brokers often refer to the derivative broking market as an information network. An information network is a network of people, as well as a technological network. Both can define, accommodate and facilitate communication and information exchange. This represents both the human actors'

network and the technological network. Actor-network theory has questioned whether we are entitled to make a distinction between those networks. Both human actors and technological artefacts are seen in a symmetric way.

The users' perceptions and also their actions influence the way specific technologies are developed in due course. It is argued that the structure of the relationships in the market shape technology through its use and is being shaped by the use of technology. The case study is described in terms of relationships and information technologies. Agents are treated as reflexive, knowledgeable actors (Giddens, 1984). These relationships enable or limit specific flows. Writing-up the evidence collected in the field is consistent with the framework.

The selected professional informants can be defined as a category of workers:

1. Who have distinct skills,
2. Who work in the company employment relationship or have similar long term contracts
3. Whose work activities involve inter-departmental work activities
4. Who are software suppliers, generally vendors
5. Who are the company's important clients

Most of the interviewed professionals were employed by the organisation directly. Those in London and Düsseldorf had also been working in different organisations, with an average of ten years work experience. At the initial stage, the informants were chosen by my personal network. Later, these informants referred me to other informants. In other cases, I simply went to the department and started a conversation. I have been able to interview people from March 2003 to October 2005. During the interviews, I asked the interviewees to introduce me to their colleagues, such as people in the IT departments. It was good that some did that without being asked. The process of selecting and contacting informants relied upon various personal networks, or what Nardi et al. call "intentional networks" (Nardi et al., 2002). The informants had direct or indirect relationships with each other. This fieldwork of contacting and interviewing various professionals can be seen as utilisation of those personal networks and the basis for conducting the fieldwork over a long period. This chosen approach was very time consuming though (Walsham, 2006).

As explained above, I employed two data collection methods in this field study: semi-structured interviewing and ad-hoc observation. The main data collection method was semi-structured interviewing. Each interview took from forty-five minutes to one hour on average. The interviews were recorded, except five that could not be for confidentiality reasons. All the recorded interviews were transcribed and the non-recorded ones were reflected on and summarised immediately afterwards based on the notes taken during the interviews. I also have e-mailed all interviewees. The following list outlines the interview themes applied throughout the semi-structured interviews:

- Employee's personal background: age, education, nature of job, position, year(s) of working in current position, previous positions and job history
- Use of IT tools: PC, numbers of email sent and received, frequency of phone calls to customers
- Frequency of meetings with clients, with employees or external vendors
- Details of projects currently involved in: types, members, duration, current stage, activities in your charge, project management
- Business objectives and development, personal development
- Location of work e.g. head office, subsidiary, home
- Frequency of communication
- Positive and negative aspects of independent work activities
- Impact of computing technologies on everyday work activities: New opportunities and problems?

Ad-hoc observations were conducted during each interview session. The period in which the interview was actually held was a good opportunity to observe the informants' daily activities. During various coffee breaks I had the opportunity for an informal talk with the informant after the interview session. In two cases an opportunity occurred to interview the relevant person in local pubs after work. In three cases interviews were also conducted during dinner in restaurants in Germany. The informal talk provided me with the opportunity to gain "lived" data about the nature of their current work. I could observe in depth their activities. Observations have been followed up by notes shortly after. E-mails have been sent using the internal company e-mail and I had my own company e-mail address. These e-mails are stored and will be kept for seven years, since the German legislation requires storing and keeping all e-mails for a long period of time for compliance reasons. Another advantage of having a corporate e-mail address was that I was able to continue verbal interviews supported by formal e-mails locally or globally.

This section explains some general aspects of the informants. Occupations of the interviewed professionals were different. Due to their specific individual skills it was not easy to involve external people without those specific skills. Important informants were the IT specialists. Their working activities were distinct from other professionals, such as sales people. I interviewed professional workers who were employed full-time by the firm but were not given much independence in their everyday work activities. The activities can be described as involving a high degree of customisation and interaction with other departments such as sales and with clients. A high degree of knowledge is required in order to fulfil the client's needs. For example, the salesman has to get approval for travelling and other marketing costs from his boss.

The management constantly evaluated the pros and cons of every penny spent for a project. The evaluation procedure was not standardised and a decision was based on experience and future income expectations. In this regard, the salesman had to defend his actions constantly and keep the management updated. As mentioned, computing technologies and internet-based applications have dramatically transformed their work. I have interviewed several professional workers whose work practices were often standardised. Those included heads of departments. Around thirty informants were male and six were female. There was an under-representation of females in terms of gender distribution in this field study. The age distribution of the informants was as follows: 15 in their 20s, 35 in their 30s, 40 in their 40s and 10 in their 50s and older. People in their 40s accounted for the largest age group in this field study.

Amongst all the informants, some were travelling a lot. Also, the dramatic increase in the accessibility to the internet benefited their work practices. Most of the informants regarded their offices as their main work sites. The work place has been split into two daily shifts. The daily shifts applied and concerned departments with client contacts and the IT-department, the so-called E-support desk. They planned to expand the daily shifts to three shifts, enabling them to offer a 24-hour customer service. Derivatives broking is a diverse industry, which concerns all forms of transaction either via phone or via the internet. As a result of this diversity there are various types of broking markets, with different degrees of regulation and standardisation of offerings in each of them.

All the interviewed professionals had a good command of new ICTs. All of them used internet-connected personal computers (PCs) for their daily work activities. The results

presented above concerning the informants' profiles and their ICT use aimed to offer an overview of the professionals interviewed during the field study. It is obviously necessary to examine much more detailed data in order to discuss their everyday work practices.

4.5 Data Analysis

The report format is descriptive. It determines and describes "the way things are" and is the basis for the case study and this PhD (Wood-Harper, 1985). It is predominantly social science and does not necessarily have independent variables.

Throughout the research, I combined interviews with the collection of documentary evidence, in terms of investment costs and outcomes. I relied mostly on semi-structured interviews with managers, developers and users who are closely involved with the project. Also the heads of the E-support team, including the back office and transaction management and occasionally the human resources department have been involved. Due to my good access to these people, I was able to attend relevant IT investment and project management meetings to observe exactly the actions taking place. I also collected relevant documentation concerning, for example, accounting standards and investment evaluation criteria.

As mentioned earlier, this research has a specific scope and analytical lens. The field study has been conducted in this line of conduct. With in-depth interviews and ad-hoc observations of more than thirty professionals working in London, New York and Frankfurt aiming to provide contextualised data about how they got their job done. The analysis of fieldwork materials has been done simultaneously to the data collection. The outcome of fieldwork activities has been texts, such as interview transcripts and minutes of meetings. Certain emerging technologies such as algorithmic trading systems have also been described. Access to the entire German office's clients and other important data of that company was possible. At the beginning of the fieldwork the data collected was not in proper order. It was referenced within the fieldwork diary though. The diary linked data to various events. Then it has been translated into an index of fieldwork documents. Latour (1999) identifies the preservation and re-arrangement of temporal order as one of the key analytical acts made possible when the researcher moves from the field site back to the research school.

The focus of the case study chapter reflects the course of events as the researcher observed them. They were also reflected in the fieldwork documents collected. Fieldwork documents were classified in terms of time, location, date, fieldwork event and the type of text collected. The significance of data was related to the core research question.

The process of data analysis can be divided into the following stages:

- thematizing, the reason and subject of the research;
- designing, planning the structure of the study;
- data collection, conduct interviews, obtain observations, use of questionnaires;
- analysing data; verifying, assign the validity of the research findings;
- reporting, to process the findings of the research.

In order to support my research I collected data in the form of interviews, observations, and questionnaires. Interviews were conducted with Refco's employees, Lehman employees, Eurex employees, Deutsche Börse employees, Patssystems employees, and FSA, various hedge funds and HFT firms. Interviews lasted between thirty and sixty minutes. From these interviews only the essential parts that were relevant for the research were extracted, summarised and integrated in the thesis. Interviews were very useful to get the story behind the interviewees' experiences. This provided me with the opportunity to pursue in-depth information around the topic. In some cases I used interviews to clarify and to further investigate responses to questionnaires. Certain people have been interviewed repeatedly in order to probe follow-up questions related to the complex project.

I used different types of interviews, including informal, conversational interviews without pre-fixed questions. One of the advantages was to remain adaptable to the interviewees' circumstances. On the other hand, a general interview guide approach has been used to ensure that the same general information could be collected from each interviewee. In certain situations, telephone interviews enabled me to gather information rapidly. In order to avoid jeopardising the results of the study it was important not to bias the study. Parts of the research that could not be covered by the interviews were filled in with my own observations of action and relationships amongst the companies' employees. I took notes of my observations and used those in order to support my findings.

Regarding the questionnaires, it was crucial not to influence the interviewee in terms of outcome. The aim was to remain objective and ask the questions in a specific, neutral and

anonymous way. I promised to keep the results of the questionnaires anonymous in order to retain honest answers.

All collected data in the form of interviews, observations and questionnaires had to be consolidated because the entire mass of data would not have fitted into the thesis. Only the important data contents were brought forward in order to remain focused. Data collection and processing has taken up a major portion of the research time, since it has been time consuming and extensive.

In structural terms, ANT is fairly simple, comprising actors and networks. Thus the first stage of the analysis comprised scouring through the data to identify actors, both human and non-human, and to gauge their relevance to the network. The former (identification) was straightforward but the latter (judgement of relevance) was much more subjective; for example, how relevant were human resource actors or vendors' maintenance programmers? Rather than aiming for comprehensiveness in this huge and complex network, as this was exploratory research, I focused on the 'main players', both human and non-human. I wanted to gain insight rather than trying to log the entire network.

The other key element of ANT for this research was the notion of inscription and moments of translation. This involved taking the data concerning the main players and coding the relevant actions and motivations according to the four moments of translation. This was inevitably subjective and became an iterative process as I uncovered the narrative and refined my understanding of what had taken place.

4.6 Summary

This chapter described and justified the research approach, which is interpretive, the research method, which is a case study with elements of action research, and the research design, including the data collection and analysis.

Terms such as accuracy, timeliness and reliability tend to play an important role in the evaluation process. This research does not create a brand new method; its purpose is to provide insight into existing practices through taking a rather different perspective: actor-network theory.

The overall research design of this thesis is exploratory. It does not aim to validate pre-defined theoretical constructs. The data collected in Refco aims to improve our knowledge of evaluation in the context of electronic markets. Theory generation can be a derivative objective for interpretive research. The research process of this thesis adopts an iterative approach.

Chapter 5 - Case Study

The Rise and Fall of a Global Financial Services Firm (Refco)

- The Role of IT Investment -

5.1 Introduction

This chapter outlines the data within the global financial services firm, Refco Group, collected during March 2004 and December 2005. It describes Refco in a detailed manner. The chapter concentrates on internal issues at Refco, including its status as a financial services firm, its organisational structure, and its relationships with its branches in other countries, head office, vendors and clients. This thesis does not go into great detail regarding specific financial products such as fixed income, commodity, equity and foreign exchange derivatives. Our journey investigates whether IS/IT investment evaluation is socially constructed or, in other words, where and how related decisions are made. It is without doubt complex and certainly not straightforward to measure or define IS investment evaluation. Moreover, there is an overwhelming instrumental focus and, besides standard corporate interests, individual interests are highlighted within the development process and project evaluations.

The chapter presents the empirical findings of the research project. The first section outlines the background of the case. The second and third sections focus on empirical findings and related case studies. The data collected and employed in this project are both primary and secondary.

5.2 Company Background - History of Refco

Refco began operations in 1969 by providing execution and clearing services in agricultural commodities. In 1974, it started to diversify after it realised the potential of the newly launched listed financial futures markets. In 1982, the company initiated capital markets broking operations following the introduction of margined foreign exchange products. In 1985, it acquired a U.S. brokerage firm and it continued building a global futures markets operation. During 1998, Refco moved into asset management by acquiring asset management firms in New York and in the U.K. Following the acquisition of a futures

broking firm in 2000 the company became a leading online broker. Between 2001 and 2003, Refco continued to consolidate its leading market position through acquisitions. These acquisitions were followed by massive redundancies some months later, which occurred as a result of overlapping business areas and due to the pressure of keeping IT and operational costs low.

Refco became recognised more widely after it handled Hillary Clinton's cattle futures trades, which converted a $1,000 investment into more than $90,000. During the 1990s, Refco repeatedly came under the scrutiny of the Commodities Futures Trading Commission (CFTC), the US governmental body that regulates these kinds of operations. In 1999, Refco was fined for allegedly manipulating customer accounts and for failing to comply with rules regarding order taking and record keeping of customer orders due to the lack of compliance, IT investment and other related skills. The securities arm of Refco, Refco Capital Markets, which was not regulated by the Securities and Exchange Commission (SEC) or the CFTC, was under investigation by the SEC for improper short sales in an IT company, ITC. The CEO built the additional unregulated business and offices of Refco in the U.S. and independently of the FSA-regulated European subsidiaries. The unregulated U.S. offices functioned like "stand-alone" offices and were not very transparent entities compared to the healthy and regulated brokerage subsidiaries. For example, Refco Overseas Ltd. London was regulated and regularly checked by the FSA. Also, the German subsidiary was regulated by both the UK FSA and the German Bafin. Bafin has a similar role to that of the FSA, namely monitoring members and the market from the compliance point of view.

Refco's clients included Wall Street banks, hedge funds, companies with exposure to commodities and retail clients, who were generally speculators or day traders. In spring 2005, the CEO and other senior management based in New York decided to list the company on the New York Stock Exchange (NYSE); in other words, to register the company via an IPO. The official argument was that Refco needed external shareholders or additional cash in order to invest in IT and also to start penetrating the Chinese market. It seemed that some managers wanted to 'cash in' by listing the company on the NYSE. According to Refco's August 2005 IPO prospectus, its 2,500 employees served over 200,000 customers in 14 countries. In its fiscal year ending February 28, 2005, Refco processed 654 million listed derivatives contracts, clearing more trades than the Chicago

Board of Trade or the New York Mercantile Exchange and making it the largest broker on the Chicago Mercantile Exchange.

Refco became a publicly traded parent company and consisted of three main units: Refco LLC, its regulated futures trading business; Refco Securities LLC, its regulated broker-dealer securities unit; and Refco Capital Markets, Ltd., its unregulated over-the-counter division, which engaged in a variety of off-exchange trading, including derivatives. After the successful IPO, Refco Capital Markets was investigated by the SEC and ceased operations at the end of 2005.

Refco's May 31 2005 balance sheet showed $74.3 billion in assets and $74.1 billion in liabilities. As with many financial institutions, the bulk of Refco's assets consisted primarily of "goodwill" and other "intangible" assets, the value of which depended largely on its ability to operate profitably and free of scandal. Its assets were very small and consisted of $185.4 million in shareholder equity. The equity-to-assets ratio was only 0.2%, compared with other Wall Street brokers' ratios of 3 to 4%.

The CEO of Refco joined the company in 1982, after working for more than a decade in commercial lending with an international bank. He became chief financial officer in 1984 and was promoted to chief executive officer two years later, becoming CEO and chairman in September 1998. He kept a low profile and was credited with building Refco into the largest independent futures broker in the world mainly through acquisitions. A private equity company (anonymised as PEQ), founded in 1974, had a good track record in the private equity buyout area, such that their previous four buyout funds had over 20 years enjoyed estimated average annual returns of over 50%. PEQ's involvement with Refco began late in 2003. As a new main shareholder of Refco, PEQ was concerned about "reputation issues" associated with Refco's history of compliance. The CEO of Refco assured PEQ that he had cleaned up the company and that no compliance issues remained. That was supported by an outside law firm and by the fact that Refco had brought in as general counsel a former regulator from the Commodity Futures Trading Commission (CFTC). PEQ may also have seen in Refco, which was growing 30% annually, an opportunity to duplicate the success of the Chicago Mercantile Exchange.

After ten months of due diligence in which PEQ spent millions of USD on advisors such as KPMG, McKinsey & Company and others, PEQ bought 57% of Refco in August 2004 at

$8 per share. It invested a total of $500 million in equity as part of a $2.25 billion leveraged buyout that included an $800 million bank loan due in 2011. Before the IPO, the senior managing director at PEQ confirmed that the firm's ultimate objective was to take the company public: "That is certainly a goal of ours. We can't put a timeframe on it. We hope that we'll be able to become a public company within the next few years, but it will depend obviously on the performance of the business and the market opportunities."

In August 2005, Refco went public despite the fact that its IPO prospectus disclosed two "significant deficiencies" in its internal controls at fiscal year-end February 28, 2005. The auditor of the prospectus reported that Refco's finance department "did not have the resources to prepare financial statements that complied with federal law".

Apparently Refco's IPO was launched successfully, although internally some senior people from branches outside the New York head office did not understand why an IPO was launched in August without prior marketing and without the complete involvement of senior managers outside New York. Also, it was very unusual, and to a certain degree a breach of trust, not to issue shares to all employees, at least at face value. One senior employee sent an e-mail to the head office, asking how he could participate in the IPO because he wanted to become a shareholder of "his" own company. No feedback or comment was available from the head office, which provided an e-mail address for specific questions related to the IPO.

Refco raised $583 million on 26.5 million shares at $22 per share on the first day of the IPO listing. The stock price increased 25% during the first day of trading on the New York Stock Exchange. Refco's two main owners, the CEO and X Partners, according to Securities and Exchange Commission (SEC) filings, netted $145 million, by selling 5.375 million shares, and about $210 million respectively. X Partners kept 38% of Refco after the offering. Almost two months later, Refco's announcements of the CEO's possible wrongdoings caused the company to collapse. The largest independent financial futures brokerage company in the world had collapsed. News of the collapse was on every major TV channel and all major newspapers including the Times, BBC, CNN and FT.

In October 2005, the regulated core business of Refco was split into two. An American hedge fund bought the American entity and an English hedge fund bought the remaining European parts of Refco. The name Refco no longer exists; it disappeared like a ghost.

Instead, Marex Financial Ltd. was created at the end of 2005 and commenced trading on 26th January 2006. Marex was formed following the acquisition of Refco Overseas Limited by Marathon Asset Management. Marathon also acquired the assets of Refco Trading Services (RTS) and EasyScreen. EasyScreen provided integrated electronic trading systems used by traders to connect to worldwide financial exchanges. The CEO stated:

> "We are delighted to announce the launch of Marex Financial. This is the start of a new independent brokerage company that will allow us to provide our clients with value-added services. Marex Financial is well capitalised and the company's experienced team commences business with the infrastructure, technology, and financial controls associated with the best firms in our industry. We are grateful for the widespread support we have received from our clients throughout Europe and our peers in London as we look forward to building upon this solid foundation" (CEO Marex Financial Ltd., 26th January 2006).

Marex offers execution and clearing services in metals, energy, agriculture, interest rates, equity indices, stock options, foreign exchange and fixed income. It was capitalised with £100 million from its sole shareholder Marathon Asset Management LLC ("Marathon"). Marathon is a New York based alternative investment and asset management company with over $5 billion in capital and approximately $11billion in assets under management. Marex provides global clearing services across all major exchanges. It has memberships of the following exchanges: London Metal Exchange, Euronext Liffe, ICE Futures, EDX, Eurex, IDEM, MEFF and SAFEX.

The change of senior management at Marex continued in 2009. On December 10th 2010, JRJ Group, the London-based investment firm announced that it had reached agreement to acquire a majority stake in Marex Group Ltd. Europe's leading independent futures broker. Marathon Asset Management, the current majority shareholder, retains a minority stake in the business.

JRJ, said:

> "Marex is already a leader in a dynamic, growing market and is run by a great management team. We're delighted to partner with this excellent company" (10th December 2010).

JRJ, which is regulated by the FSA, is a specialist investment firm established in January 2009 focuses exclusively on the financial services sector, providing capital, operational expertise and strategic guidance to enhance the value of its investments. Samsung Futures Inc. reported that it established a platform enabling individual and corporate clients to trade LME metal products on line via Home Trading System (HTS) for the first time in Korea. The on-line trading platform is an in-house system developed by connecting its HTS with the electronic trading system, E Trader, of Marex Financial Ltd (Marex), which is Samsung Futures' LME clearing broker and business partner based in London.

Marex announced in January 2011:

> "After many years of hard and successful work, the CEO will be leaving Marex. He has been instrumental in the firm's growth and development, after its spin-off from Refco, through its ownership by Marathon and its sale to JRJ" (www.marexfinancial.com, January 2011).

5.3 Products and Services

Refco offered their clients exchange listed derivatives. Retail and institutional clients were looking for a service, namely execution and clearing services, which Refco could provide. Refco was an industry leader in execution and clearing services for global exchange traded derivatives in electronic and open outcry markets including: listed futures and options on metals (precious and non-precious), energy, agricultural, financial, equity and also OTC derivatives. These products are all well known in the financial services industry. Refco provided banks and hedge funds with execution and trading services via strategically located execution desks, electronic trading (Direct Market Access (DMA), research, clearing facilities management, risk management, account management and, to a certain degree, IS services. Refco's diverse and global client base was comprised of institutional clients, corporate clients, private clients, government agencies, hedge funds, managed futures and pension funds. Refco offered clients access to various exchanges; its global access to financial futures and options markets throughout the world included membership of the following exchanges:

Chicago Board of Trade (CBOT)
Chicago Board Options Exchange (CBOE)
Chicago Mercantile Exchange (CME)

Coffee, Sugar & Cocoa Exchange (CSCE)
COMEX
EUREX
Euronext Amsterdam (AEX)
Euronext Brussels (BELFOX)
Euronext LIFFE (London International Financial
Futures and Options Exchange)
Euronext Paris (MATIF and MONEP)
Helsinki Exchange (HEX)
Hong Kong Exchange (HKEx)
Intercontinental Exchange (ICE)
International Petroleum Exchange (IPE)
Borsa Italiana Group (IDEM)
Kansas City Board of Trade (KCBT)
Korea Stock Exchange
Kuala Lumpur Commodity Exchange
Kuala Lumpur Options & Financial Futures Exchange
Berhad (KLOFFE)
London Metal Exchange (LME)
MEFF (RV and RF)
New York Mercantile Exchange (NYMEX)
OM London Exchange (OMLX)
Singapore Exchange (SGX)
Tokyo International Financial Futures Exchange (TIFFE)

Refco made sporadic investments in information systems after 1988. General basic accounting applications were the first areas of investment for the then small company. As the years passed, more basic IT services needed to be supported by information systems investment.

In particular, during the period from 1991 to 2003, a very rapid growth and expansion of the company occurred. Refco's client base and trading volume increased dramatically. In the fiscal year of 2004/2005, which ended at the end of March, Refco became the world's

largest independent Futures Clearing Member (FCM), mainly due to acquisitions and aggressive pricing, beating most competitors. More and more clients asked for access to various exchanges, executing via algorithmic trading machines. An information system processing department and a more globally focused back-office was established in order to process the exploding order flows. Generally, during the early years in the eighties, the order flow processing was conducted mostly manually via the back-office clerks in the different time zones: New York, Chicago, London and Singapore. Other offices, such as Paris and Frankfurt handled client order flows either via London or through the other main time zone head offices in order to be processed during the day. Senior management established back-offices in the main time zones, which can be seen as a sort of 'centralisation'. Since client complaints of miss-bookings rose from year to year, the management was forced to invest more in IS, mainly related to back-office and accounting.

It was obvious that the increase in client complaints, such as booking mistakes or missing bookings, threatened Refco's reputation. During the final years, more and more hedge fund start-ups and also established hedge funds became clients of Refco. Later, the number of hedge funds rose to ten thousand during the peak of 2007. The aim of hedge funds is to invest client money in a way that the return on investment outpaces traditional asset managers and traditional investment. In particular, Alternative Investment (AI) hedge funds often used short-term investment approaches that required different services from Refco. For example, one AI hedge fund was a so-called trend follower and had an investment style based on daily market volatility, in other words algorithmic. If the market became more volatile, the number of transactions rose.

During higher market volatility and increased market uncertainty the increased number of transactions needs to be booked quickly via a central counter party in order to reflect the straight-through processing. Also, orders taken from clients need to be recorded properly. According to FSA Policy Statement 08/1, telephone recording, recording of voice conversations and electronic communications have to be managed by certain rules (FSA, March 2008). FSA introduced new rules requiring certain firms to record and retain telephone conversations and other electronic communications linked to taking client orders and dealing in financial instruments for a period of six months. FSA wanted to become more efficient and detect more market abuses in the UK. FSA can ask firms 'in certain cases to retain, for longer than six months, recordings that might be useful as evidence'. Records of phone conversations and electronic communications can help to understand

each individual case. The FSA markets division has the authority to contact a firm and to ask for telephone or electronic communication records. This may follow the receipt of a suspicious transaction report (STR), or follow from notification by an exchange. In the FSA June 2008 'market watch' issue no. 28 it was highlighted that

> "[…] records of phone conversations and electronic communications can play an important role in investigations of market abuse by providing context and helping to establish the facts. Taped records can provide evidence of knowledge and intent – crucial elements in building an enforcement case but not always easy elements to establish" (FSA market watch, issue no. 28, June 2008, p. 1).

5.4 Clearing Transactions

In 2004, Refco processed and cleared more than four hundred and fifty million futures contracts in one year. Refco employed only a few data processing people who had experience in the new areas of information systems. The rest of the back-office employees were young clerks with just minor experience in listed derivatives. Many of the young clerks interviewed did not know the products they cleared and inputted manually. Certain IT people worked in the same company for many years, which was not helpful in terms of knowledge transfer. Generally, it is assumed that people working for various organisations gain more skills and transfer these skills to the new employer when they change organisations. Internal or external training can improve the skill set as well. No regular training occurred in the company.

It became clear that, due to the massive increase of data processing, the way the data used to be processed had to be improved and updated. In particular, the data processing centre in U.S.A. became more and more vulnerable, since IT investment was minimal. The last IT investment had been some years ago and the staff interviewed would not reveal the amount invested.

Pressure rose to hire new people and increases in staff levels and new computer equipment expenditures occurred. New hires also dramatically increased information systems costs though. IT expense levels grew to 30 Million USD from 1991 to 2003, according to a senior IT manager. Still, compared to investment in IS/IT by the banks, Refco's investment was much lower. It seemed that the company was financially unable to invest in IT, even if

they had wanted to. Due to the company's low level of own equity it was not possible to invest larger amounts in IS.

Management concern about the increasing costs was manifested in increasing control over information systems expense through the establishment and operation of a management steering committee. The management in the global headquarters in New York dominated this committee. In 2004, a few external consultants were engaged to review information systems activities and to advise the management about information systems control processes. The external consultant recommended stronger "user" participation in planning information systems expenditures and in project systems development activities. The consultant recommended a feasibility study with an emphasis on user determination of the benefits of information systems investments. The external consultants had been asked to do the job in a short period of time but it appeared that the findings of their initial research was never discussed or analysed by the senior management. In other words, the management continued as normal and did not refer to the recommendations of the consultants.

The consultant's recommendations were not taken on board, apparently due to lack of money. From the interviews, it was widely believed that the responsible people within the organisation always felt under pressure to make money. It was not easy to explain that a large part of the net income should be re-invested in information systems. A legal framework or pressure from regulators did not exist at that time; there was much less oversight by regulators compared to 2011.

By the end of 2004, very simple procedures for implementing and developing systems had been established. These procedures included various written and verbal evaluation procedures. They were dominated by the simple expression "how much money is the company going to make if we decide to increase IT investment expenditure".

Managers were participating in the definition of business objectives. The organisation was learning how to calculate the financial benefit of achieving their objectives. The management involved continued to express concern about the size of the information systems expense. Most managers asked, "What is the value of our investment in information systems?" Exchanges upgraded their infrastructure regularly to improve the way clients were connected. This was the beginning of fierce competition between exchanges for business. Every year, Eurex introduced software releases in November to

improve processing speed for customers. It changed the way in which it handled messages pertaining to order book activity that were sent to members. Messages relating to non-persisting orders and quotes became faster compared to persistent orders. Various exchanges continued offering clients the choice of which order type they preferred to prioritise in terms of speed or reliability. The way clients were linked to the exchange via Refco or any other clearing house determined how fast orders were submitted and executed. In the world of algorithmic trading, a financial services firm needed fast connections to exchanges, otherwise it would be out of business. Such clients required a particular IS infrastructure. Some interviewees believed that algorithmic trading companies comprised more than 30% of the exchange volumes.

5.4.1 Accounting Methods and Transaction Reporting Failures

Schedules of investments and benefits by objective were developed to track the flow of value in each month. Generally, discounted values were used. When I started the interview procedure, the accounting people in London did not calculate the daily income for the European subsidies. They calculated and collected all income during each month and compared the overall expenditure against it for each department or subsidiary. Invoices such as utility bills for external data suppliers were booked during the first week of each month. Therefore, it was not possible to have an exact figure in terms of net income before the second or generally the beginning of the third week of each month. Also, other subsidiaries, such as Refco Chicago or Refco New York, charged other offices, such as the German branch, indirectly via the London office. The London office then charged service costs to the German branch. Also some other costs such as account opening documentation work were charged as 'other overhead costs'. These other overhead costs were not transparent and used to differ from month to month.

During the year 2003/2004, the London head office implemented a more accurate calculation methodology in order to evaluate the daily P&L. This daily P&L was calculated on a simple statistical method, based on the last month's net income. The accounting department took the accumulated previous month's commission income and divided this by the previous month's total expenditure. This figure can be illustrated as following. If the total net monthly commission was USD 1 Million and the total expenditure was USD 800.000, then the net income ratio for the previous month would have been 80%. Based on this ratio the accounting people calculated the current daily gross commission income and

compared the previous total expenditure, namely USD 800.000 divided by twenty business days. The daily total expenditure was then USD 40.000. This daily expenditure figure was used for upcoming months until it needed to be adjusted due to changed costs in the following quarter. In other words, if on a typical Monday the real actual gross commission income was USD 10.000, - then on that specific day the relevant department would have lost USD 30.000, - due to the average daily cost of USD 40.000. At the beginning of the month these gross daily income figures were adjusted and subtracted by the total month to date (MTD) commission expenditure. The advantage of this method was that the management had a clear idea of the daily fixed costs, so that certain pressure existed due to the fact that everybody knew how much money needed to be earned on a daily basis in order to cover at least the costs. This methodology was not adjusted for bank holidays.

This meant that, if the management decided to invest USD 200.000 in IT today, the daily average office costs would have increased substantially in the upcoming months. Even if the following month showed a ten per cent net client commission income increase to USD 1.1 Million the overall net performance would have decreased to a daily gross income of USD 5.000, - instead of daily income of USD 10.000. That shows the return on investment would have decreased by 50% due to the additional IT investment in the following months and gradually neutralised in the upcoming months. It was not difficult to imagine that the local management hesitated to invest in IT or other related areas, which in turn influenced the client services and other required basic services such as providing transaction data to regulators such as FSA, Bafin or CFTC.

Information systems investment at Refco between January 1st 2003 and December 31st 2006 aimed to enable the company to cope with the growing demand for electronic access to various electronic exchanges and at the same time also make a net profit. Refco did not establish a performance standard for attaining objectives. For example, the company expected to achieve a high percentage of the high priority objectives, although no official framework or evaluation methodology existed.

5.4.2 The Role of Back-Office Employees

The middle managers believed that no standard IS investment evaluation methods were in place. Generally, they said that they did not know any IS investment method used in the industry. Middle managers were the link between various front offices and back offices. They tried to filter important activities in order to channel to the right persons or departments and find ways to process orders or process missing executed orders. They aimed to support various departments and at the same time communicate between front office and back-office. Generally, the back-office was on a different floor or in a different part of the building. Questions from a back-office clerk regarding specific trades, which needed to be processed, would be followed up by the middle manager.

As an example, a sell of 10 March Oil futures at market price was executed. The related client was a hedge fund with the account number 45671. The back-office clerk was not able to process the trade because the original order had a different sell order execution place at New York Mercantile Exchange (NYMEX) instead of IPE. The trader who took the order from the client needed to write on the trade confirmation the exchange's name and product code as well. He forgot to mention the exchange NYMEX and the order was placed at 9:14 am London time. Orders received in the morning were generally executed at the exchange (IPE) unless the client mentioned otherwise, as he did in this case. Oil can be traded on NYMEX or via the International Petroleum Exchange (IPE). If the trader had written CLH11 as a product code then the clerk would have known that the product code CL stands for Crude Oil, listed on NYMEX, H stands for the month March and 11 for the year 2011. Due to the lack of IT investment the firm had to take many orders via phone instead of electronically. The way orders were executed and processed, namely manually, increased the miss-trade rate enormously. Various people interviewed in separate banks mentioned that such error rates cost companies millions of dollars annually.

The typical back-office role was to process client data in order for the clients to receive all necessary information. At the same time, the back-office's role was to select and process certain information that would then be used for internal evaluation criteria. These internal evaluation criteria incorporated the following subjects: frequency of conducted trades, number of contracts a client trades per day, size of the traded contracts and type of contract. Another important aspect was whether clients exclusively traded and cleared within the

firm or whether the client used a different clearing member. All the above-mentioned criteria influenced a client's risk profile.

In order to gather and analyse the data within a short period of time, the electronic trading system needed to be connected to the back-office. This happened via multiple internal servers. Some of these servers delivering the information were located in cities around the world. The client interlinked particular servers with the London and U.S. office in order to process all conducted activities. For example, if the client conducted a trade on the Mini-S&P futures contract via the electronic trading system in London, the trade would then be processed in the US. Overnight, the information would be processed and would be available in London for the back-office. Certain in-house staff, such as the E-support team could constantly watch and monitor the clients' conducted trades simultaneously.

Peter (not his real name) was a 42 year-old back-office employee interviewed, who was working in London and was experienced in back-office as well as front office trading. He used to work for a large organisation prior to being approached by Refco. His role at Refco was to improve the organisation of the back-office, which he'd recently reorganised in order to make it more efficient and effective.

When asked to describe his day-to-day work activities, he responded:

> *My job is to make sure that all conducted orders and trades are booked and reported in the most efficient way. I am also trying to reduce the error rate in terms of processing trades as well as the required time to process trades. We need to process trades fast and correctly. I have to ensure that all conducted trades are processed as soon as possible. According to the exchange rules and according to the clients' account documents, which have to be signed by each individual client, we have to make sure that the processed client data is accurate.*
>
> *The client on the other hand has the obligation to check his or her statements every morning and let us know whether specific information on his/her statements is incorrect or missing. The client has the obligation to report the possible mistakes on the statement within twenty-four hours, after trades have been conducted. Our company also checks the client's statements on a daily basis, but due to the nature of the business, lack of time and human resources, we often are not able to find possible miss-bookings. Fortunately, our clients tend to check their statements*

regularly. Though, some clients do not call or send us an e-mail in order to complain about incorrect statements. If we have accidentally booked a trade in favour of the client, most clients wouldn't complain, because it could mean a profit. We process millions of contracts every month and are simply not able to do this without a certain error rate.

When asked about the usual miss-booking rate, he replied:

There is no clear answer to that. We do not have an official figure or conducted a statistical research in term of evaluation yet. Although, in order to give an indication it needs to be highlighted that the booking error rate is much higher in the US markets. Various US markets are still based on open-outcry markets and therefore bookings are input manually. The use of technology is still limited in the US and has only caught up in recent years, compared to many years of electronic processing experience here in Europe.

He stressed the importance of collaboration among the other project members. In his opinion, an organisational structure involving a number of projects could help to achieve his goal, namely optimising internal structures in terms of processing the flow of data. In the interview, he noted how difficult it was to keep members' motivation and productivity up and to maintain organisational unity. He argued that professional services rested heavily upon each professional worker's experience and skills, but also in particular on IT services.

When asked whether he was also responsible for integrating various electronic trading systems into the back-office infrastructure, he responded:

Yes and no. Many systems, which need to be integrated, are sometimes very complex IT integration projects. Since I am 'only' the project manager, I have to rely on our IT staff. Our IT staff are not programmers though. What we normally do is to ask the relevant vendors to program the system in a way so that it fits in our system. Sometimes, these people spend weeks and months either in our office or in their offices in order to achieve this. Certainly, the external programmer needs to know our internal system before we are able to go ahead. This can be very time-consuming. Generally, we tend to use the same external people for various projects, in order to reduce our workload.

At the time, some employees, especially these based in Germany, believed that the CQG system was an ideal fit with the existing trading systems. Peter claimed he did not know the system very well. He believed that it would be a waste of time to enrol CQG, because it would be very time-consuming. In addition, he was unsure what senior management would think about it:

> *At the end of the day, we will be asked how many clients are going to use CQG and how much money this system can contribute to our P&L. We also have to consider that the German office is relatively small and new and I am not sure whether we should support them more than necessary.*

Despite the view in the German office that this new trading platform could be a door-opener to many new clients such as hedge funds who had been using CQG before, he was very sceptical:

> *I doubt that many of our clients will use CQG. As mentioned, I don't believe that our management will massively support this idea. We also have never evaluated the idea integrating CQG because, if people come up with new ideas or project suggestions that would consume resources and money, we would rather reject them. We usually follow the management's instructions.*

When pressed about how this potential project could be enrolled or kick-started within Refco, he said:

> *As you can imagine, the first step needs to be done in the form of discussions between several departments. For example, it would be helpful if certain members of staff, ideally some with higher influence, suggested that a number of potential clients or ideally existing larger clients would like to use CQG instead of the standard established electronic trading systems such as Patssystems, which we have been using for years. Alternatively, the IT or E-support staff could discuss this topic between various departments and offices until a common demand or awareness occurs. In other words, the idea must spread around for a while and be discussed further before we would move on to the next level and involve the senior management. Another approach could be made if the senior manager from CQG talked directly to our boss and informed him about this new project. Only at this stage, we would be able to evaluate these ideas in more detail.*

Dan (not his real name), 39, had worked for the company for five years. He worked in a separate 'risk office', together with five risk management colleagues. They worked independently of each other.

He described their work as follows:

> *Every morning, we look at the data in order to find out what different clients have traded on the previous day. Than we compare the open positions with the margin requirements from the exchanges. If a client has not the sufficient margin in his account, we immediately notify the responsible sales person. The sales person has to contact the client and ask him to close his positions or to transfer some additional money on his account, in relation to his margin requirement from the end of the previous business day. We do have some exceptions. If a larger and well-established institutional client has not transferred the required margin, we do not worry much, even if the margin requirement is large, since it is unlikely that a client will go bankrupt. Technically this well-known institutional client has got no restrictions in terms of having large positions. Generally, we assume that these balance sheets or clients are sound.*

In accordance with his work, Dan sometimes had to travel to visit clients in various cities. It was the nature of his job that not all risk management investigations could be performed electronically or by telephone; some required face-to-face meetings with clients.

5.4.3 IT Investment at Refco

Refco had made investments in information systems since 1982. They purchased hardware and software from vendors such as IBM. General accounting applications were the first areas of investment in the 80s and 90s. As the years passed, more accounting needs were satisfied by information systems investment. Management control, timeliness of reports, accuracy of corporate records, and potential savings were reasons for the investments. Refco reflected the experience of many companies in these application investments. Business justification for the investments was not documented. During the period from 1991 to 2005, a variety of events created rapid growth and expansion of the company, as mentioned above. Within a few years, Refco's sales increased dramatically due to the rapid growth of exchange-traded derivatives.

The monthly P&L report showed all associated costs for Refco. Refco's aim was to receive a return on its investment in information systems within a short period of time. Expected ratios of values to cost had to be achieved in a relatively short period, which generally did not exceed the one-year horizon. In other words, short-term return on investment was expected and had to be achieved, rather than a long-term approach. The main reason was that the management approving IT expenditure was under pressure to keep costs low, otherwise they would lose their jobs.

Information systems investment became important to the management, due to external pressure from clients and regulators. In October 2004, one hedge fund wanted to close their account and move the business to a competitor due to either miss-bookings, lack of reporting to the regulator or even occasionally missing trades. Companies such as the examples mentioned by the FSA above had been forced to invest more in IT due to penalties. Consequently, authorisation was given for an expansion of the use of information systems. Only due to external pressure either from competitors, regulators or important institutional clients did IT investment occur. IT investment was not a proactive approach; it was a result of having no option as can be seen in the cases of Credit Suisse, Getco and Instinet.

Refco's investments in IS investments were reported and monitored by the management on an ongoing basis. Consequently, all following periods were closely monitored and evaluated. Relating IS investments to the attainment of business objectives was an accepted approach. Problems occurred when the dollar benefits of the projects needed to be calculated, evaluated and justified.

The managers understood that Refco's systems development evaluations were helpful to understand other related or unrelated intangible benefits and costs. Refco placed business objectives in the early stages of project definition. Objectives were reviewed during the system implementation. Refco established a performance measurement framework, which was vague and general in nature though and performance measurement concepts contained in reports were not followed up.

Refco's return on investment was the basis for the investment value evaluation report. The people involved realised that it was difficult to calculate accurately. Objectives were set up from a financial point of view. During various brainstorming exercises it was recognised

that no other evaluation methods existed. Only Return on Investment methods were commonly used. One manager felt that Refco should invest in basic research in the use of information systems. However, this did not happen.

5.4.4 Investment Value and Cost Evaluation at Refco

It was difficult to predict the dollar cost of an investment in information systems and the value of the objectives that were attained. A useful report was a summary of prior periods, monthly and present period. The organisation of objectives into priorities was also useful. The percentage return on the investment was shown by the ratio of values to costs. This ratio was used to evaluate the merits of new projects or to evaluate a long period of investment in the field. This had a lot in common with return on investment evaluation. The expected ratio for investment was compared with the actual ratio. This value was established by management and used in the investment evaluation process. A proposed introduction of performance standards aimed to measure performance of the information systems activity. Such reports could be used to evaluate the level of current investments and the return on those investments. Various benefits of information systems investments fell into the group of intangible benefits. This category of evaluation was used when improvements or changes did not have clear tangible benefits.

As mentioned, the process of determining a dollar value in this category was very difficult. Evaluation methods such as replacement costs and performance measurement represented simple ways to evaluate. The value of the implemented information system against the alternative to replace the current information system was discussed as well. Was the internal and external user able to use the data could also be seen as an evaluation method. The business objectives of information systems needed to be clearly identified. Within senior people, it seemed that different business objectives existed. The lack of common business objectives led to the inability of choosing the right information system.

As an example, we can use two electronic trading systems. The first one, called Refco Express, was designed in particular for small retail clients. The other was called J-Trader (Patssystems), which was designed for institutional clients. Choose to promote and build a retail client business platform, one would have to cope with thousands of small clients paying a very small fee and consuming a lot of time and corporate resources.

The assignment of costs to objectives was subjective. It was difficult to allocate costs of systems development and computer operations to general business objectives. An information system was implemented to assist in reducing costs. A starting date for historical accumulation of data had to be selected. Refco's information system history showed collecting historical data was selected as the starting point. Costs and benefits were evaluated from that point. Previous investments have not been included in this research generally. However, they cannot be ignored. Refco invested in various business projects but had not established a performance standard for attaining objectives. Expected ratio values were calculated from actual input from the operation of the information systems.

5.4.5 Refco Report Format

The concept of relating information systems investments to the attainment of business objectives was readily accepted as an appropriate process. One of the core problems managers had was calculating the dollar benefit of the objectives. The format of the objectives attained evaluation report was helpful in order to keep the manager's attention focused on the attainment concept. Measuring performance was crucial through the use of information systems. Managers found that measuring performance, as a function of time was helpful in understanding the report. The managers recognised that time dependencies were the reality and therefore the time dependencies were mentioned in the reports. The first display of time was the day-to-day comparison. The day-to-day report or display was based on the previous day's activities. The involved managers were generally interested in the day-to-day report, even if they received a monthly report at the end of the first week of every upcoming month.

The second display of time was in measuring performance in achieving business objectives that were scheduled for attainment in the current and past period. Some managers did have clear objectives, but had not been able to measure those other than in real currency terms. Information systems staff had only been involved during the implementation and, after the IS was established, only in case of troubleshooting.

Refco's systems were generally from external independent providers and their standards required that business objectives be set in the early stages of project definition. Managers wanted objectives to be clearly stated. Objectives were needed so that evaluation and measurement could be accomplished. Managers discussed the subject of how to state an

appropriate number of objectives. Refco's European arm established a performance measurement programme for management control during 2002/2003. Returns on investment concepts seemed to be the basis for the investment value evaluation report. These concepts were related by the managers to the return on investment procedures used by Refco in evaluating capital investments.

Managers expressed increased interest in the information system investment. They agreed that the objectives should be evaluated from a financial point of view. The assignment of dollar value was the responsibility of the person requesting the information systems expenditure, controlling it with a "cap". However, this internal expenditure cap was set at a very low level. Very useful was the display of investment in "non-profit" activities. Only one manager felt that FSF should invest in basic research in the use of information systems. The feedback regarding the objectives attained values was positive. Translating the business activity into business objectives was a little more common than the other way round. Some people said that the common values confirmed their impression that information systems were important contributors to the expected objectives.

5.4.6 Case Study-The Early Days of High Frequency Algorithmic Trading

The following project has been selected in order to highlight the importance of electronic trading systems in regards to connecting clients to various exchanges. Clients opened accounts with Refco because they wanted access to various exchanges such as Eurex, NYMEX, CME, CBOT, and EuronextLiffe. In order to enable Refco's clients to conduct buy and sell orders through the main derivatives exchanges it was essential that the best electronic trading systems were chosen and implemented. If the client were not able to get an easy, reliable and cheap access to these exchanges then Refco would not survive. In short, clients needed to trade fast and cheaply.

To satisfy customer demand, Refco needed to provide various trading systems, with different strengths and weaknesses. This project is particularly interesting, as it shows the necessity to combine different systems in order to allow customers to have access to the trading screens. The back-office played an important role, since the entire client activities had to be processed, either automatically or often manually. The manual work error rate

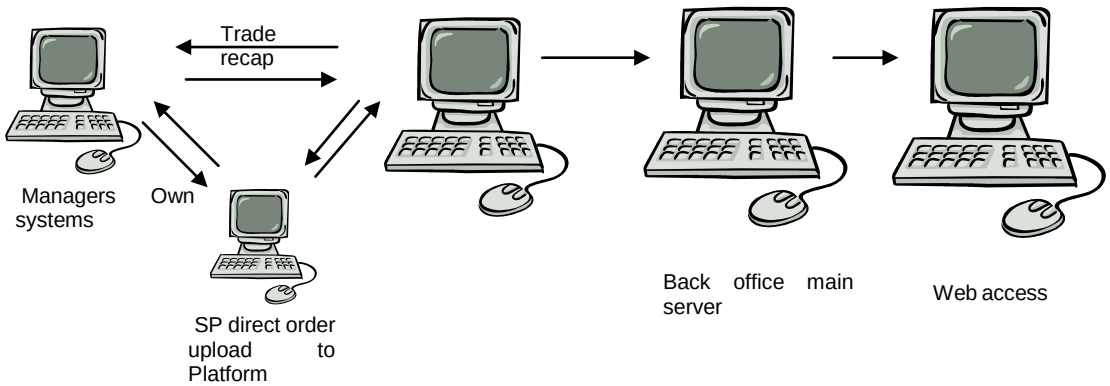
was generally higher. Various systems in different locations had to be integrated and the data had to be properly processed in the back-office. It was also important for the project that more and more traditional open-outcry exchanges were transforming themselves into electronic exchanges, which led to pressure on Refco. The exchange transformations meant that Refco could not process the entire chain starting from taking the orders and placing them in the pits to clearing manually anymore. Gradually, the pits or floor trading disappeared. The nature of electronic exchanges is that certain processes and clearing occur electronically. We also witnessed exploding exchange traded derivatives due to the electronic exchanges. Companies such as Refco needed to increase process capacity in the back-office substantially such as increasing the number of servers able to process the increased business.

Refco's business strategy comprised:

Front end trading systems such as Pats Systems, TT and CQG: In line with the core objective of a high operating efficiency and non-proprietary trading business model, Refco had embraced and driven new trading technology:

- Providing access to multiple platforms and offerings and let the client decide which ones suited their trading preferences.
- Proactively driving this process into the market place.
- Driving Application Programming Interface (API) integration and working with Internet Service Providers (ISPs) for the clients' benefit.

However, the implications for the back-office, including the IT infrastructure, were not properly thought through. The IT infrastructure, aiming for full straight-through processing, web access to accounts and risk management services would be as follows:



5.4.6 Risk Management Aspects

Dan, employed as head of risk management, had been involved in many of the company's projects. He used to work in an unrelated department and had just recently moved to the risk department. As head of the risk department he worked together with five employees. His job was to collaborate with numerous sales people including these who worked for other subsidiaries in Europe. One of his principal day-to-day activities was to 'watch' clients. He needed to be informed about clients' trading activities.

At the time, many people, especially in their 30s and 40s, had experienced redundancies or decided to leave their financial institution. Faced with unemployment, many decided to become independent and self-employed. With few exceptions, these people had been accepted as self-employed clients by Refco, who worked from their homes or for small 'trading arcades'.

Dan described the motivation to work in the risk department as follows:

> *Constantly handling different clients' behaviour in terms of risk from Refco's point of view is interesting. My personal experience shows that most clients prefer using electronic trading systems rather than the phone in order to conduct trades. Most of them try to trade as much as possible in order to make as much money as possible. Often, they try to breach the position limits we have previously agreed and set up. In general, position limits are set up in correlation to the margin requirements from the exchange and the available deposit. Retail clients in particular have to transfer a certain amount of money to our corresponding bank before we calculate the daily intra-day and overnight limits. Position limits are expressed in the amount of contracts this client can keep. Within these limits the clients can trade as much as he/she wants.*
>
> *The dilemma we face on a daily basis is that the client having access to our electronic trading system or via phone, can breach these limits persistently, since we are not able to fully control his activities. For example one constantly active retail client has got four FDAX overnight contract limits and eight intraday contract limits. With our existing electronic trading systems we are not able to stop this client breaching the limits. The professional automated trading systems (e.g. Patsystem) are not able to stop this client from keeping/holding eight contracts*

overnight instead of the allowed four contracts, approved by Refco. The reason for that is our not sufficiently updated internal IT infrastructure.

Dan also pointed to the risk that retail clients could have problems transferring additional cash following the margin requirements on the next day. The company decided to develop an in-house trading system, which was able to monitor the risk, the so-called 'risk based margining'. Here, clients could trade as often and as much as he/she wanted, depending on the clients' collateral.

This IS project lasted for two years. The aim was to roll out everywhere in the world in due course. Due to the complexity of this IT project and the global scale, many other departments such as risk management, compliance and marketing from the London and New York offices had to be involved.

Dan's concerns in terms of business processes were that, in a competitive environment like this, they had to be profit seeking and risk averse at the same time. They also had to work as efficiently as possible in a limited period of time. The market or contracts could move so fast and within a very short period a client could lose a lot of money.

Dan had concerns about this project:

I have not been very satisfied, knowing that the project started in the U.S. and we have not been much involved so far. Here in Europe we are going to start getting more involved with this project soon and it will consume many months to test the system before we can finally implement it. Meanwhile, I have to tell our clients and sales people that we are not able to automate the risk control. At the same time we have to look at clients' needs and expectations on a case-by-case basis. I felt like being involved in internal politics rather than solving the client's problems. Our company does not allow me to speed up the process, because implementing new processes would consume a lot of money. I have to be careful since I do not want to annoy certain colleagues in the New York head office. They will give me a hard time if I am suggesting different business processes too aggressively.

Clearly, Dan and his risk management colleagues were struggling.

5.4.7 Evaluation of Electronic Trading Systems

Dan regarded himself as being ahead of the current organisational changes, which he saw as too slow in terms of implementing suitable and up-to-date technology. He received calls from various clients demanding a more sophisticated electronic trading system. He found himself squeezed between the clients and internal management:

> *As I mentioned, working in this company puts a lot of restrictions on your daily work. Take the example of a specific client: in a firm, you need to have a confirmation from your boss that you can loosen the internal rules in terms of potential risk. It is time consuming and your boss will ask you what the current standard internal rules are and the effects the changes may cause. He will also ask you about the client's importance and for more background information about the client. Generally, he would rather orient himself to the proven internal rules rather than accepting new loosened or different rules.*

Dan found the degree of flexibility in his work activities was restricted. In such a work environment, inflexibility hindered the daily work activities and hence the business as a whole. His experience showed that the important client will move on to a different firm in due course if a certain degree of flexibility is not shown. It frustrated him that larger clients would get almost everything approved and the question of internal corporate risk standards would be avoided.

Dan saw the importance of being flexible and adaptable to the clients' needs:

> *Several clients are very skilled nowadays. Some clients used to work for banks or other organisations and therefore have gained some education and have sometimes incredible skills. They keep asking for an electronic trading system being capable of providing multi-products at the same time. They want a system that matches and calculates the entire client positions. As an example, one large client wants to trade futures and options electronically. Both futures and options long and short positions should be matched against each other in order to reduce the amount of money used as margin. Instead, Refco asks the customer to open two separate accounts, one for the electronic futures trading system and one sub-account used for options trading conducted via the phone.*

Often we reject the client's demand to conduct trades solely via the electronic trading platform. The risk department seems unable to monitor the option trades. Although, this does not make any sense and I believe that the risk for Refco can be reduced, if we enable the customer to conduct all his/her trades via the electronic trading platform. Now, quite frankly, I think the technology can enable us to offer the clients what they want. For me, it seems that certain people within our organisation are simply incapable of evaluating this matter properly. I also believe that a certain resistance to technology implementation and investment occurs due to the fact that some employees are afraid of losing their job. Instead of being proactive, they rather reject the clients' needs and therefore risk losing several clients.

5.4.8 Technology-Network Access to Exchange Applications

Dan stressed how using IT helped his daily work. The computer had become essential to his work: writing reports, emailing, storing data, etc. These day-to-day activities helped to evaluate the clients' activities. He was not particularly advanced in terms of technology adoption in work activities. He would rather not be too dependent on technology, since his IT skills were limited and regular training was too time consuming and expensive. The company had no specific training budget. Therefore he had to ask his boss for approval, something he considered as inefficient. Dan explained he planned to buy a PC for his private use and hoped it would improve his PC skills. At work he had to ask the IT helpdesk on an almost daily basis to help him with a hardware or software problem. He gathered the IT skills he gained so far through learning by doing and on a trial and error basis.

Refco connected clients to various exchanges including Eurex, which allowed members to connect to the exchange system via the Member Integration System Server (MISS). A multi-member installation allowed a centralised hardware operation and maintenance and could reduce the infrastructure costs of the members. The provider of a multi-member front-end installation had to ensure that mutual data privacy for the members sharing the multi-member installation was guaranteed. A member must not be able to access another member's private data such as position reports and trade confirmations. Eurex offered members a connection portfolio for the Enhanced Broadcast Solution comprising of 10, 20,

30 and 50 Mbit/s connections. This enabled members to select the appropriate bandwidth tailored to their individual business requirements.

Refco's network administration and responsibilities: The exchange was responsible for the administration and operation of the network from the back-end up to the boundary of the carrier demarcation point at the member's site. The administration and operation of equipment beyond the connection to the Exchanges such as routers, MISSes, workstations and other members devices at the member's site were the responsibility of the member. Refco needed to buy the hardware, software and also needed to be capable to install and cope with any new software releases. Exchanges constantly improved their technical offering. As an example, Eurex continued to invest in its trading system in order to reduce the processing time of technical transactions. At the same time, Refco's and also the exchange's daily load on the system had grown massively over the years.

According to Dan, the level of IT investment has a major impact on Refco's operations, IT and risk management. There was a need to invest in IT because:

- Speed was so important to achieve low latency
- Risk needed to be evaluated in the context of algorithmic trading

5.5 Development of Algorithmic Trading

Algorithmic trading is redefining system boundaries including higher data transmission speed. One investment bank has stated that every millisecond lost results in $100m per annum in lost opportunity. Milliseconds seem to be crucial; latency will affect its competitive advantage in the marketplace. Brokers are using models for analysing market data for subsequent trade execution. Also hedge funds with focus on algorithmic trading push the market to invest in technology and try obtaining comprehensive market information faster such as order book and execution data. The aim is to monitor market movements faster and delete or change orders before others can match them in the market space. Data signals will be transmitted at speed of light soon. The main causes of latency in networks are propagation delay: time for a certain amount of bytes to be transferred over a medium, depending on the physical distance. Serialization delay is the time a unit of data (e.g. packet) requires to be serialised for transmission on a narrow channel. It depends on

the chosen bandwidth. The figures below demonstrate the sort of delays occasioned by propagation, serialization and queuing.

Propagation Delay — Fixed

Fiber Length	One-Way Delay	Round Trip Delay
1m	5ns	10ns
1km	5us	10us
10km	50us	100us
100km	500us	1ms
1,000km	5ms	10ms
10,000km	50ms	100ms

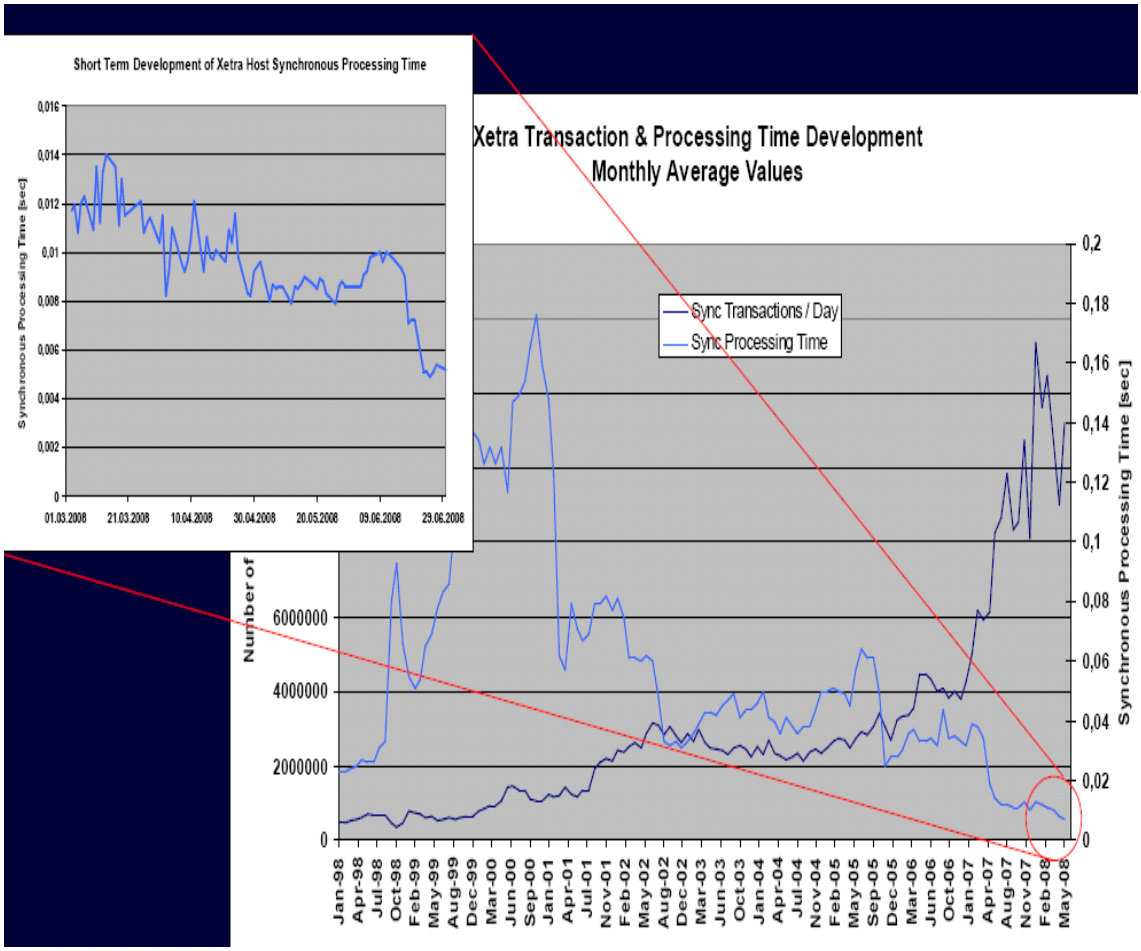
Serialization Delay — Variable

Packet Size	Link Speed 10Mb/s	100Mb/s	1Gb/s	10Gb/s
64B	51.2us	5.1us	0.51us	0.05us
512B	0.41ms	41us	4.1us	0.41us
1500B	1.2ms	0.12ms	12us	1.2us
9000B	7.2ms	0.72ms	72us	7.2us

Queuing Delay — Highly Variable

Qucuing Size (IMIX Pkts)	Link Speed 10Mb/s	100Mb/s	1Gb/s	10Gb/s
64 Pkts	17ms	1.7ms	0.17ms	17us
128 Pkts	33.8ms	3.38ms	0.33ms	33us
512 Pkts	135ms	13.5ms	1.35ms	0.13ms
1024 Pkts	270ms	27ms	2.7ms	0.27ms

Due to growing algorithmic trading, the volume of market activity is rising from year to year (Futures Industry, 2010; Hall, 2010; West, 2010). The transaction load and sync time development on Deutsche Börse/Xetra can be seen on the diagram below:

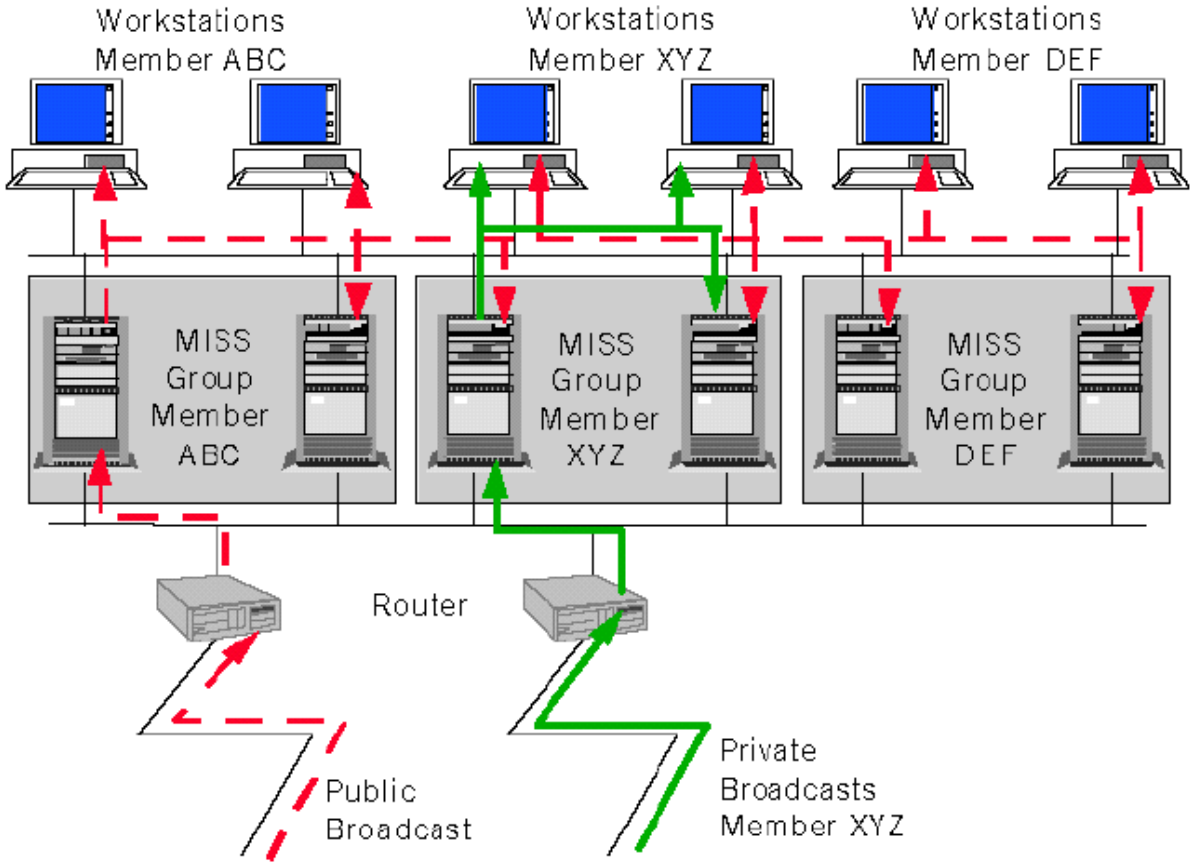


The risk related to algorithmic trading is that human beings constantly need to adjust or change the algorithm. An algorithm working today can be useless in six months' time. Pre-trade risk functionalities empower members to proactively manage their risks in terms of order size; order frequency; maximum order quantity; order limits per time interval. The following kinds of order types are handled in the matching engine (E=Eurex, X=Xetra): market orders (E/X), limit orders (E/X), stop orders (E/X), combination orders (E), one-cancel-the-other (E), market-to-limit orders (X),iceberg orders (X), mid-point orders (X), immediate-or-cancel, ill-or-kill, good-for-day, good-till-date, good-till-cancelled.

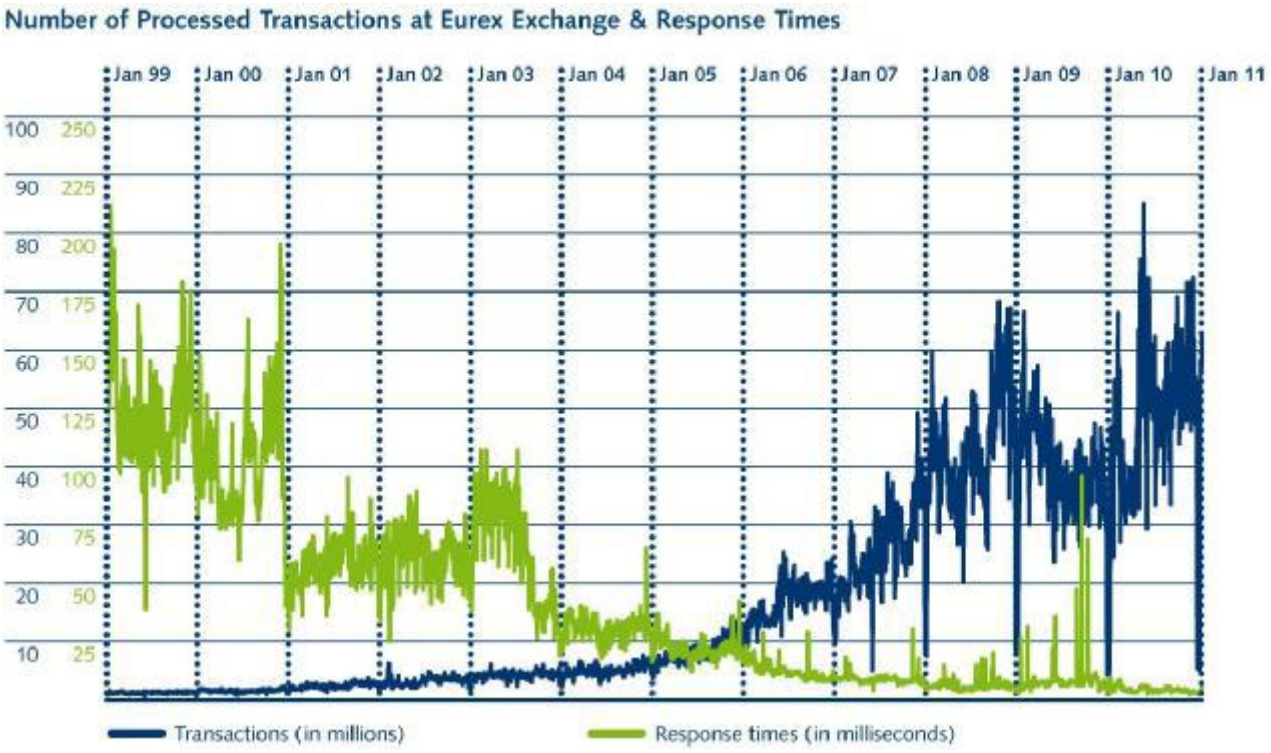
In the case of an outage of the backend computers, an automated failover takes place. The control over the affected order book will then be taken over by a different new 'host'. At the same time, all 'persistent orders' will be transferred as well. 'Non-persistent orders' will get lost. This will be signalled to the market via a dedicated broadcast message. Orders

marked as ‘persistent’ will be stored on hard disk. It will consume additional round-trip time and will be recovered in case of failover.

Orders marked ‘non-persistent’ are only kept in ‘memory’ and this important for algo-traders. Recovery is not possible. Users will only be aware of a failover situation through an electronic message. Execution confirmations will be sent instantly after an order has been matched. This is a synchronous message which carries only minimal data and goes back straight to the user ID of origin. Trade confirmations will be communicated slightly later. These will carry all trade-relevant information and is an asynchronous message which will be broadcast in a specific data stream. Execution confirmations support fast round-trips. Backlogs in matching should not occur at all. For efficient load-balancing order books are spread across multiple exchange backend hosts.



Following diagrams 1, 2 and 3: Eurex Deutschland AG, Neue Börsenstrasse, Frankfurt.



5.5.1 Systems Integration into the Back-Office

The second project concerns the integration of different electronic trading systems into the existing back-office.

Electronic trading and back-office systems needed to be integrated into the in-house risk management system. The external vendor or systems supplier provided the systems' descriptions or manuals. A well-established company that had been offering online analytical tools and online research for years had developed one electronic trading system called CQG. According to CQG, the new expanded software provided extensive historical online data for charting and technical analysis. For people using the CQG platform, trade data was constantly accessible. CQG offered the following online historical data: Intraday historical bar charts, long term historical bar charts, tick charts and volume charts, online trading system.

CQG had been offering the above-mentioned services for many years. Customers were generally long term customers. During 2005, CQG decided to add and offer clients the new online trading facility, enabling them to analyse historical data *and* conduct trades via the same system. This new CQG software had been presented to some Refco offices during 2005 but was rejected by some executives. The ones who knew the older version saw the

potential due to their experience and personal judgement. The German office members discussed the CQG software and all the new changes CQG could implement were highlighted. It was obvious to some people that this new electronic trading system could be distinguished from others in terms of:

- Accessibility: some old and new clients were already using the old CQG version.
- Price: the added trading function did not cost extra.

It allowed customers to analyse their trades before they conducted them. The experienced people were aware that this combination could add value if implemented within Refco. CQG mentioned that they had also talked to Refco offices in France, the U.K. and the U.S.

CQG also highlighted that new clients could get a 20% discount on the system, which costs USD 700 per month rental fee per customer, if they signed up via Refco's promotion or recommendation. The German office had several meetings with the vendor and wanted to support CQG as much as possible. In another meeting several weeks later, a senior CQG representative informed some Refco Germany employees, that they were the most interested and most supportive office members so far. He also mentioned that various executives in the European head office in London decided not to support offering the CQG software to clients. German office employees could not understand why this new software should not be promoted within the group. Nevertheless, Refco Germany still pushed the London head office to enrol and implement the software. However, this attempt failed in the end.

5.5.2 Outsourcing Back Office and Trading System Upgrades

Peter stated that firms often outsource electronic trading systems to independent vendors. In order to accomplish this task, companies have to efficiently coordinate the constantly changing system with the external vendors. There are three main reasons for outsourcing the electronic trading systems software:

- Costs and budget
- Employees' skills and knowledge and
- Risk of failure

In terms of the evaluation of the offerings of independent external vendors, Peter said:

> *In many areas it is difficult and sometimes controversial to evaluate certain aspects of IT investments. But in this case, it has been relatively easy and straightforward for various reasons. Certainly, the three earlier mentioned aspects (costs, skills and risk of failure) played a major role in this decision. It was easy for us to take external vendors services on board, since they already existed and had developed functional systems some time ago. About eight years ago, many smaller or more established vendors existed in this area. Due to a lot of competition some did merge or had been taken over.*
>
> *These vendors' core business is to develop and maintain the software constantly. We are simply afraid of ending up spending a lot of money and not being able to deliver. Even if we could do it today, we may not be able to continue to do so, due to fast technological changes and advances. We have seen so many financial services companies who spend a lot of money and time and finally failed to develop. Additionally, maintenance is very expensive, clients' needs change constantly and the software used today may be useless next year. Therefore, our strategy is to offer clients various electronic trading systems in order to give her/him freedom of choosing the right trading platform software.*

Peter saw few disadvantages in linking the back-office to external vendors' software.

> *The external software has been developed in a way that enables different financial services companies to use it. This means that other competitors use or offer their clients the same software too. But since our back-office distinguishes from other competitors' back-offices, the software is not tailor-made. Initially, it was very time- consuming and sometimes frustrating to enrol or integrate the system in our current back-office. After having accomplished that any standard software upgrade can now relatively easily be adopted. Certain adjustment exercises have become a routine. Clients generally know that multiple financial services companies offer the same trading platform. More than a dozen other companies, for example, use the software Patssystems.*
>
> *The clients can therefore choose with which they want to open an account. And generally, they don't care. Although, if the clients believe that our competitors are charging similar prices and we can't offer a better service, I wouldn't necessarily*

expect the clients to choose opening an account with us. In my opinion, it was a good idea to outsource the development of our own software. As you know, we have been developing our own system. But even after years it still fails to deliver.

Having integrated various external electronic trading systems into the back-office, and gained some years of experience with these systems and customers, he viewed the systems as a highly important control system. Without them he would not be able to implement a day-to-day control system in regards of the number of conducted trades and the constantly trackable profit and loss situation per individual client. He said that without these systems any 'rogue trader' would be able to increase her/his overnight position to a level where they could go bankrupt. Unauthorised trades would go undetected for a certain limited time. In other words, the electronic trading systems enabled them to act transparently. The systems needed upgrading from time to time but this became more or less routine. The vendor did most of the work. With Patssystems, they had an excellent relationship with the company and they also employed ex-Patssystems staff in order to reduce their own workload and to balance their own lack of skills within the company. They also offered clients an electronic trading system called Trading Technology (TT). However, following litigation between TT and several financial firms they were evaluating whether to dispose of TT. Many sophisticated clients were using TT and liked the vendor's capabilities in terms of a relatively reliable order routing system. If they wanted to continue using TT as one of the few electronic trading systems that are integrated into Refco's back-office, they might have to pay higher charges in future.

Peter emphasised the issue of controlling and measuring risks. Every sophisticated electronic trading system offered so-called risk tools, with which the user and also Refco could manage potential market risks. The system's risk tools needed to be evaluated as well, by the risk department. If they did not like the risk tools, they would not be implemented.

Peter also emphasised that external systems had been implemented due to the failure to deliver internal systems.

5.6 Personnel and Organisational Issues

John (not his real name), aged 50 and a senior sales manager with more than twenty-eight years of working experience, had been working for the company for five years. John didn't have a university degree and was not overly excited about technology. He was not very keen on using technology and didn't believe it helped him a lot.

> *Technology might make me unemployed. The clients I have been covering for many years are clients who call me on the phone to receive a service. If they don't call me anymore I will become unemployed. Some traders moved to Gibraltar and use direct market access (DMA) from there. The electronic trading systems are very much reliable now. The traders don't need to interact with me anymore. Once they are set up they stop calling me. We normally receive calls if they have a technical problem, which doesn't happen more than once a year.*

The personal goals of individuals may have a significant impact on project success. Individuals can influence project by the level of motivation and John doubted the effectiveness and reliability of the technology. He confirmed that, as a senior manager, his individual decisions and his motivation concerning technology could affect the chances of a successful project.

Clearly, keeping individuals' motivation at a high level is essential. A lack of motivation to apply skills in the organisation can endanger the success of the project. Amongst the interviewees, nine declared that they needed technology and their subjective evaluation supported the idea to implement more IS. Another six employees supported IS expenditure and preferred being technologically skilled or trained.

Most of the interviewees highlighted that the success of software projects would increase if the managers had some ownership of the outcome. This could be achieved through outcome-based contracts. If the three parties, management, vendor and user shared responsibility for outcomes, rather than for work accomplished, more successful software projects could be witnessed.

Project failure could be avoided if actors support the project rather than reject it. More than twenty interviewees mentioned that they would like to be their *own* risk managers and to

influence their individual risks and rewards. Software implementation and investment alone are not a guarantee of project success. More than thirty interviewed employees highlighted that outcome-based contracts would help towards a project's success.

5.7 The New Role of Regulators

The FSA mentioned in its Newsletter, Issue No.19 March 2007, anonymous cases related to Suspicious Transaction Reporting (STR) in order to help firms understand FSA expectations and to promote additional internal training:

"We have attempted to address areas that are currently of particular priority to the FSA. Such a case is referring to Contract for Differences (CFD):'you work for a medium-size broker as a compliance executive; most of your clients are either institutional or medium to high net worth individuals. Part of your daily job is to monitor all the previous day's trades against regulatory announcements. You review recent regulatory announcements and run a sample, risk-based physical check of yesterday's trades. You notice that a large UK-based defence company has just announced winning a major US contract and so far today the share price is up 20% to 120p. Three accounts have made significant long positions in the week before the announcement. You decide to look at the accounts and their trading history in more detail. Your firm usually transacts this particular name at the 100,000 shares, and it's a very liquid name.

Account 1. Long 100,000 shares at 98p. This account belongs to an institutional investor who trades regularly in the name; there is nothing unusual in the size. Also, the account had put on similar trades on three other defence companies at the same time.

Account 2. Long 150,000 at 97p. This account belongs to a private investor. However, you notice that he has only just opened the account and this is his second trade to date. The first trade was a long 50,000 on a different stock and is still flat profit. You review Know Your Customers (KYC) documents and find that his stated annual income is £ 50k. The timing and the size of the trade strike you as suspicious, especially in the context of his income relative to risk taken on the trade.

Account 3. Long 80,000 at 99p. This also belongs to a private investor. The account has traded regularly but only ever in small cap tech stocks and usually in much smaller size.

You look at his KYC documents and discover that his stated income is £ 500k. Despite the size of his stated income the size and sector of the trade strike you as suspicious when reviewed in light of the good timing. We would expect an STR for the second and third accounts, along with as much detail about their trading history as possible. You should provide relevant recordings about the orders (if phoned in).

After MIFID we will require a new directive type classification to be used when reporting transactions in credit default swaps. We will not proceed with our proposal to require firms to identify whether a principal transaction was executed for proprietary or for client facilitation. It will not be mandatory to include seconds in the trade time field. Where seconds are unavailable they can be defaulted to '00'. To identify the client or counterparty, firms should use either the FSA reference number or Swift Bank Identifier Code or, in circumstances where neither is available, a unique code. This internal code must be allocated specifically and consistently to that client or counterparty by the reporting firm across all asset classes. When reporting a transaction in a single stock (or debt) over the counter (OTC) derivative or a single name credit default swap it will be mandatory to populate the underlying security code field with an ISIN" (FSA, Newsletter, Issue No. 19, March 2007).

On 8th April 2010 FSA announced in Issue 62 that they imposed fines totalling £4.2m for transaction reporting failures. The firms mentioned are Credit Suisse (£1.75m fine), Getco Europe Limited (£1.4m) and Instinet Europe Limited (£1.05m). Credit Suisse Europe is a bank with headquarters in Zurich, Getco is an algorithmic trading company and market maker on certain exchanges and Instinet is a niche player in agency brokering.

FSA states:

> "Firms are required to have systems and controls in place to ensure they submit accurate data for reportable transactions by close of business the day after a trade is executed. The FSA uses the data to detect and investigate suspected market abuse such as insider trading and market manipulation. All three firms were found to have committed multiple breaches that resulted in failures to provide transaction reports promptly and correctly to the FSA. Instinet was also found to be in breach of FSA principles, as the firm did not have adequate systems and controls in place to meet the transaction reporting requirements and failed to take adequate steps to review its processes and the accuracy of its transaction report data. Each firm could have

prevented the breaches by carrying out regular reviews of its data. Despite repeated reminders from the FSA during the course of 2007 and 2008, none of the firms did this" (FSA, Newsletter, Issue No. 62, April 2010).

Alexander Justham, Director of Markets, said:

> "Firms must meet their obligation to provide accurate and timely data. Without quality data we cannot properly detect and investigate market abuse, identify market wide risks or have a comprehensive understanding of the activities of each firm. This data is vital in our efforts to combat financial crime and we will continue to pursue firms that fail to provide quality data. Firms and their management must ensure they implement and operate systems and controls that are able to ensure quality transaction reporting. The standard of regulatory reporting by these firms fell far short of what the FSA expects and requires" (FSA, Newsletter, Issue No. 62, April 2010).

According to the FSA:

> "The firms cooperated fully with the FSA in the course of the investigations and agreed to settle at an early stage. In doing so each firm qualified for a 30% discount. Without the discounts the total fines would have been £6m" (FSA, Newsletter, Issue No. 62, April 2010).

5.7.1 The Credit Suisse Case

The problems of Credit Suisse concerning the FSA's new approach to regulation are described below because of their relevance to the situation in Refco and to the wider financial services industry. The problems concern regulatory provisions and inadequate controls in relation to transaction reporting. The material presented comes from FSA publications and is not a result of primary research.

The FSA wrote in a letter published on 8th April 2010 as follows:

> The FSA gave Credit Suisse Securities (Europe) Limited, Credit Suisse (UK) Limited, Credit Suisse International, and Credit Suisse AG (collectively "Credit Suisse" or the "Firm" a Decision Notice on 29 March 2010 which notified the Firm that pursuant to section 206 of the Financial Services and Markets Act 2000 ("the

> Act"), the FSA has decided to impose a financial penalty of £1.75 million on the Firm in respect of breaches of rules set out in chapter SUP 17 of the FSA Handbook which occurred between 5 November 2007 and 20 November 2008 ("the Relevant Period").

The Firm has confirmed that it will not be referring the matter to the Financial Services and Market Tribunal. Accordingly, for the reasons set out below, the FSA imposes a financial penalty on the Firm in the amount of £1.75 million.

FSA stated:

> "Accurate and complete transaction reporting is essential to enable the FSA to meet its statutory objectives of maintaining market confidence and reducing financial crime. The primary function for which the FSA uses transaction reports is to detect and investigate suspected market abuse, insider trading and market manipulation. A transaction report is a data set submitted to the FSA and related to an individual financial market transaction which includes details of the product traded, the firm that undertook the trade, the trade counterparty and the trade characteristics such as buy/sell identifier, price and quantity".

In the Relevant Period Credit Suisse breached Chapter 17 of the Supervision Manual, which is part of the FSA Handbook in that it failed to submit accurate transaction reports in respect of approximately 40 million transactions. The FSA considers these failings to be serious, particularly because:

> Credit Suisse's failure to submit accurate transaction could have a serious impact on the FSA's ability to detect and investigate suspected market abuse and consequently could impact the FSA's ability to maintain market confidence and reduce financial crime. In addition, its failure has impaired the FSA's ability to provide accurate transaction reporting data to overseas regulators;
>
> Credit Suisse failed to report all 30 million LSE transactions it executed during the Relevant Period, and inaccurately reported a further 10 million transactions across all of its asset classes; and
>
> Credit Suisse's failures occurred during a period of heightened awareness around transaction reporting issues as a result of the implementation of the Markets in Financial Instruments Directive ("MIFID") and public statements by the FSA.

After the FSA brought errors in Credit Suisse's transaction reporting to its attention, the firm took a number of steps, which mitigate the seriousness of the failings. These included:

> Conducting a "Front to Back" Review of the Credit Suisse transaction reporting process, and engaging external consultants to provide quality assurance in relation to that review;
>
> Developing and implementing a quality control process to ensure the accuracy and completeness of transaction reporting to the FSA going forward;
>
> Implementing an enhanced Transaction Reporting Awareness training programme;
>
> Improving communications with the external reporting mechanism for LSE transactions.

The transactions, which are required to be reported to the FSA, are defined in SUP 17.1.4 R, which states:

> A firm which executes a transaction to trading on a regulated market or a prescribed market (whether or not the transaction was carried out on such a market or in any OTC derivative the value of which is derived from, or which is otherwise dependent upon, an equity or debt-related financial instrument which is admitted to trading on a regulated market or on a prescribed market) must report the details of the transaction to the FSA.

On page 6 of the FSA publication from 8th April 2010 it is mentioned:

> Prior to the implementation of MiFID, all of Credit Suisse's transaction reporting of LSE transactions was conducted through the External ARM. Credit Suisse decided that after MiFID implementation:
>
> It would continue to transaction report all of its LSE trading, amounting to 25% of its reportable trading activity in the relevant period through the external ARM; and
>
> The remainder of its transaction reporting would be through its own in-house ARM named DARE, which it set up for this purpose. As a result Credit Suisse's MiFID implementation project in respect of transaction reporting focussed upon the design, development and testing of systems to report transactions via DARE.

Between August and October 2007 the external ARM issued eight operational bulletins to a Credit Suisse email account designated to receive such operational bulletins. These Bulletins stated that if firms wished the external ARM to continue transaction reporting on their behalf after MiFID, it was necessary to submit a mandatory static data form prior to the implementation of MiFID.

Credit Suisse did not submit the static data form to the External ARM, and the External ARM stopped transaction reporting on behalf of Credit Suisse on 12 November 2007. However, after this date Credit Suisse believed that the External ARM was continuing to transaction report its LSE trading, as it had done prior to MiFID. Credit Suisse had several meetings with External ARM during the Relevant Period in which they discussed the inclusive fees paid by Credit Suisse for clearing, settlement and transaction reporting. Credit Suisse assumed from these discussions that the reporting was continuing. Between August and early October 2007, Credit Suisse conducted User Acceptance Testing ("UAT") in respect of its arrangements for reporting non-LSE transactions, which it intended to submit to the FSA through DARE. As part of UAT 2,930 test cases were executed, focussing on many of the transaction reporting requirements. As a result of the testing a number of shortcomings were identified and remedied. Between February and May 2008 Credit Suisse conducted a review of the key changes to transaction reporting through DARE in the three months following MiFID implementation. No equivalent review was carried out in relation to transaction reporting through the External ARM.

During the relevant period Credit Suisse mistakenly assumed that 25% of its reportable LSE transactions were being reported on its behalf by the External ARM but failed to develop and implement controls to confirm that these reports were being submitted, whether in accordance with the standards of SUP 17 or at all. This failure occurred despite repeated warnings by the FSA in Market Watch and TRUP that firms should regularly review the integrity of their transaction reporting data. Firms were also encouraged through Market Watch to request transaction reporting data from the FSA in order to verify the integrity of transaction reporting data. Credit Suisse did not request transaction-reporting data from the FSA submitted through the External ARM. If it had done so, or had otherwise monitored the accuracy of its transaction reports, it would have become apparent that none were being submitted in relation to LSE transactions.

In early August 2008, the FSA observed, in the course of a review of non-LSE transaction reports, that Credit Suisse was reporting the unit price of some transactions in minor currency (pence) instead of major currency (pound sterling). After analysing the issue, Credit Suisse confirmed that this affected a total of approximately 300,000 equity transactions denominated in sterling, which were attributed to a single system and business area.

Credit Suisse's own analysis of the "unit price issue" also identified that a number of exchanges and Multilateral Trading Facilities ("Miffs") were being incorrectly identified as "Off-Exchange" rather than by the identifying Market Identifier Code allocated to each exchange and MTF; this error affected 1.3 million transactions. In mid-September 2008, the FSA identified that Credit Suisse was reporting certain transactions using Greenwich Mean Time ("GMT") rather than British Summer Time "BST") during British Summer Time. After preliminary analysis of the issue, Credit Suisse stated that this affected transactions executed on a single exchange, totalling 5 million transaction reports, and identified that a further 140,000 transactions were affected by a similar issue where the time was incorrectly adjusted. In addition, the FSA identified in December 2008 that Credit Suisse had incorrectly populated the "Counterparty one" field in certain transaction reports with an internal code instead of the Counterparty Swift BIC. Credit Suisse subsequently confirmed as part of its "Front to Back" transaction reporting review that this issue affected 2.2 million transactions, 0.5 million transactions of which had already been affected by incorrect categorisation as "Off-Exchange", as stated in paragraph 2.29 above. The FSA identified in November 2008 that Credit Suisse had not submitted any transactions executed on the LSE for an extended period of time. Credit Suisse confirmed that the External ARM had stopped reporting such transactions on its behalf on 12 November 2007, affecting 30 million transactions, and re-enabled reporting with the External ARM from 20 November 2008.

Transaction reporting has been discussed globally recently due to market uncertainty. As a result of market uncertainty legislation for OTC derivatives is undergoing change. On 20th October 2009, the European Commission published its proposal to reform the OTC derivatives markets. In the US legislative process has begun and the first draft bills have been published already. The G20 issued a statement on 29th September 2009 outlining commitments for reforming these markets. The main area of discussions covered at global level is:

- How greater standardisation of OTC traded contracts can be achieved;
- How the involved banks and other financial services can contribute by offering STP, electronic trading and clearing.
- How CCP can reduce counterparty risk and potentially stabilise the entire financial services industry;

- How IT investment has an important role to play in supporting regulatory objectives;
- Whether it is possible meeting regulatory objectives without forcing trade flow through organised trading platforms.

Companies such as JPMorgan, Morgan Stanley, UBS, Credit Suisse and Goldman Sachs (to name a few) have many institutional end clients such as hedge funds and asset managers. These end clients started demanding so called OTC flexible contracts and wanted to trade these options and futures. Two main exchanges in Europe offer these OTC flexible contracts as an exchange traded and centrally cleared product. Clients can trade these non-standardised OTC Flexible Contracts via Eurex or via Euronext/LIFFE.

The problem is that the client can chose to specify any strike price, maturity or whether the contract should be cash settled or based on physical delivery. Due to the fact that these kinds of contracts are tailor-made contracts, it is not easy to straight-through-process them (STP). Certain back-office clearing systems such as Rolfe& Nolan systems have got the functionality and enable the banks or brokers to clear these non-standardised products. Other clearing systems such as the market dominating Sungard System do not offer the entire OTC flexible contract module to their clients. Some banks such as UBS, Credit Suisse, JP Morgan use Sungard and are not able to clear OTC flexible futures due to the fact that Sungard is not able to offer them this specific clearing module.

Instead, institutional clients trade these products via other financial services firms with the capability to clear flexible futures. Also, according to interviews with JP Morgan, Credit Suisse, UBS and Goldman Sachs, Sungard charges clients an extra amount for this extra service. Sungard told its customers that they would consider programming and offering a new extra OTC flexible futures module if they paid for it. Alternatively the costs could be covered by the exchanges directly since they are interested to increase volume in this relatively new segment. According to the feedback from various involved banks, institutional clients 'forced' the banks to conduct the OTC flexible futures trade even without the capability to clear the contracts. It had to be booked manually and was a very time consuming exercise for the involved banks. The risk management department was involved since having positions in products you cannot clear properly is a nightmare for any bank. As an example, it is not possible to calculate the entire portfolio margin requirement for this specific client. That means the institutional client may have to pay an

excessive amount of money in order to cover the margin. Still, the risk management team is not able to calculate the entire portfolio since part of the portfolio is not reflected in the margin calculator used.

5.8 Summary

The past fifteen years have seen an explosion in the amount of electronic trading, much of it high frequency, algorithmic trading. The huge increase in the number of transactions has been accompanied by increasing demands for fast execution of complex trades, such that latency and proximity became important. These trades, in turn, created a huge demand for fast, reliable back-office clearing, as well as significantly raising the levels of risk in the market, which called forth much more intensive regulation from the FSA and other regulators. All of this created massive demands on the IT infrastructures of financial services firms like Refco.

What was needed by companies like Refco was a change in the way that they viewed IT and hence the way that they evaluated IT investments. Unfortunately for Refco, they were unable to make these changes and continued to view IT as an overhead cost that needed to be minimised.

The case shows that gathering information is crucial. Flexibility and adaptability of work activities to clients' needs and some other contingencies are the professional's competitive advantages in the market. The PC enables employees to utilise time and space in daily work activities efficiently. The work activities need to be seen in specific contexts. As one may realise, traditional exchanges are transforming into electronic exchanges and can be seen as IT companies nowadays. In order to be linked to exchanges in a most efficient and effective way, organisations such as Refco need to adopt and implement new technology.

Within the organisation, the concept of power played a major role. The designing, developing and implementing of IT/IS had always to be approved by the management. Some employees mentioned that the organisational actors used power and political actions to affect the way IT/IS was managed and used. Several employees pointed out that power concerns affected how individuals within the organisation adopted technology, trained the users, designed systems and promoted projects. Departments used their control of financial resources to guide systems implementation.

Electronic trading systems enable firms like Refco to control the number of conducted trades and the profit and loss situation per individual client. These electronic trading systems limit any potential 'rogue' traders' intentions to build massive positions to a level where the company could gain severe losses. Unauthorised trades would go undetected for a certain time. Electronic trading systems enable financial services companies including large banks to control the clients and protect them at the same time. Such firms provide their clients with access to exchanges via electronic trading systems, which on the other hand can offer a risk management and control tool.

Globally, regulators and politicians started to realise that the financial services industry had to be regulated. New legislation was (and still is) implemented in order to 'control' the way derivatives are traded and processed. Expected new legislation will force financial services firms and exchanges to increase their IT investment budget over the next few years.

On April 2010, FSA declared on their website:

> The final notices for Credit Suisse, Getco Europe Limited and Instinet Europe Limited can be found on the FSA website.
>
> Previous warnings on the importance of transaction reporting can be found at: Market Watch issue 19 and Market Watch issue 28
>
> The FSA regulates the financial services industry and has four objectives under the Financial Services Markets Act 2000: maintaining market confidence; promoting public understanding of the financial system; securing the appropriate degree of protection for consumers; and fighting financial crime (www.fsa.gov.uk).

Chapter 6 - Analysis and Discussion

6.1 Introduction

This chapter brings together the key issues and insights from the case study through an analysis using actor-network theory. The objective is to provide insight into how information systems investment evaluation interacts with the other activities within the electronic trading network. The analysis starts by highlighting the major findings from the case study in terms of the research agenda of the thesis. A discussion of the empirical research findings is undertaken based on ANT.

6.2 Case Study Findings

This section summarises the contributions and the problems experienced in the case study in terms of the research agenda and the integration of IS evaluation into the electronic trading (actor) network.

All exchanges acknowledge that HFAT has reached a critical mass within the industry and needs to be served properly. The exchanges offer low integration costs and in some cases offer to contribute to clients' infrastructure costs. Advances in electronic trading infrastructures reduced transaction costs per trade. Hedge funds started demanding extra resources from Refco and other brokers' operations in the back-office. Those hedge funds became new actors within the financial services industry with specific demands for services.

The Social Shaping of Technology approach (SST) provides information concerning the context within which technological innovations are framed. SST suggests that the materiality of every technology is socially shaped and diverse political and social powers influence the process of any development such as the emergence of hedge funds. Compared to SCOT's focus on social determinism, ANT sees the social and the technical with no distinction in this case study. More than ten thousand hedge funds needed a connection and a service from one or the other financial services companies such as Refco. At the same time, regulators monitored and regulated both actors: Refco and its hedge fund clients. In

order to serve the client properly certain Refco senior managers based in the U.S. had different and divergent ideas in terms of problematization. Problematization did not occur.

As we know, the hedge fund as an actor can only be defined in association with another actor such as Refco. 'The symbolic boundary between people and information technology is in a constant state of flux.' The actor-network is constituted by various heterogeneous actors connected with associations. Refco had a specific relationship to hedge funds as actors. However, they had divergent and often conflicting interests. Refco itself was an actor within the financial services industry actor-network and aimed to keep costs as low as possible. On the other hand, hedge funds wanted to receive the best execution services in terms of IT and operations. The alignment process of a network where both human and non-human actors are engaged was not in place when the volume started to increase rapidly. Hedge funds were successfully enrolled when the required technology infrastructure was offered by Refco. The actor who is animated to use a specific technology such as HFT would join the network.

The four stages of translation mentioned in Chapter Three were not followed in the translation process and in the creation of an actor-network. Translation could have happened between actors when an actor introduces to another actor his/her preferred scenarios for the use of an existing or new technology. Here, Refco did not have an upgraded IT infrastructure and at the same time it had had problems with the regulators for many years. For instance, various clients complained about execution prices for futures. In an ideal world, Refco could have followed the 'four stages of translation', namely prolematization, interessement, enrolment and mobilization.

As we know, the process of translating the actors' diverse interests in order to offer them in a certain way to enact and at the same time keeping the network stable is known as the 'sociology of translation'. This process depended on the situation of the hedge funds. A rejection of alternative translation(s) occurred when more and more hedge funds decided to open accounts with Refco's competitors, because they started offering an advanced IT infrastructure by investing in technology. Actor-networks can become unstable and they can constantly be in a state of fluctuation because of their aim to redefine their structure as we have seen in this case. The process of translation can lead to alternative translations, where Refco decided to ignore regulators' concerns and at the same time ignore hedge funds' and other large institutional clients' requests for advanced technology. When a

translation leads to alignment of the interests of the majority of allies, the actor-network formed will be coherent. In this specific case this did not occur.

Legislation can influence translation. When a network is resisting reversibility within the frames of specific institutional legislation, then the behaviour of its actors can become standardised. The network can become reliable and predictable. This new network can also be seen as a black box, which can be transferred within the contexts of other actor-networks. An actor-network is constituted by various heterogeneous actors connected with complex associations. Refco's employees in various departments such as IT, compliance, risk, sales and HR often conflicted with each other and were actors at the same time. A network can be considered as successful when an adequate body of actors is enrolled. An actor can be persuaded that it is in his/her own interest to utilise a technology. As soon as it provides an answer to his/her problems, he/she will decide to become part of the network.

The process of translating the actors' diverse interests in order to enact in specific ways while maintaining the overall network stability is known as the 'sociology of translation'. We need to consider the specific situation in which the actor is in order to expect a positive translation. For example, a human actor will try to secure his/her job before making any decision with the consequence of losing his/her job afterwards.

For Refco, translation took place only among senior Refco management in the U.S.. Refco's management introduced their preferred scenarios for the use and purpose of technology to the hedge fund world with contradicting objectives. Refco wanted to spend as little money as possible and the hedge fund world wanted the most state of the art technology in order to continue increasing daily transactions. During the translation process, fewer and fewer hedge funds followed Refco's suggestions and the creation of a stable and sustainable actor-network was more and more under threat.

During the problematization phase, a hedge fund based in Guernsey, tried to communicate the lack of available IT infrastructure and the problematic situation to other actors. The focal actors' aim was to highlight to other actors within Refco what kind of resources were needed to configure a solution to their mutual problem.

Other hedge funds, or in ANT terms 'allies', started supporting the hedge fund. In this situation, the hedge fund was seen as indispensable and started establishing an obligatory

passage point (OPP). According to Callon (1986b), the OPP is highly aligned with the focal actor's interests, other actors need to be persuaded and adapt their behaviour in order to pass through this point. A network cannot be stabilised if there is no successful translation of such point. As a next phase, the focal hedge fund actor continued to animate other hedge fund to not enrol into Refco's IT infrastructure but to set up new accounts with other brokers. Problematization and continued communications aim is to show alternative benefits and stabilise other hedge funds in the new infrastructure.

Obviously, the focal actor was successful with the translation and animated other hedge funds to use the competitors' HFT technology and enrol to their network. The mobilisation phase continued and the new structure of the network became more and more obvious. Hedge funds that set up their new accounts with other brokers were not willing to leave the network again. Actor-networks may always be in a state of fluctuation because of their tendency to alter and redefine their structure (Callon, 1989). Even if the translation had been positive the result does not need to be a new stable network. Refco's management's preferred scenario was undermined by the focal actor's alternative translations.

After Refco went bankrupt, a new 'follow-up' company was created in Europe. Alternative translations reversed and hedge funds started using the follow up company, Marex Financial Ltd. The relevant translation depends also on the new financial legislation. The level to which the actors of the network value structures defines how convergent the network value is. A successful translation leads to a robust network and becomes irreversible. Marex Financial Ltd. was created at the end of 2005 and started processing client orders on 26th January 2006. Marathon also acquired the assets of Refco Trading Services (RTS) and EasyScreen. EasyScreen provides integrated electronic trading systems used by traders to connect to worldwide financial exchanges.

6.3 Trading in Proximity with Exchanges

Global exchanges have provided proximity services since 2007. The number of members participating in proximity hosting surpassed one hundred in 2009. Deutsche Börse (DB) provides proximity services through two sites with a round trip time of information transmission of less than 10ms. Members are provided with ultra-secure data centre space, no power failure and high reliability. Until recently traders could only connect through DMA to their local exchange or any other exchange in order to receive price information.

Refco's clients based in the USA received information at a much slower pace of 130ms compared to a firm located in London which offered less than 30 ms.

Milliseconds are important in HFAT. Information transmitted within a network is impeded by serialisation and so called switching delay. The serialisation delay is associated with the bandwidth of the connection and can be minimised by high capacity transmission lines. Various nodes in the network cause the switching delay. Propagation delay depends on the physical distance between the network nodes and can only be minimised when the distance is reduced.

During the transformation of exchanges, actors have gained new roles within the industry. Refco's clients' IT infrastructure was often outsourced to a low-latency specialist IT provider. DB has contractual arrangements with global network operators such as COLT, BT or Deutsche Telekom. Now, the translation and mobilisation phases will be described and discussed.

6.3.1 Processes of Translation

Proximity hosting was seen as a possible solution to decreasing revenues on the one hand and increasing client knowledge on the other hand. Refco's clients became more and more sophisticated and at the same time gained access to relatively cheap advanced technology. Exchanges such as DB and NYSE coped with this new trend and started offering additional services based on IT. Exchanges started initiating the problematization phase. They invited exchange members, banks and brokerage companies into so-called 'IT working committees'. The working group consisted of IT, back-office and business staff across the entire financial services industry and consulted every three-month. The identification of the problematic situation and its communication to other actors within the industry including vendors and telecommunication companies took place regularly. The main actors supporting such services were the members with the end client demand and new revenue streams.

Exchanges and also new vendors proceeded into the interessement of potential allies. The new partnerships enabled the emergence of new services and new collaboration between actors. Refco was not involved and did not show any interest to participate or being engaged in this new industry trend and transformation. No representative from Refco was

invited to the relevant working groups set up by exchanges. The emergence of proximity hosting led exchanges to engage with telecommunications companies. The creation of the actor- network occurred while exchanges worked with companies from different sectors.

When mutual interests were aligned with those of the exchanges, they enrolled to the actor-network as inscribed by the focal actor. Refco and other brokers knew that it was too expensive to set up data centres on their own. Proximity services are relatively cheap and provided exchanges with an alternative way of connecting clients. Compared to Refco, other brokers decided to be involved in order to remain competitive.

On the other hand, regulators such as FSA were concerned that HFAT was disruptive to the market. Software vendors such as Patssystems offered platforms allowing orders to be spread simultaneously on multiple exchanges at the same time. Meanwhile, few exchanges started offering enhanced risk solutions without adding significantly to latency in terms of execution time. As technology supports the development of HFAT, the role of hardware vendors in proximity trading has become very important. Brokerage firms and trading companies have to rely on vendors to support their business. An actor-network has been established and does not seem to be reversible. New actors such as Colt in the telecommunication industry and independent data centre providers are enrolled and mobilised.

Is technology constructed of society or society made up of technology? The key term actor, for example, is not used as in conventional sociology where actors are usually defined as "discrete individual, corporate, or collective social units" (Wasserman and Faust, 1994, p.17). This network can be read through the inscription in the intermediaries. The more heterogeneous elements a text or object are implicitly or explicitly able to align, the more it becomes part of the network. An algorithm is an actor because it can mobilise a network of heterogeneous allies to do things and exchange value. In an electronic trading system this network of allies is tightly sealed and it is hard to question the connections of those networks for an individual.

The new financial legislation is a collection of black boxes. In its formation stage legislation is a contested set of competing sentences around which occasionally large alliances are built to influence their specific shape. During the legislative process they seem to be fluid and open. After implementing the legislation, contested sentences turn into a

black box, sealing all the elements. The stability of a black box is influenced by the costs of reopening it. This is not only determined by the social groups and procedures sealed into the black box, but also by the materials which are included. Algorithm software is constantly reopened and sealed again because of its fluidity and low production costs.

This is the process of constantly questioning some elements of the box and trying to seal it again. "The more automatic and the blacker the box is, the more it has to be accompanied by people" (Latour, 1987, p.137). HFT as an actor can be seen as "any element, which bends space around itself, makes other elements dependent upon itself and translates their will into a language of its own" (Callon and Latour, 1981, p.286). “Actor and network constantly redefine each other; one is dependent on the other” (Callon, 1987, p.93). Since there is no actor without a network, new networks emerge out of already existing ones. “By translation we understand all the negotiations, intrigues, calculations, acts of persuasion and violence thanks to which an actor or force takes, or causes to be conferred to itself, authority to speak or act on behalf of another actor or force” (Callon and Latour, 1981, p.279).

Humans and non-humans as equal actors are tied together into networks, built and maintained in order to achieve a particular goal such as the development of HFT system. Competences are negotiated on a trial and error basis.

Elements represented in the electronic trading systems act and do specific things. Outside Refco, the elements are actants, entities that have an independent reality. Inside the firm, they become actors, entities that do things, hopefully those things the texts were written for. A trading system can be seen as a network aligning heterogeneous elements, such as people and equipment. A black box contains a sealed network of people and things. A network mainly ties together two systems of alliances, namely people and things. Things enable people to be connected. People and things were interconnected within Refco constantly. However, Refco failed to support and interconnect people effectively. The size of a network depends on the number of actors it can align.

Hedge funds wanted to use a reliable Refco electronic trading system or in other words an intermediary that passed the futures products between actors. Intermediaries are the language of the network. Through intermediaries actors communicated with one another

and that is the way actors translated their intentions into other actors, including Refco's senior management.

Networks allow actors to translate their objectives, be it conscious human choice.

> "By translation we understand all the negotiations, intrigues, calculations, acts of persuasion and violence thanks to which an actor or force takes, or causes to be conferred to itself, authority to speak or act on behalf of another actor or force" (Callon and Latour, 1981, p.279).

Networks emerge and are shaped by aligning more and more actors. The importance of an actor depends therefore on the number of actors within his/her/its networks which he/she/it can employ to a particular purpose.

Refco failed to successfully translate others and therefore did not grow any more during the last few months before the collapse. The emergence and growth of the Refco network, was interrupted by the failure to recognise intermediaries that appeared. Those intermediaries' objective was to translate hedge funds' needs.

A network can develop in two different directions, towards convergence or towards divergence of its actors. Adding new actors to a network at first increases their divergence. The processes of translation by which the will of one actor is transferred to another actor become initially more difficult because each new actor is already included in other networks that might have aligned him/her/it for different goals. Refco could not handle the new situation and failed to evaluate the hedge funds' and other HFT companies' expectations and needs. Translation is a process that is performed by one actor such as the IT employee working either for Refco or the hedge fund. Refco's senior management was not independent and already part of other networks such as the unregulated entity in the U.S. The stronger the coordination of the circulation is, the more the different elements are aligned, the more stable and predictable it becomes. Refco's network changed to a divergence point and towards disintegration in which it reversed its connections to the hedge fund world.

Refco's network was not able to stabilise due to the lack of translation and ability to achieve a certain convergence. On the other hand, the HFT community as an actor-network stabilised and converted. The promotion of a network supports the actor's development.

It is important that the associations that actors form and the networks to which these associations bind them can be recognised. Whether an actor is seen as an empty vessel through which an intermediary passes, or whether it is an explicit concern in itself will vary according to standpoint. As described, society and technology are not 'two ontologically distinct entities but more like phases of the same essential action' (Latour, 1991, p. 129).

Hedge funds' demands associated with introducing a new technology and the re-arrangement of work practices within Refco provided a platform for evaluating how priorities were set. Listening to explanations given from within a field site with respect to why a particular course of action should be taken opens out the question of priorities to analysis. Priorities were maintained even with the knowledge of potential self-destruction as we have seen in this case. Marex Financial Ltd., the successor to Refco, aimed to stabilise the network. Also, Marex aimed to achieve heterogeneity by having diverse interrelated elements. There is a positive correlation between the size and the heterogeneity of a network. This new actor-network is stable and resists competing translations.

6.3.2 Enrolment and Translation

Collective responsibility implies a joint working relationship. It should be highlighted that the performance being measured is the collective performance of the management group to achieve business objectives by investing in information systems.

The attainment of business goals and ownership desires is the responsibility of the management. Specific activities with the aim to support organisational objectives are the managers' responsibility. The manager should use the electronic trading system to support the business objective. The head of department should be involved and ensure appropriate control and application of the information system. It should be his/her responsibility, as well, to decide how much money should be invested in IS. Ideally, the IS investment should be contributed by relevant managers and be part of the project authorisation. At the same time, a translation to these processes is required in order to have a meaningful evaluation activity.

Various firms refer to management consultants when they want to assess their activities. They treat IS investment as an opportunity rather than a threat. Banks and insurance

companies also treat IS investment as part of their day-to-day lives and as something enabling them to add value compared to the competitor. Here, data processing is integrated into their primary operational activity. Other companies chose the learning-by-doing approach.

6.3.3 Evaluation of IS

The success rate of a HFAT system depends on the way exchanges provide data in terms of speed of transmission, network latency, information processing time, other related data such as margin requirements related to the number of open positions and risk management tools. Highly frequent information exchange is crucial within High-Frequency Algorithmic Trading (HFAT). Here, orders are triggered from an algorithm (CEO, U.S algorithm trading company based in London). Low latency in data updates is very important. Demand for highly specialised people with expert knowledge within exchanges such as Deutsche Börse is high.

More and more firms had to cope with this new trend and spend money in HFAT trading infrastructure. Highly specialised HFAT clients demanded from Refco and also from exchanges to place their customers trading equipment physically close to them in order to reduce latency even more. New independent data centres accommodate clients' hardware as close as possible to the exchange, which is called co-location. Proximity trading has transformed the derivatives trading industry. New actors such as telecom companies are involved as well. It is very much IT driven and requires a lot of investment by all involved parties.

Exchanges used to be controlled by their members before they were transformed into public ownership. According to Deutsche Börse AG, the company's shareholders are mostly UK and US based investors. Germans own less than a quarter. Exchanges have new competitors and the barriers to entry are much lower now for those new players. New service providers offer functions previously monopolised by local exchanges. Pit or floor trading has been replaced by electronic trading systems.

The role of technology and the introduction of 'Smart Order Management Systems' (SOMSs) have changed the way client orders are executed during the last three years. Large orders are executed in a different way, compared to a few years ago. They are split into

small portions and executed throughout the day with the aim not to reveal the initial large size.

The quality and professionalism of the data processing managers that I met throughout the company was generally satisfying. However, no regional or global policy was available. It seemed, and has been confirmed later, that each office was more or less an independent isolated “island”, since they were all profit centres and had their own local agenda. Even within local offices, various departments competed with each other. After being aware of this fact, it was necessary to establish a personal relationship with managers from various areas. I found that a co-operative working relationship resulted in trust. It seemed to be helpful in working with a unique subset of people.

Refco used established processes controlled by a small number of managers. Upon becoming alarmed at the size of the information systems investment budget, Refco implemented controls to one of the largest expenses, namely IT. Cost and efficiency measures were reflected in the request of data. The local organisation had its own local IS, generally not compatible to other offices’ IS. This was a major problem in terms of efficiency and compliance. As an example, clients in Germany needed a different format of year-end statements, which needed to be submitted to the German Inland Revenue for tax purposes every year. These statements could only be delivered by Refco London European head office. However, the required IS was not in place and it was also not possible to link the German local IS system with the UK or US version. Instead, certain work had to be done manually, which was very time consuming. High error rates occurred due to manual work.

Senior managers felt the increase in information systems budgets were negative for their own jobs and career prospects at the same time. Refco senior managers began to feel better about the information systems investment because of the newly available reports. However, as mentioned, this occurred only locally in the head office. On the other side, Refco senior management was searching for a way to understand and manage the information systems investments. Less powerful managers would have liked to increase investments in new areas but needed the budget approval from the office manager. The reports created a new form of communication about information systems investment at Refco, which was seen by many as a positive approach.

Various evaluation approaches introduced could be seen as attempts to close the gap between the theory and practice of IS evaluation. Particular stakeholders attempted to increase the awareness regarding the business contribution of IT. Evaluation contributed considerably to organisational learning and brought business and systems managers closer together. The proposed methodological approaches were supported by tools and techniques, which unfortunately had limited relevance to the needs of Refco managers.

An attempt to integrate IS evaluation approaches within Refco can be seen as an incentive for organisational changes. Often, evaluation related changes are not considered in advance. Evaluation activities conducted by specified actors were changed from time to time. We witnessed gaps between the attempted evaluation approaches and their related context. The role of context was decisive to the degree of adoption of the evaluation approach and the preservation of the current status quo.

The organisational integration of evaluation was largely the responsibility of a few. Their lack of success might have been due to the unclear definition of their tasks and authorities. Various issues experienced in the case study were related to various aspects of the evaluation roles such as authorities and tasks.

The research findings emphasise two areas for the emergence of evaluation approaches, namely the dominant role of the context, and the definition of the evaluation roles. These areas are considered in more detail in this chapter. The analysis uses the principles of the research analysis proposed in Chapter Three and is utilised as a basis to examine the case study in Chapter Five. This chapter focuses on the relationship of evaluation and its context.

6.3.4 Organisational Context of Information Systems Evaluation

The internal and external contexts including Refco's culture and norms, strongly influenced the role that evaluation was expected to play. Four different orientations of IS evaluation can be identified, namely computation, judgment, inspiration and compromise. Authors such as Farbey et al. (1994) refer to the beliefs about causation such as means and processes and the setting of the objectives of the decision-making process. 'Sense-making' evaluation dominates, if no clear objective or understanding has been crystallised. Sense-making evaluation is often used when business managers try to negotiate a basis for IT

budget in certain areas. Control evaluation is used in areas where IS are used to automate well-defined processes. The expected outcomes of the investment are normally certain and the organisational context is relatively visible. It is useful as a financial control evaluation tool. Exploratory evaluation is needed when the social learning faces a lack of consensus in terms of the objectives. Its orientation does not exclude any other but complements it.

Roles of the Evaluation Actors

The definition and performance of the evaluation roles occur within the four mentioned orientations. In order to understand individuals' evaluation roles, the structural characteristics such as position and power and department play a major role. Cultural background, experience and motivation are also important to consider.

Hirschheim et al. (1996) discuss in their 'social action perspective' the four types of social action. This approach is built upon Habermas's (1987) 'social action theory'. Instrumental actions exist when actors attempt to achieve predefined 'measurable' objectives such as financial costs and benefits, applying control to resources and constraints. Stakeholders' actions can be strategic when they try to achieve predefined objectives. Further examples include the manipulation of evaluation outcomes to promote personal or group interests, and the treatment of organisational power in evaluation. Communicative action focuses on achieving an agreement and common understanding with the aim to reach consensus among different actors. A discursive action is observed when issues and values are challenged.

Evaluation as an Organisational Control Mechanism

This section analyses the four orientations across the structures, processes and roles of individuals. It uses the orientations of IS evaluation as a basis to re-examine the evidence from the case studies.

Evaluation is deliberate and plays an instrumental role to control organisational and human behaviour. Control evaluation is often used in case studies. Angell and Smithson (1991) highlight that the organisational control orientation of evaluation is common. Control evaluation is related to the issues of efficiency and effectiveness of IT investments. Organisations using control evaluation are able to monitor evaluation processes more

efficiently. Two ways of implementing control can be filtered, centralised and decentralised. Centralization created a bureaucratic and less attractive way of approving IS project proposals. It may be less attractive for those not working in the head office or in the same country, because real involvement in decision-making is less likely on an individual basis. Elements of 'sense-making' seem to dominate for the organisation with less control. The aim is to achieve an evaluation consensus for IS investment.

Evaluation as Social Learning

Authors like Farbey et al. (1993) argue, that some reasons for IT failing to deliver benefits are related to learning. The reasons include the absence of clearly defined business goals and objectives and the inability of senior managers to align IS with business and IS evaluation with strategic thinking. The ability of an organisation to learn is likely to be a necessary precondition of an emergent and contingent approach to evaluation against a constantly changing context. One of the positive indirect deliverables of the formulation of IT investment appraisal methods is the definition of IS strategy.

This thesis argues that a gap exists between evaluation concepts that appear in the academic literature and techniques applied in practice. However, the perceived need for change was low and thus the pace was slow. Control evaluation should be seen in the context of IS planning. It is also necessary to support formal communication channels. Control evaluation can be ineffective when power games prohibit individuals and rather promote individual interests.

Changing organisations such as Refco is often difficult. To make the change sustainable, employees need to be supported by training. This thesis shows that evaluation does not only deal with the changes introduced by an information system but it should also consider the changes that it caused through Refco's integration, such as access to exchanges and related influence on IS performance. Evaluation changes are triggered by contextual turbulence such as new legislation or other external requirements. It seems critical for the involved stakeholders to understand that a paradigm change in evaluation is a cultural change, which requires consideration of the existing evaluation approach.

6.4 Enabling Technologies

Advances in performance and cost-efficiency of three interrelated technologies, computer power, data storage and data transmission bandwidth, reduce the cost of collecting and processing information. Technology is responsible for the emergence of what is variously referred to as the new, information, digital or knowledge economy. Advances include the declining cost of computer processing power, data storage and data transmission bandwidth.

These advances are causing lower cost of information, making the previously un-economic strategies efficient. Costs of information and matching orders are declining. At the same time, demand for direct exchange connectivity is rising. It is obvious that there is a correlation between advances in technology, declining cost of information and falling transaction costs. Employees have access to client information and are able to react fast. Refco was slow changing their corporate structure to facilitate new decision-making behaviour. New information flows can allow new organisation structures. A quantitative analysis of 273 large firms conducted by Hitt and Brynjolfsson (1997) highlights a correlation between corporate investment in information technology systems and the decentralization of decision-making. Lower cost of connectivity enables companies to capture vast amounts of client data. Firms like Refco are often reluctant to restructure the organisation even if customers are demanding this. Exchanges seem to evolve, with information flowing from customer to broker and back to exchanges.

Direct market access (DMA) and the internet lead to a threat to traditional brokerages; namely the proliferation of free financial data and a more balanced brokers' information advantage over clients. More and more brokers, such as Refco, were forced to provide online trading at low cost due to lower costs for the end user. We witness continued disintermediation and a reduced role for intermediaries. Direct exchange connections are reducing the round trip time of an order. In some markets, direct market access is capturing exchange traded derivatives volumes during the last five years. The challenge financial services firms faced recently and continue to face, was obvious in the Refco case. Insiders expect that more than 30% of volume will be conducted through algorithmic systems soon. Electronic intermediaries that provide information and match buyers and sellers, replace traditional sales intermediaries. We can introduce the notion 'cybermediaries' and refer to the 'new' actor. These new information intermediaries provide opportunities to reduce

price discrepancies. In 2011, DMA is a common term used within the financial services community. DMA enables the clients to conduct trades directly without a physical intermediary from brokers. In 2010, more than 90% of all trades originated in the U.S.A were matched through DMA (ISE, 2010). Orders can be sent to exchanges from almost any location in the world now.

6.5 Black Box Trading Example

Unprecedented growth in electronic trading and algorithmic trading is redefining system boundaries and accentuating the need for increased data transmission speeds. Brokers are using improved models for analysing market data for subsequent trade execution. New hedge funds, with heavy reliance on algorithmic trading, emphasise the need for speed. Optimising hardware, such as Titanium processors, and software, such as memory based matching, is essential in order to avoid bottlenecks to cater for smooth data flow and to avoid queues building up. Data signals are transmitted at about the speed of light. Bandwidth determines the number of parallel transmissions of signals.

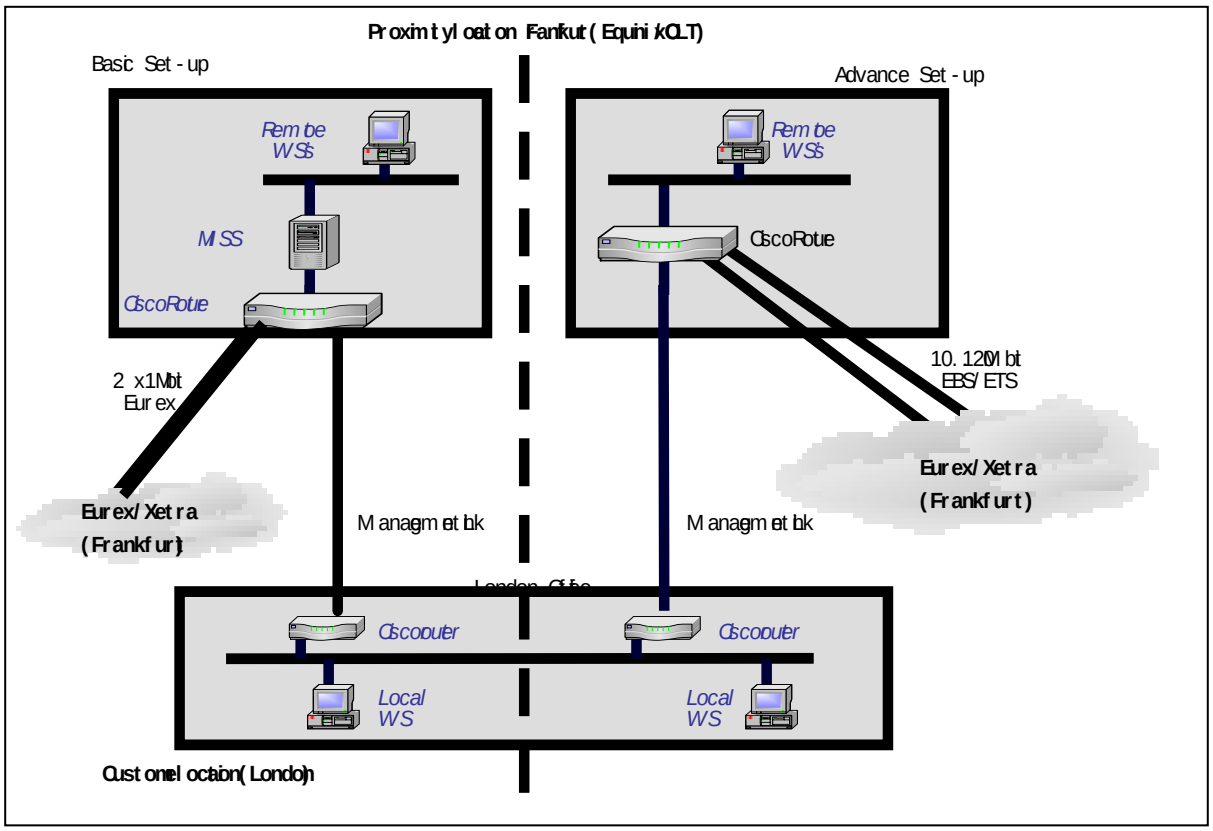


Diagram was provided by Deutsche Börse AG, Frankfurt.

Black box trading is a simplified way of buying and selling products based on your own fair value. The black box that converts known inputs into programmed outputs could be seen as an actor. In other words, if you believe product 'a' is cheaper related to product 'b', you buy the cheaper and sell the more expensive one very quickly. The aim is to be faster than others. The following example illustrates details of such a product and the way it is evaluated (Higgins, Patel and Baygeldi, 1997):

The Basis Relationship between Future Price and Cash Price

Each contract has a face value of Euro 100.000, - with a notional coupon of 6% and time to maturity between 3.5 and 5 years to be deliverable into it. The Cheapest to Delivery (CTD) (OEZ2) is Deutsche Bundesrepublik (DBR) 6% 07/04/07 (price 108.93) and (OEZ2=108.33).

In order to equate each of these securities to the futures price, the trader needs to separate conversion factor for each bond which is simply the price as a percentage of par at which each deliverable bond would yield the notional coupon (in this case 6 per cent) of the futures contract on the day of delivery.

Euro Bund Future 110.75 RXZ2 Convergence

	Price	Yield	C. Factor	Gross Basis	Implied Repo%	Actual Repo%	NetBasis
1. DBR 5 07/04/11	103.835	4.461	.934161	.377	3.16	3.32	0.370
2. DBR 5 01/04/12	103.815	4.486	.931496	.652	1.99	3.32	0.331
3. DBR 5 07/04/12	103.900	4.497	.928434	1.076	.31	3.32	0.737

Euro BOBL Future 108.33 OEZ2 Conv.

	Price	Yield	C.Factor	Gross Basis	Implied Repo%	Actual Repo%	NetBasis
1. DBR 6 07/04/0	108.930	3.917	.999571	.646	2.86	3.32	0.118
2. OBL*41/2* 07 #140	102.355	3.945	.939135	.619	1.70	3.32	0.395
3. DBR 5*1/4* 01/08	105.875	3.993	.967937	1.018	0.74	3.32	0.658

Euro SHAZ Future 104.41 DUZ2 Conv.

	Price	Yield	C.Factor	Gross Basis	Implied Repo%	Net Basis	Actual Repo%
1. DBR 7 ½ 11/04	108.210	3.465	1.026310	1.053	2.58	3.32	1.93
2. DBR 7 3/8 01/05	108.390	3.496	1.025856	1.280	1.57	3.32	0.462

The implied repo rate is the annualised percentage return for buying the bond today and selling the bond for future delivery.

Net Basis= {(P1+A1) * (1+TN/360)} – (C * (1+TM/360))- ((F * CF) +A2)

F = Futures price;

CF = Conversion Factor;

P1 = Original price of the bond;

C = Coupon;

A1 = Accrued interest on bond at purchase settlement date;

A2 = Accrued interest on bond at delivery date;

N = Number of days between purchase and delivery date;

M = Number of days between interim coupon and delivery date.

Why is the net basis always positive and why does the cash bond always command a premium over the future? This is related to the risk of owning the future. The net basis can thus be interpreted as the value of the deliverability option that the person who has sold the futures contract holds. As the seller, he can choose which bond to deliver. Referring back to the net basis formula, we can see that if we assume T, N and M are identical for all deliverable bonds (in reality T may differ if a particular issue is trading special in the repo market), then the difference in net bases will be due to the price sensitivity of each bond. As duration is a measure of price sensitivity, if the yield falls below 6 per cent the bond with the shortest duration will experience the smallest price rise in relation to the final term of the equation, which, owing to the conversion factor, is derived using the price of the bond when yields are 6 per cent. In an environment where yields are less than the notional coupon of the future and the yield curve is flat, then the shortest-dated bond will generally be CTD. However, if the yield curve is steep enough to offset this effect (as with the current BOBL contract) or a particular issue has been squeezed, then this need not always be the case. In a 6 per cent yield environment, bonds with the longest duration are likely to be CTD.

Other reasons why we might purchase a bond and sell the future, even though a positive net basis exists, are that we might envisage a reduction in our funding costs either due to the bond becoming "special" in the repo market or because we are anticipating an official interest rate cut. In this case our "carry" would become more positive (or less negative) and we may eventually realise a profit on the trade.

For a long position of Euro 100 million of OBL 140 (4 ½ 07) bond, the hedge ratio would be: **100/0.10 * CF bond = (100/0.10) * 0.999571 = 999.57**

The second method, duration hedging, overcomes this problem, but this time is reliant on a subsequent movement in the basis for a given move in the future, since we are assuming a parallel shift in the yield curve. As we have already seen, the relationship between CTD and the future is very close. In fact, the basis point value or BPV (i.e. the actual change in price for a given 1 basis point change in yield) of the future will be equal to the BPV of the CTD divided by the latter's conversion factor. The software or trader can quickly calculate the number of futures required to duration hedge our position:

(100/0.10) * (BPV bond/ BPV future) = (100/0.10) * (3.62/4.30) = 337

Market Rates		**Official Rates**	
US Libor	= 1.8150	US Fed Funds	= 1.75
US overnight repo	= 1.75	US Prime	= 4.75
Euro Libor	= 3.298	UK Repo	= 4.00
£ Libor	= 4.40875		
Sterling 3m Dec.	= 96.02		
Eurodollar Dec.	= 98.21		

Pricing of Fixed Income Futures Contracts

The pricing of interest-rate futures closely correlates with the pricing on the corresponding cash markets. Those prices can change every millisecond during the trading hours between 7:00 am and 09:00 p.m. GMT.

Basis

Over the term of an interest-rate futures contract, the price of this contract is usually different from that of the underlying cash instrument. The difference between the futures

price and the cash price is called *the basis* in futures terminology. The difference may be positive or negative.

The basis is positive if futures price < cash price
The basis is negative if futures price > cash price

A distinction is made between the carry basis and the value basis, depending on the factors reflected in the basis.

Carry Basis

The so called cost of carry (net financing costs) has a dominating influence on the basis. The cost of carry refers to the costs of holding a cash position corresponding to the futures position. For example, if the trader plans to make actual physical delivery of federal bonds for a short position in BUND futures, the investor can already buy the securities at the current cash price plus accrued interest and refinance the costs of the position up to the maturity of the contract by means of a short-term credit. The cost of carry is then the balance (the "net" amount) of the accrued interest earnings from the long-term federal bonds and the short-term financing costs. The cost of carry may be positive or negative, depending on whether the financing costs of the position (short-term) prove to be higher or lower than the interest income from the federal bonds (long-term).

Futures Price < Premium Cash	**Discount > Futures Price**
Negative cost of carry	Positive cost of carry
Current yield < Short-term interest	Current yield > Short- term interest

The basis will be positive or negative, depending on whether the money-market rate is higher or lower than the quotient of the coupon of the underlying instrument and its current market price (current yield) when the futures contract matures.

If the short-term interest rate is lower than the current coupon of the bond, the interest earnings from the underlying instrument are higher than the financing costs. In this case, the cost of carry will be positive. Holding the bond will result in a net profit that is necessarily reflected in a discount of the futures price relative to the cash price. It will be reversed if the money market rate is higher than the current interest earned on the underlying instrument. In this case, the financing costs will exceed the income from the

bond. In other words, holding the bond will result in net costs that are reflected in a futures price that is higher than the cash price. The cost of carry is negative.

Value Basis

In addition to the cost of carry already described, other factors such as market participants' expectations, day-to-day events, structures of supply and demand and market liquidity also influence pricing. All of these factors, in which the advantages of a futures contract over a sale or purchase in the cash market are reflected, are summarised in the value basis (net basis, premium, value basis). It represents the information aspect of the financial futures markets. In some cases, the price distortions can be considerable and represent a genuine additional risk for a portfolio.

Fair Value

There is a balance between the cash market and the futures market if the basis corresponds exactly to the cost of carry. In other words, if no value basis exists, and the price of the interest-rate future assumes the so-called fair value. If this is not the case, namely if the basis is higher or lower than the cost of carry (plus any arbitrage transaction costs), i.e. if the futures contract is overvalued or undervalued relative to the underlying value (value basis) – then traders will in all likelihood try to take advantage of the price disparities by taking opposite positions in the futures and cash market. Profit oriented arbitrage of this kind, which can be 'risk free', generally balances out the price and restores the equilibrium.

Dominating Factors Influencing the Futures Price

The theoretical price of an interest-rate future is higher:

- the higher the cash price.
- the lower the yield of the cash instrument.
- the higher the financing costs of a cash position.
- the longer the (remaining) term of the contract in the event of a positive cost of carry, or the shorter the (remaining) term in the event of a negative cost of carry.

Convergence of the Basis

The size of the basis depends on the time of performance. The further away this point is in the future, the greater the influence will be on the above mentioned cost of carry. In other words, the amount of the basis will tend to decline over the course of time. When the contract matures, the cash price and futures price must be equal, as otherwise there would be opportunities for arbitrage ignoring transaction costs.

Delivery and Price Factors

If the trader decides to make physical delivery in settlement of his short position, for example in the BUND future, he can deliver any Federal bond or debt security of the Treuhandanstalt with a remaining term of no less than 8.5 years but no more than 10.5 years on the delivery day. The invoice amount, which the purchaser of a futures contract ultimately has to pay the seller, varies from one deliverable bond to another. It is based more specifically on the official Exchange Delivery Settlement Price (EDSP) on the last trading day of a contract, multiplied by a so-called price factor (conversion factor) calculated by Eurex for the respective bond delivered. In addition, the interest accruing on the bond up to the delivery day is taken fully into account, since it is still owed to the seller.

The price factor is used to find a common yield denominator for the various residual maturities and coupons of the securities that are deliverable. With respect to the Eurex fixed interest rate futures, the conversion factor represents the price per EURO 1 nominal of a Federal bond, Federal debt obligation or Federal Treasury note or, as the case may be, of an exchange listed debt security of the Treuhandanstalt, with which the security would achieve a yield of 6 percent on the delivery day. Eurex calculates the price factor, the accrued interest and the invoice amount accounting to the following formulas: Price Factor (PF) = 1,

$$\text{Accrued Interest} = \frac{\text{Days} * \text{coupon (\%)} * \text{Euro } 100.000}{360}$$

All interest earning days, excluding the delivery day, are taken into account. A month is calculated as 30 days, a year as 360 days.

Invoice Amount

Invoice amount = (EDSP * Price factor * Euro 1,000) + accrued interest

Example: The trader or algo-machine is short in March 2007 BUND futures. He decides to deliver the 6 per cent Federal bond maturing on January 4, 2017. The remaining term of 9 years, 9 months and 24 days is rounded of to 9 years, 9 months, to calculate the price factor.

$$PF = \text{Accrued interest} = \frac{66 * 0.06 * \text{Euro } 250.000}{360}$$

Assuming an EDSP of 102.63, the invoice amount is as follows:

Invoice amount = (102.63 * 0.999674 * Euro 2.500) + Euro 2,750 = Euro 259.241.36

PF= Price factor

C = Coupon of the deliverable bond

N = Number of years to maturity of the bond

F= Number of full months until next coupon payment, divided by 12

The EDSP is based only on DM 100 of the nominal value of the contract. Therefore, to calculate the invoice amount, the EDSP must be multiplied by Euro 2,500.

C=6

N=9

F=9/12

PF=0.999674

Interest payment- January 4 (p.a.)

Delivery day = March 10, 1997

Interest payment days =66

Coupon in percent =0.06

Accrued interest = Euro 2, 750

The 'Cheapest –to –deliver'

The paper with the highest implied repo rate is also the current CTD. 'Cybermediaries' act as arbitrageurs between two or more different products in the marketplace. Some cybermediaries serve as market makers and gain more market power. The technology and algorithms used constantly aim to reduce price discrimination between similar products.

An investment bank based in London has stated that every lost millisecond results in approximately $10m per annum in lost opportunities. Milliseconds count, and whether it is a buy side or a sell side firm, latency will affect its competitive position in an expanding

marketplace. According to Clark (2008) reducing the latency of transaction processing in order to gain a microsecond of improvement may cost around $250. If you aim to reduce latency by another 6 milliseconds it can cost up to $1.5 million.

6.6 Summary

Sustained improvement in the capability and cost of computing power, data storage and data transmission bandwidth are leading to declines in the cost of transaction. The growth of networks is simplifying information sharing and further accelerating the decline in transaction costs. Employees work in a social and political environment and do not generally report to their boss directly. Back-office employees, sales staff, project managers, vendors, programmers and clients can be seen as actors for the organisation but also as intermediaries between vendors and end-users. Various types of relationships and power exist.

ANT's strength is that it is process-oriented, aiming at description rather than explanation of the phenomenon. It can answer the 'how' questions about structure and power (Law, 2001). Networks can be treated as individual actors. This is known as 'punctualization' (Law, 2001). An actor-network stresses the means to enlarge the scope of a study in order to map the interrelation of an information system with its outer-context. The initial problematization and the parallel translation of different interests led to Refco's and other financial services firms' failure. ANT helps to analyse socio-political characteristics where the role of technology dominates. Refco illustrated that technology triggers changes. Not separating human and non-human actors in the analysis allows a comprehensive assessment of the role of technology and the behaviour of employees.

The use of ANT in the above analysis gave insight into the position of IS evaluation within the complex network of electronic trading where large numbers of (trading) companies trade huge numbers of complex transactions through exchanges. This is an incredible challenge for all the actors, both human and non-human, in the network. This analysis demonstrated how the failure of the link between (some) Refco managers and Refco's information systems caused the demise of the company and its replacement by Marex. One network folded and another emerged successfully. However, Refco's link failure was not a technological failure but a failure of evaluation.

Chapter 7 - Conclusion

7.1 Introduction

This chapter summarises the thesis and outlines the theoretical, practical and methodological contributions made by this research. The main contribution of this research is a descriptive in-depth understanding of the IT investment appraisal phenomenon, in the context of the wider and longstanding research field of IS evaluation. I hope that the contributions will help academics and practitioners to continue the debate in this field. The chapter also discusses the limitations, including those regarding generalisability of the chosen methodology and theory. This chapter also refers to future developments such as extending the theories developed in the analysis chapter and the findings gained from this research could be used in the process of theory building.

The research question, how IS evaluation is socially constructed, entails an examination of the behaviour of the main actors in an evaluation context and their interpretation of the concepts of IT investment and its possible outcomes. From a review of the literature, it is arguable that these issues deserve further research, as they remain elusive and complex.

It has been discussed that these concepts are socially constructed and thus a social science approach is needed. An understanding implies taking into account subjective, social and political factors. By using actor-network theory, the formation of the heterogeneous network involving the investment appraisal of one or more projects in a case study organisation has been examined. This approach, the social construction of IS evaluation, falls neatly into the tradition of interpretive evaluation research and represents a step forward into empirical research in the area, based on the ideas of writers such as Smithson and Tsiavos (2004). The case study organisation granted full access and no practical problems occurred during the collection of data. The further insight gained through carrying out the research could be of value to practitioners: "The failure to understand IS evaluation, and adopt appropriate evaluation practices, can lead to misconceived decisions with deleterious consequences for users and developers alike." (Smithson and Hirschheim, 1998, p.171). It is argued that actors are embedded in the network. The way actors interact in society needs to be analysed further. The following sections outline the main

contributions of this thesis. They also highlight limitations and ideas for potential future research.

7.2 Summary of the Thesis

This thesis is divided into seven chapters. Chapter One illuminated the background of the research topic by exemplifying the need and justification for this thesis. The aim of this chapter was to introduce the reader to the topic of IT investment development in the financial services industry and the consequences firms face if they do invest or decide not to invest in infrastructure in general and in HFT capabilities specifically. Some firms have lost various hedge funds and other clients due to a lack of state-of-the-art software and hardware availability within the firm, including a lack of ability to process conducted trades using STP. One of the reasons why companies struggle in the environment we live in is because clients' emphasis points towards technology and the demand for high level technology is still growing.

The introduction outlines the transformation witnessed in the financial services industry globally and locally. This industry influences our life directly or indirectly regarding the way firms operate and are regulated. Therefore, even this very specific case should be seen as a trend in the market, which more and more politicians, researchers and regulators treat as a potential risk factor for the entire financial services industry. Other schools of thought are convinced that the increasing HFT driven by technology is good for all involved parties, leads to more transparency and is easy to manage from the regulators' point of view.

Chapter Two delivered an insight into the literature on IS investment evaluation and outlined the development of IS investment evaluation. It presented the research domain and analysed the past and current research literature on evaluation of IT investment. It was discussed that one of the major issues is that the focus of most studies in relation to the evaluation of IS investment effectiveness is restricted to the use of quantitative data. Contextual issues are discussed in order to reflect the importance of this area. The basis for the thesis is a strong focus on context related activities. Without relating to specific context(s) the research would not have been conductible.

Chapter Three discusses the conceptual framework that has been chosen for this thesis. It is argued that an investment appraisal, like other evaluations, is socially constructed. It is not a mechanical application of accounting but is rather a social process based on human perceptions and interaction. It involves the interpretation of evaluation methods and accounting conventions. The use of ANT including the use of the moments of translation is discussed, in particular the enrolments and activities of the principal actors. Also, heterogeneous networks and the role they play in relation to HFT are analysed.

Chapter Four covers the research approach, research method and design for this study and the main reasons for choosing an interpretative research approach are provided. The basic method is a case study but with strong elements of action research. Data gathering and access to the financial services firm case study are described. The author of this thesis acknowledges that much of the research took place between 2004 and 2006. The extensive engagement with the company was only possible due to the fact that the researcher worked for the company in both the U.K. and Germany. The employment was further extended with the new firm Marex from March 2006 until October 2006.

Writing up the thesis was delayed due to various factors including the birth of my first child in 2008 and my second child in 2010. It was extremely helpful to work for both companies since the in-depth engagement and related data collection would not have been possible otherwise. The researcher is also convinced that various interviewees would not have revealed so many details without him being employed at Refco and Marex. At the same time the researcher would not have received access to various trading and back-office systems such as Patssystem, Sungard or Rolfe & Nolan.

Chapter Five, the findings chapter, describes the selected financial services firm in depth by using the empirical data collected from the beginning of 2004 until October 2006. The collected data is essential to this thesis. It reflects the organisational context and the background of the case. The main part of this chapter describes the events regarding the employment of IT evaluation method(s) and the enormous growth of daily transactions on electronic exchanges. This chapter reflects the context in which various firms struggled and even collapsed. The role of senior management in the U.S. entity in particular was not obvious and difficult to evaluate. Various questions, such as why they acted in a specific way, remain unanswered. Additional research to answer any remaining questions would be useful.

The findings from the case study chapter are analysed in detail in Chapter Six using actor-network theory. The empirical findings such as transaction growth supported by HFT are highlighted. Also, the processes of translation and enrolment are discussed. The roles of the new legislation in conjunction with cheap accessible technology are discussed in relation to the way Refco conducted short-term and medium-term business. Human and non-human actors are both essential parts of the network. Heterogeneous networks are either supported or rejected by individual actors during a specific context related action. Some HFT companies believe that speed-of-light trading is achievable. It needs to be seen how much firms like Refco need to transform in order to facilitate transactions from the operational point of view if they are conducted at such a speed.

Chapter Seven finalises the thesis and contemplates the outcome and process of this research. Previous research has not covered translation processes and the creation of black boxes in depth within the financial services industry. It is demonstrated that the transformations triggered from the emergence of HFT in the financial services industry are likely to continue. Companies with HFT, including processes in operations, draw attention to the theoretical and practical contributions of this thesis. In addition to identifying these contributions, the researcher also highlights the limitations of the research, followed by suggestions for further research. It is recognised that much more research is needed in order to understand human actors' translation and enrolment into any new network.

7.3 Practical Contributions

Various points have been contributed by this study. As mentioned in Chapter Two, much has been written about the impact of evaluation of IT investment in general. However, evaluation of IT investment with a focus on ANT is not common (see Chapter Three). Due to accessibility to high technology in a relatively cheap way off the shelf, an explosion in transactions on exchanges and various other organisations has been witnessed. Even firms in other sectors, such as Amazon or E-bay, have experienced massive volume growth in transactions during the last few years. This research can contribute to the field because it aims to reflect on changes in this area.

Three areas are worth highlighting in terms of contribution: the relationship between technology and humans; the emergence of networks; and the network stability.

Many "side effects" such as network collapse have rarely been covered by the literature. The world has changed in terms of 'processing' and we need more understanding of those new processes. This study contributes towards our understanding of these new ways in which products are processed in our new reality. The empirical findings show that transactions generated by institutional investors such as asset managers and hedge funds are very much technology driven and make huge demands on the IT infrastructure that have to be met if such markets are to continue to develop.

This thesis makes a contribution for people who are interested in knowing more about HFT. It is an alternative way of understanding and evaluating HFT. Other findings from this dissertation suggest that operational issues are still very much underestimated in the entire industry. These issues include the back-end clearing of often complex transactions.

An Executive Director of Goldman Sachs, London, mentioned during a meeting in December 2010:

> "We are bombarded with ever increasing numbers of new and existing contracts to be processed and cleared. We are concerned of not being able to fully or timely process those transactions. Almost all exchanges are launching and trading more and more products such as the recent launch of Korean Index Options (Kospi) on the Eurex platform. I am struggling to keep an overview of all those new products." (an Executive Manager of Goldman Sachs, London, December 2010).

It is obvious that end clients can easily move to other clearinghouses if they are not satisfied. A similar comment was made in November 2010 from a U.K. based commodity focused broker. Their aim is to offer existing and new clients access to most financial exchanges such as CME, Eurex and LIFFE. The global head of business development said:

> "We have selected exchange memberships and offer various trading platforms such as GL Trade and Patssystem to our end clients. Those end clients are based in various countries such as Asia, Russia, and Middle East. Clients would like to trade futures and options calendar spreads and we do not know how to process those. We have got no experience and need help. In case the front end trading system GL is down and the client calls us to enter and process the trade on behalf of the client we would struggle." (U.K. based commodity broker, global head of business development, November 2010).

Larger investment banks, such as a Swiss based one, mentioned their struggle to cope and process all conducted client trades properly and timely as well. The head of flow execution desk, based in London, said in October 2010:

> "My team and I do not know how to input certain trades such as OTC flexible options into the system. If a hedge fund buys 12.000 lots in Stoxx 50 call, with maturity December 2017 and ask us to execute the trade and split the order into six different sub-accounts after the trade I would not know how to process or allocate it" (Head of a London based Flow Execution Desk, October 2010).

These examples are common and reflect the industry's day-to-day problems. Only a few people in the industry know the answers. It is astonishing to find out that other senior people in American, German, French and Japanese Banks are struggling to cope with the ever-growing volume executed electronically. A senior banker at a Japanese Investment bank mentioned that they do not understand the way fees and margin calls are calculated. This applies for many banks.

Operational issues are still very much underestimated in the financial services industry. This study demonstrates that the forces behind ever growing daily transactions influence attitudes toward technology even if they are multifaceted and more and more controlled by local regulators.

The collapse of Refco and Lehman Brothers was also supported and potentially driven by the inability of using technology in an efficient and effective way. The author of the thesis has spent two weeks in the former Lehman Brothers building in Canary Wharf, Bank Street, from the day it collapsed on 15th September 2008. During this period of time he witnessed the lack of IT infrastructure as well as the lack of systems compatibility. Senior Lehman bankers, including the head of trading, head of operations, head of IT, head of clearing, risk department and the responsible administrator Price Waterhouse were not able to split and evaluate trades generated by clients and executed via leading exchanges in time before it collapsed. When I asked whether they knew what their client positions are they said: 'No'. Due to time limitations in this research the author suggests additional research.

Technology has taken over daily transactions and there is a need to understand what really happens behind the scenes. The issues with a bigger impact on society will not be entirely

technological. However, we have seen that Refco and other financial services firms struggled to cope and incorporate both technological and social aspects.

7.4 Contributions to Theory

In Chapter Three it was mentioned that interpretative research is very flexible in terms of research direction. However, it needs to be supported by empirical findings. ANT was chosen because of its flexibility and usefulness to study IT investment evaluation. However, the empirical findings still support the idea that we understand very little. It should be highlighted that the gathered data here is very sensitive to context. Therefore, ANT's specific vocabulary is very useful. Various authors have argued that ANT has considerable weaknesses as well. One aim of this study was to contribute in terms of supporting those authors willing to see ANT's strength and usefulness in specific contexts.

The case study showed the relatively unique opportunity to support ANT and potentially gather more information in order to continue additional research with those who are willing to be involved. The dissertation attempts to make a contribution more than supporting what researchers have said. The study researched on micro level actors' activities in specific contexts and the way networks are created within the framework we live in. As an example, financial services firms have the habit of moving in the same direction at the same time. They tend to 'support' and drive each other. If this area is researched further, more information may be found that is related to the social construction of IT investment and other related areas.

Another contribution of this thesis is to increase awareness related to a shift in the industry towards computer mediated trading with all its potential consequences and side effects. An additional contribution to theory is revealing each individual actor's actions within the heterogeneous network in terms of 'transition points'. We have seen what happened in the case study and aim to describe each action point by point until we are able to describe actors in a more sophisticated way.

7.5 Methodological Contributions

The methods employed in this study aimed to use gathered data on social construction of IT investment appraisal. It is understandable that the methods used here are open to critique. It is the hope of the researcher that more and more researchers will support IS scholars using this methodology. The author of this thesis believes that filtering the underlying factors can potentially lead to misinterpretations of the phenomenon. The aim was to contribute to theory and practice. These contributions are summarised as follows. Social construction of IT investment evaluation literature rarely uses in-depth industry case studies. It needs to include new actors as forces such as hedge funds and should continue highlighting technology's new evolving roles in transactions and processing. Also, a lack of experience and knowledge within the industry in terms of HFT needs to be admitted.

A further contribution is that the study indirectly provides support for the use of action research combined with ANT. By its very nature, action research can lead to an emphasis on 'action' rather than 'research' while ANT is often considered to be the preserve of theoreticians. This study shows that the two seemingly disparate tools can be combined usefully.

7.6 Limitations and Reflections

I have contributed in certain areas and have also seen limitations that must be acknowledged. One of these limitations is the topic of generalisability. The data was drawn from one main case study. This obviously raises the questions about the generalisability of the Refco case study. At the same time it is obvious that the findings are applicable to certain financial services actors such as brokers and banks. One of the acknowledged limitations concerns the focus on international or global financial services firms. Local small players may have different actors involved. It is visible that a certain generalisability of the findings exists. This research was conducted with the focus on social construction of IT investment and social construction of HFT. The findings relate narrowly to actors involved in the specific context. Some may argue that the findings of this thesis are only applicable to HFT companies linked to exchanges via their brokers.

The limitation related to ANT as a theory should be researched further. ANT does not offer a solution to actors' roles in the network they are engaged in. In an ideal world, more financial services firms should have been used as case studies and analysed in depth. But this was not possible within the given framework. Various interviewed people were too anxious to be mentioned by name. However, the existing accessible pool of people in the industry is immense and can be used for follow-up research.

A further limitation, due to the limitation in time, is the decision taken not to examine in depth, using ANT, the role of the regulators. As shown in Chapter Five, data was collected about the increasing activities of the FSA and other regulators. I had hoped to analyse this, as it represents a particularly interesting aspect of the network: the interaction between regulators, firms such as Refco and the underlying technological infrastructure. As shown in Chapter Five, the FSA have been active in 'prosecuting' Credit Suisse for their transactional failings and this would have been an interesting aspect to examine and one that lends itself to ANT analysis. However, the involved effort was not trivial and I ran out of time.

7.7 Recent Developments and their Potential for Future Research

Global derivative trading volume rose significantly during the past few years. In particular interest rate options and futures saw a massive rise during the last ten years in terms of volume and open interest. Nominal value of more than 900 billion USD was outstanding during the peak at the end of fiscal year 2009. (Bank for International Settlement, BIS, 2010). The financial crisis revealed various structural deficits related to market infrastructure of derivative products. New derivative products were created constantly during the last few years. At the same time those emerging new derivative products need different infrastructures related to front office and back office processing and transactions. Central Counterparty Clearing (CCP) emerged from a low profile status to a new important role within the financial services industry. Another newly created and tradable derivative product has an additional risk profile, which needs to be monitored and evaluated ideally.

Those new products influence trading systems, operations and clearing, and risk management just to mention a few areas. Product liquidity and product price changes need to be 'built in' to ANT. The derivative product itself has an important role with ANT and also within the network. The interrelation between the non-human derivative product and

the human actor has become crucial for the topic evaluation of IT investment. Hence, further research, leading on from the current study, should include these important products within the actor-network analysis.

At this point it is important to highlight that derivative products are not only used by the financial services industry. According to International Swaps and Derivatives Association (ISDA, 2009a) more than 90% of Fortune 500 companies use derivative products for hedging purposes. Most hedging with those products takes place in interest rates, commodities and foreign exchange.

Recently, we witness a move towards more regulation and new regulatory bodies monitoring and implementation of new frame for those products. The question how new regulation can influence the way those products are traded and behave within the network needs to be answered when we get more updated data.

On 7th February 2011, chief executive Hector Sands updated the industry on progress made towards a new regulatory structure related to financial services firms.

The government is aiming to replace the FSA by two new regulators. In his letter to CEO's Sands wrote:

> "The Prudential Regulation Authority (the PRA), which will be a subsidiary of the Bank of England, will be responsible for promoting the stable and prudent operation of the financial system through regulation of all deposit-taking institutions, insurers and investment banks. The Consumer Protection and Markets Authority (the CPMA) will be responsible for regulation of conduct of retail, as well as wholesale, financial markets and the infrastructure that supports those markets. The CPMA will also have responsibility for the prudential regulation of firms that do not fall under the PRA's scope. The government is currently consulting on including unsecured credit within the scope of the CPMA. To ensure a smooth transition we are making changes to our current management structure to help us evolve over the next two years from one unitary regulator into the proposed new structure. These changes will begin on 4 April 2011 when we replace our current Supervision and Risk business units with a Prudential Business Unit (PBU) and a Consumer & Markets Business Unit (CMBU). You may also be aware that the government has to introduce new legislation to allow for the formal transfer of

power from the FSA to the new regulators" (Hector Sands, Chief Executive of FSA, 7th February 2011).

Electronic trading systems are used for trading in financial markets, differing between types of trades and users, and between the various stages of the trading processes. Transactions conducted via electronic trading systems, between dealers and their customers are growing rapidly. Strong competition seems to have led brokers to promote new trading systems to their customers in order to expand.

So far, volume generated via computers is not significant in the OTC derivatives market. Since Lehman's collapse, counter-party risk has become an important topic driving the OTC business in electronic market environment. Most trading systems such as CQG, TT, and Patssystems are not perfectly designed to be the platform of choice for traditional OTC business. Those systems need to be re-designed or a new generation of alternative trading systems need to be developed in order to be able to facilitate a new emerging heterogeneous network.

On 24th March 2011, Bloomberg's Nina Mehta wrote:

> "CBOE Holdings Inc. and NYSE Euronext may create venues for derivatives that now trade over the counter to capitalise on proposed rules designed to bring more transparency to the $583 trillion market. The exchange operators may form swap-trading platforms for privately negotiated derivatives that the government plans to move onto regulated trading systems or exchanges that will provide public data about prices and transactions, according to interviews with company executives over the last week. Most of the contracts are now traded between broker-dealers over the phone or through private electronic systems. Congress last year ordered that most standardised OTC derivatives in the U.S. be guaranteed by clearinghouses and traded on exchange or swap-execution facilities, also known as SEFs, after a 100-fold surge in trading of credit-default contracts over seven years made oversight of the financial system more difficult. Regulators are now writing rules for the swap platforms and the product that will be traded on them" (Nina Mehta, Bloomberg, 24th March 2011).

The role of voice broking and direct dealing between dealers is decreasing from year to year. Only less liquid and exotic markets are still relying on the brokers as voice brokers.

Intermediary trading is moving from bilateral OTC relationships towards a marketplace with more centralised price discovery. In principle, electronic trading execution costs tend to decrease in due course. But the development of IT infrastructure can be costly and also time consuming. Liquidity does not move easily from one venue or trading platform to another and actors will decide the location of choice. Trading systems provide the user with a full log of the transaction behaviour of the users but can affect the market's structure and its dynamics as well. They are also accessible without limitations to specific locations. In relation to open-outcry markets, electronic trading systems can be upgraded regularly and also tested via a simulation environment with the aim to handle more trades by increasing the capacity of the relevant computer network.

There are a number of technological and economic factors that have no doubt led to the emergence of algorithmic trading. The three main factors that probably contributed to that are the increase of telecom performance in line with dropping costs as well as the evolution of office and exchange automation. High bandwidth, high accuracy, high network availability and reliability with low cost hardware support the emergence of computer driven electronic trading systems or in other words algorithmic trading.

In February 2011, London School of Economics (LSE) and the Department for Business Innovation and Skills (BIS) announced (http://www.bis.gov.uk/foresight/our-work/projects/current-projects/computer-trading):

> "[…] that advances in technology continue to transform how our financial markets operate. The volume of financial products traded through computer automated trading taking place at high speed and with little human involvement has increased dramatically in the past few years. For example, today, over one third of United Kingdom equity trading volume is generated through high frequency automated computer trading while in the US this figure is closer to three-quarters. This Foresight project … involves leading experts in this field and will explore how computer generated trading in financial markets might evolve in the next ten years or more, and how this will affect:

- Financial stability;
- Integrity of financial markets including price information and liquidity;
- General competition;
- Market efficiency for allocating capital;
- Transaction costs on access to finance; and

- Future role and location of capital markets" (announcement of London School of Economics and the Department for Business Innovation and Skills, February 2011).

Also, the U.S. Commodity Futures Trading Commission (CFTC) proposed new rules on 'co-location and proximity hosting services' at the end of 2010. The new rules aim to allow all actors similar access to co-location facilities. If approved in 2011, equitable pricing for co-location will be mandatory. Exchanges and also vendors and other third party providers will be asked to provide their co-location services to any trader willing to pay and to be enrolled in the network. Latency information is very important to HFT firms and they check their latency every day. In future, CFTC expects that the information needs to be disclosed to all involved parties. They aim to implement "latency transparency". Other guidelines will potentially shape the landscape and it is important that upcoming new legislations will be analysed and researched properly.

Support for additional research in electronic trading systems can also be seen in the following case: On 6th May 2010, the Dow Jones Industrial Index (DJIA) collapsed 9.16% in less than 30 minutes. At the peak of the market downward move the market value dropped by more than $1 trillion. Market participants called the incident the "Flash Crash" (reference: Bloomberg.com). Analysing this leads to the following points:

Remaining high frequency traders (HFTs) and firms stopped their algorithms when the volatility jumped. Actors simply left the heterogeneous network and it became unstable due to a lack of liquidity. Just before the 'flash crash' occurred, two main U.S. exchanges had announced not to transfer their orders to the other one anymore. The advantage was that they did not need to be matched against a potential better price. Market makers increased their bid/offer price so massively that it was obvious that they did not want to be executed against client orders anymore.

At the moment, the final answer to and the reason for this crash, triggered by machines, remains unknown. But it can be said that the heterogeneous network became instable. ANT helps to see, but not to understand. The researcher has some ideas about what needs to be done in order to continue the research. Academics are invited to participate in future research and to be involved. As an example, some U.S and European brokers do not use their pre-trade risk tools and risk solutions because it reduces latency. Erroneous trades will

be seen again. However, SEC has proposed a ban on these 'naked sponsored electronic access' agreements between the broker and the HFT firm and hedge fund.

Finally, the researcher would like to mention that HFT firms are concerned and ask how the financial markets will be restructured, driven mainly by technology and new legislation, in the near future. As an example, a relatively small American proprietary trading firm, based in Canary Wharf, London, restructured the firm in 2010 and made most individual traditional and experienced traders redundant in order to set up HFT. The reason why the organisations asked traders to leave the company was because the firm decided to change the business strategy at the end of 2009. The CEO decided to move into HFT as a new business idea. Also, he employed somebody with HFT experience. In order to implement the new required IS and IT infrastructure from scratch, they needed to spend a lot of money, including buying raw historical data such as equity future tick data from Exchanges.

The project manager of this firm mentioned during a meeting in his office in March 2011:

> "I am concerned that HFT increases further and kicks traditional proprietary traders out of the market, because HFT firms are trading against each other and the tick traders are to slow to react. Those HFT trading activities are dominating the U.S market now and I want to make sure that no more traditional traders are kicked out of the market because they cannot react within 10 milliseconds. I should not say this, but we need to make sure that the market participants do not continue to change towards algo only. I am interested in continuing to see traditional human beings as traders. It is not healthy if we continue loosing traders and increase the number of HFT. It is unclear how the market structure will change this year. We decided to employ a new HFT trader soon in order to increase our HFT exposure. I can see that normal human beings are not able to compete against a machine" (Project Manager of an American proprietary trading firm, London, March 2011).

A concern for financial stability is that trading systems that function adequately in normal market conditions may cease to be effective in volatile markets. Liquidity can simply disappear if actors decide to halt market and limit orders due to increased uncertainty. In this case HFT firms need to switch their algorithms off instantly. The question is whether this would be realistic.

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