TOOLS FOR THE FINANCIAL ENTERPRISE

: The integrated banking suite

Banks are increasingly offering online trading and banking services. Customers can login to the trading and banking services home page subject to security constraints and execute orders, view their accounts, monitor their portfolio, fill applications, and post inquiries. Electronic data interchange standards such as SWIFT, FIX, and OFX support online banking and trading.

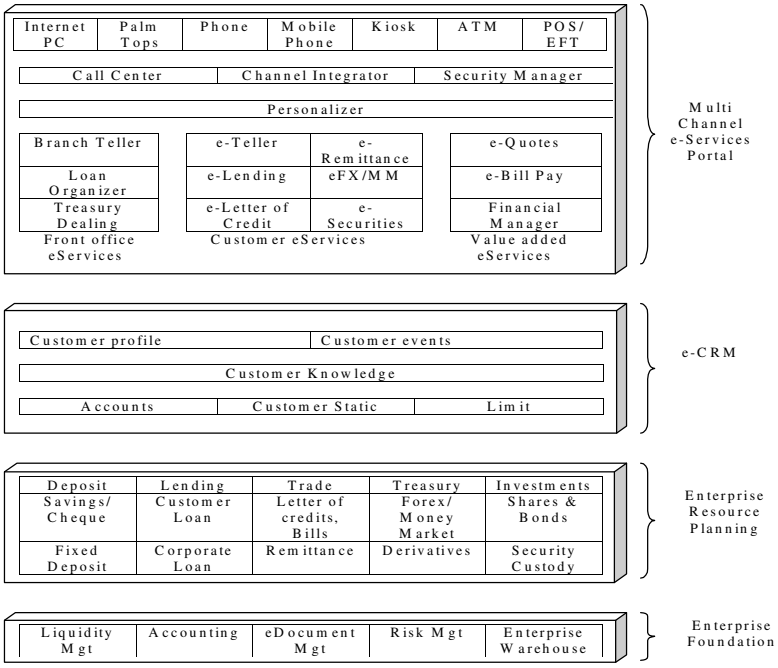

Figure 2.9 e-Banking operations

The general features of computer tools for automating banking operations are well exemplified by a suite of tools offering electronic banking services such as depicted in Figure 2.9. The Enterprise Resource Planning (ERP), multi channel integration, customer relationship management (CRM), electronic document management (EDM), and enterprise foundation tools for data warehousing that constitute such a suite are overviewed below.

Enterprise Resource Planning tools: Enterprise Resource Planning is an umbrella term for all tools and technologies used to handle the internal operations of a banking firm (deposit, lending, trade, treasury, investment) and to automate its processes. The term back office refers to the IT centre where all Enterprise Resource Planning applications are handled. ERP software used to run on mainframe, however, the advent of the year 2000 problem, and the introduction of the euro currency is forcing all business and financial institutions to upgrade the tools and technologies used in their back-offices and to re-engineer their internal processes. The shift towards a client server architecture is accelerating, and the role of Enterprise Resource Planning software tools is not limited any more to handling the internal operation in a centralized location in the firm but is extended to manage the operations over

the firms multinational network and to integrate with its online and front-end applications. Major service providers of ERP tools include SAP[1].

: Customer Relationship Management

The deregulation and the reduction of barriers to entry in the financial industry has resulted in the establishment of new institutions offering retail banking services at competitive prices and quality. Realising the need for new means to remain competitive in a global market place, top manager in banks and financial institutions started to shift their focus of interest from cutting operational cost to improving customer services and customer relationship management. Customer relationship management is referred to as the ability to capture a customer and to satisfy all their needs and requirements with minimum cost and high efficiency. This relies on many tools and technologies which can capture all the relevant information about a customer and their need via multiple channels (e.g. telephone, fax, internet), store this information in databases, and analyse it using data-mining and business intelligence tools. The CRM concept has matured and grown to become a subject encompassing all aspects of interaction between a company and its customers. It encompasses client servicing, targeting, profitability, selling, distributing channels, e-commerce, sales strategy, product strategy, and much more.

: Electronic Document Maanagement

This range of tools helps in storing, retrieving and managing the workflow of documents across the enterprise, and in undertaking collaborative work. It is very important for banks and financial institutions which have large amounts of important paper documents such as faxes, credit application, checks, financial statement, etc.. Documents are not stored in one place and are not processed by only one person. They have a workflow, that is a document is passed from one person to another across the enterprise for approval, amendment, or rejection. Automating this workflow is an important task to consolidate financial reporting and reduce the accounting errors. Collaborative work on projects such as syndicating financing, co-financing, and financial research requires the storage of documents and the management of their workflow. This task is facilitated using specialized document management tools for project collaboration.

[1] http://www.sap.com/

: Multi-channel integration tools

Survey data has shown that once e-commerce efforts were undertaken, consistency across multiple delivery channels became the greatest implementation challenge[2]. Key issues addressed in multiple channel integration are: choosing the appropriate channels, providing customers with good service across all channels, ensuring consistent information access across all channels, organizing a centralized policy to co-ordinate everything, and building and maintaining customer confidence. Tools used to ensure successful multi channel integration include tools for the data warehouse, computer-aided business process re-engineering tools, and network management tools.

: Business Process Modelling

Business process modelling tools support the re-engineering of the financial enterprise. Models used to document business processes and operations are often subject to standards (the US Federal Information Processing Standard IDEF0, the ISO9000 documentation for the manufacturing industry, etc.). Today organisations are facing a continuous change, and the effect of this change on business efficiency is highly unpredictable and risky. Simulation tools has been developed to take the risk out of change in several ways: by evaluating the impact of adding a new product line, by re-engineering the business processes, by modelling the working environment and by anticipating the implications of different business decisions.

: Data-warehousing tools

A data warehouse contains a collection of data from various operational systems and sources. It can be used as an integrated information base for making decisions and solving problems. Data-warehousing is the process of integrating enterprise wide corporate data into a single repository supporting a variety of decision analysis functions as well as strategic operational functions. The data warehouse provides a link between the operational environment and analysis environment of an organization. Tools for building, maintaining, and using the data warehouses in the financial enterprise are provided by Digital (Compaq)[3] and Informix[4].

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[2] Ernst & Young survey cited in Technology in Banking and Finance.
[3] http://www.digital.com/alphaserver/bus-intell/index.html
[4] http://www.informix.com

TOOLS FOR INVESTMENT

FINANCIAL ANALYSIS AND MODELLING

: OLAP

General purpose OLAP (Online Analytical Processing) tools are a common example of business intelligence tools. Data rich industries (such as the financial, marketing, consumer goods production, services, and transport) have large quantities of good internal and external data available in their databases to which they need to add value in order to gain competitive advantages in a global marketplace. OLAP tools have been developed in response to this need, to help conduct sales and customer behaviour analysis, budgeting, financial reporting and consolidation, tailored and intelligent management reporting, and performance measurement. However, the success of these tools relies on a high analytical functionality, large data capacity, and an underlying integrated database. The efficiency of OLAP tools might be reduced drastically in firms operating with multiple databases and low quality data (lacking consistency, reliability, accuracy, and integration).

: Data Mining

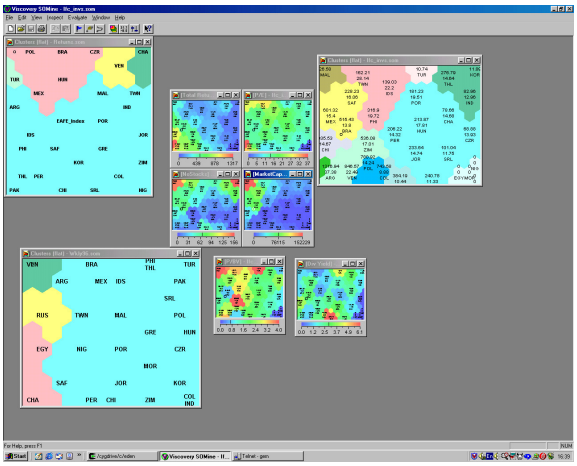
Many databases contain valuable information that is not readily obvious. An example of unrevealed information might be patterns of high-risk companies within a financial database. The search for these valuable, yet hidden, patterns and relationships within a database is known as data mining. Data mining infers rules that can guide decision making and forecasts the results of the decision. A number of different types of data mining tools are in use today, including: data visualization, neural networks, decision trees, and rule induction programs. These tools help in visualizing, detecting patterns of relationship, and inferring business rules hidden in the underlying database. The source of data analyzed by data mining tools can be loaded from ODBC compliant databases as well as spreadsheet and statistical software packages. Some of these tools can be also integrated into applications as activeX components. The features in data mining tools include: data manipulation (sampling, selecting, and merging data sets); modelling (classification, prediction, profiling, clustering, and detection models); visual exploration (visual presentation of the different stages of the data mining process, charts and graph plotting, and graphical trees views), and online distributed reporting.

: Spreadsheets

Spreadsheet modelling is widely used in business and finance. The ease of use, functionality, and built-in features make spreadsheets the most popular and basic tools for simple financial analysis and graphics reporting. Spreadsheet data models are the underlying models used in any intelligent tool with extended analytical capability. Almost all financial analysis and visual exploration tools import their data sources from spreadsheet applications.

: Visual Exploration

Visual exploration tools for building Self Organized Maps are used in finance to perform credit scoring, risk assessment, behaviour modeling, knowledge discovery in data bases, system state monitoring, process engineering, quality control, and prediction. This range of tools supports: dependency analysis, deviation detection, unsupervised clustering, non-linear regression, data association, pattern recognition, animated monitoring, as well as other enhanced visualization techniques.



Visual exploration in finance using self organized maps

Visual exploration, as its name indicates, explores the data set without needing to make any prior assumption about its characteristics. As such, it offers an open-ended potential for exploring the data set. Testing the significance of the results of a visual exploration method is not formalized, and we are as yet unable to judge the relevance of our analysis. Visual exploration has to prove itself as a reliable means for analysis.

This section considers the self organized map (SOM) as an example of a visual exploration technique and tool used in finance. SOMs have been used to understand trends and patterns among today's emerging market [Deb98], to analyse data on the emerging Russian banking system [SYa98], to translate multi-dimensional mutual fund data into simple two-dimensional maps [Deb98-2], to approximate the distribution of the interest rates structure and its

deformations over time [BGC98], and to conduct many other financial case studies where no econometric assumptions on data can be made.

The SOM technique has found a wide application in finance because it is a numeric rather than a symbolic method, it is a non parametric method, it demands no *a priori* assumption about the distribution of the data, and it can detect unexpected structures or patterns by learning without supervision. One of the tools used to develop SOM is Viscovery SOMine[5].

: Risk Management

The risk of a financial asset is defined as the variation in its underlying value. Credit granting, investing and trading involve risk. Hedging is a way to protect against risk, it can be achieved by the use of derivative financial instruments which are mainly financial contracts that can guarantee a non-loss position if all possible adverse market conditions and price movements are taken into consideration in this contract. Risk management involves the detection of trends and market surveillance. Self organized maps are used in visualizing some risk assessment and classification problems, such as the classification of countries according to their risk, where the level of risk is evaluated in term of many economic and financial factors.

: Market Prediction

Analyzing time series data in order to recognize patterns or make prediction about future values is important in many application area such as investment, trading, etc.. The ability to predict future values based upon past values and known future events is implemented using statistical time series analysis or neural networks[Bow90].

: Portfolio Management

A portfolio is the total securities held by an institution or a private individual. Voluminous amounts of rapidly changing data in financial markets create a challenging problem for portfolio managers attempting to exploit such changes to achieve their investment objectives. Changing market conditions should be exploited to optimize the value of individual portfolios [Pat90]. Prices of financial assets taken from reliable sources are fed into portfolio management models which support the decision of the buy and sell action and adjust the portfolio holding according to current prices. Portfolio management tools enable the user to download list of prices for stocks, options, bonds, mutual funds, or other investments directly

[5] Free demo available at http://www.eudaptics.co.at

from the Internet. Based upon the newly downloaded prices a portfolio is priced and reports are generated to display the results in ways that enable the investor to make clear and precise investment decisions based on the total portfolio behaviour. Appropriate visualization is used to highlight profitable transaction based on a study of asset prices, and to show the portfolio holding at any moment in time.

: Numerical Libraries

The implementation of intelligent financial analysis is supported by libraries developed by commercial firms. These libraries include a wide range of financial computation functions. Spreadsheet applications also support a library of financial and statistical functions. However, human judgement is always necessary to conclude a final judgement on the investment decision.

: Statistical Packages / Fourth Generation Languages

Statistical tools extend the features of spreadsheet tools to encompass a wider range of numerical and econometric techniques implemented as built-in functions. Statistical packages are used widely in academic financial research.

Fourth generation languages (4GLs) [WC88] were developed in response to the dissatisfaction of business users with large conventional languages like COBOL. These users are not professional programmers and wish to obtain quick results from data stored in a computer. There is a vast variety of 4GLs including spreadsheets, application generators, query languages, and decision support languages. Fourth generation tools for statistical and econometric analysis include: Excel, Gauss, Matlab[6], Eview, minitab, and SPSS[7], Mathematica[8], Stata[9] statistical software, etc..

An important issue considered in the use of fourth generation tools for statistical and econometric analysis is numerical accuracy [Vin00]. Fourth generation tools for statistical and econometric analysis are usually evaluated for their flexibility, power, intuitive syntax, ease-of-sharing, and ease-of-use. Fourth generation tools have a variety of different features, consist of different components, have different syntax and notations, and require different learning time. For example, the GAUSS system consists of three components: the GAUSS programming language, a publication quality graphics library, and a library of applications

[6] http://www.mathworks.com/
[7] http://www.spss.com/
[8] http://www.wri.com/

modules. Learning GAUSS takes about 2 weeks, while learning Excel might take hours for a computer literate person.

TOOLS FOR INVESTMENT

EDUCATIONAL

: OPTION! SOFTWARE

OPTION! is an educational package accompanying a book on options [Kol96]. The package is command line driven and consists of nine modules. Its procedures can compute virtually all of the model prices and examples given in the text book [Kol96]. Where applicable, the program can also graph option relationships. The first module, Option Values and Profits at Expiration, computes the outcome for various option strategies that are held until expiration of the option. Reports can be viewed or printed summarizing the results of the considered strategy. The second module, Option Values and Profit Before Expiration, is similar to the first module, but allows the user to price the options in their portfolio by using Black Scholes and Merton Models. Results can be viewed or printed and graphs can be plotted. The Third Module, European Stock Option, is composed of six sub-modules, covering the binomial model with specified price movements, the Black Scholes model, implied volatility according to the Black Scholes and Merton Models, simulation of stock and option prices consistent with the Black Scholes model, the binomial approximation of the Black Scholes model using stock prices movements, and dividend adjustment for European options. The fourth module, American Stock Options, consists of five sub-modules that cover virtually all dimensions of pricing American options on individual stocks. The fifth, sixth, and seventh, module cover Stock Index Options, Options on Futures, and Foreign currency Options. The eighth module deals with exotic options. The last module, Cumulative Unit Normal Probabilities, computes univariate and bivariate cumulative probabilities.

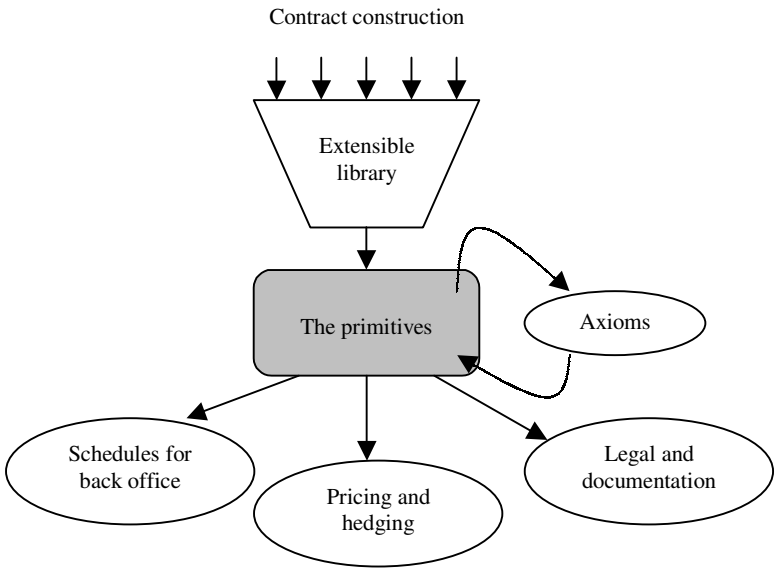
[9] http://www.stata.com/

TOOLS FOR INVESTMENT

FINANCIAL ENGINEERING

: Special Purpose Tool for Financial Contracts Description

The following sections describe joint research work at Société Général in Paris, and Microsoft Research in Cambridge, led by Jones et al (2000). This work attempts to develop a computer language for the description and valuation of financial contracts. The following paragraphs overview the proposal of Jones et al for a new "language of contracts" intended to precisely specify arbitrarily complex contracts, to build easily-extensible libraries of contracts, to perform valuations of complex contracts in a simple, modular way, and to perform other back office functions. The key idea behind this research is that complex contracts are formed by combining together simpler contracts, which in turn are formed from simpler contracts. In that context three keywords are introduced, the first is *combinators*, which refers to *bricks* and *mortars*. *Bricks* are elementary contracts from which all others are built (e.g. receive £100 on 1 Jan 2004). *Mortars* are the ways of transforming and combining contracts to make more complicated ones. According to Jones et al (2000), defining contracts using a fixed set of combinators, is similar to the specification and implementation of programming languages. A programming language has primitive elements (variable, constants, etc), and combining forms (for loops, if-then-else, procedures). The meaning, or behaviour of a complex program can be explained in terms of the meaning, or behaviour of its component pieces). The main research outcome is the definition of a carefully-chosen set of combinators which can be used to describe many familiar contracts as well as processing these contracts (by giving an abstract valuation semantic to combinators). A compositional approach is used for pricing and hedging purposes. For this purpose, a formalized language to describe financial contracts is being developed with the aim of facilitating back office contract execution, accelerating in a substantial way risk analysis, graphically representing a contract as a decision tree, reminding the front-office about any potential exercise decision that has to be taken, and generating intuitive simulations for the marketing departments of investment banks. The following picture, reproduced from Jones et al (2000), illustrates the main features of the formalized language to describe financial contracts.



Features of the formalized language to describe financial contracts proposed by Jones et al (2000)

In describing financial contracts, a precise vocabulary is used. This includes the following terms: rights and obligations, observables (a time varying value whose value at any time is a matter of legally-enforceable fact e.g. LIBOR rate, the temperature in Dover), unit of currency (unit of currency in which a traded asset is measured), acquisition date (date of acquiring a contract), horizon (expiry date of the contract).

A notation is used by Jones et al (2000) to define financial contract, this notation is implemented in the functional programming language Haskell [JHA98]. A simple zero coupon bond contract is described using this notation as follows:

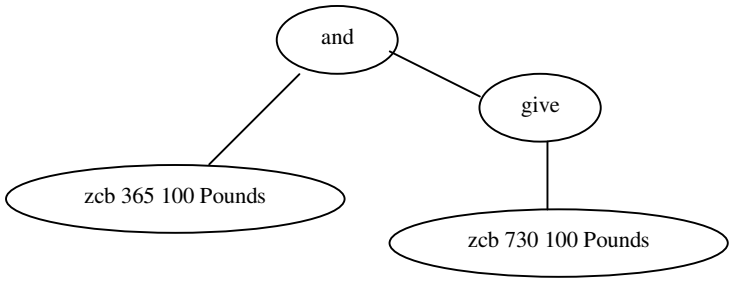
C1::Contract ← Type signature for C1, that is C1 has type contract

C1=zcb t1 100 GBP ← The application of the function zcb to three arguments

zcb :: Date ◊ Float ◊ Currency ◊ Contract ← Type signature for zcb

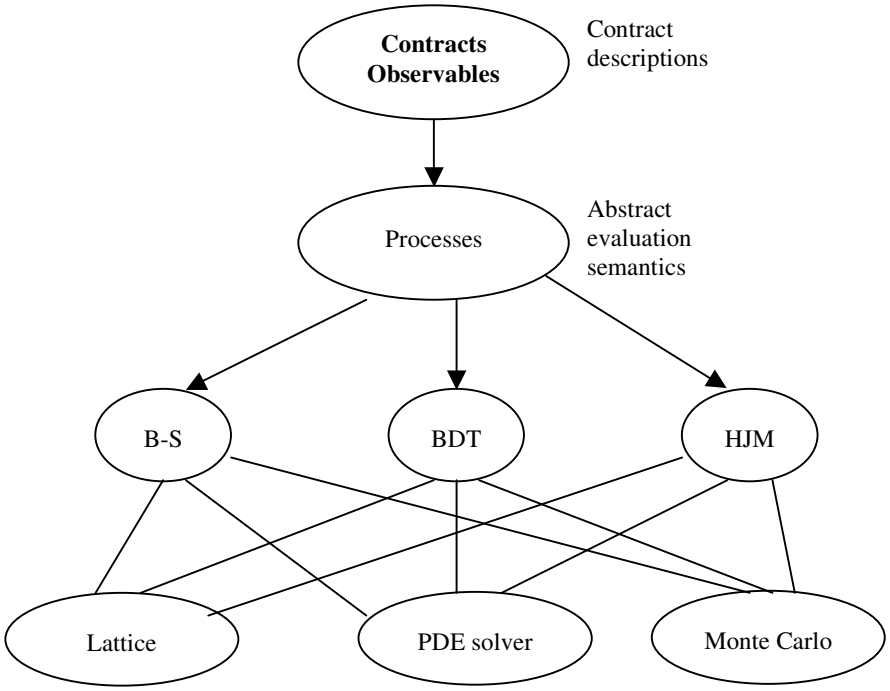
The description of the contract, c1, Zero coupon bond contract "receive £100 in 1st January 2010" using the Haskell notation.

Examples of combinators are **and**, **give**, **andGive**, etc…. The use of combinators (*bricks* and *mortars*) is illustrated in the tree description of the following contract composed of two *bricks* (elementary contracts) and two *mortars* (combinatory factors).



A contract as a tree [JES99]

For evaluating financial contracts two layers are used: abstract evaluation semantics (translate a contract into a value process) and concrete implementation (concrete implementation of processes). The following picture depicts the contract valuation framework proposed by Jones et al (2000).



Framework for contract valuation proposed by Jones et al (2000)

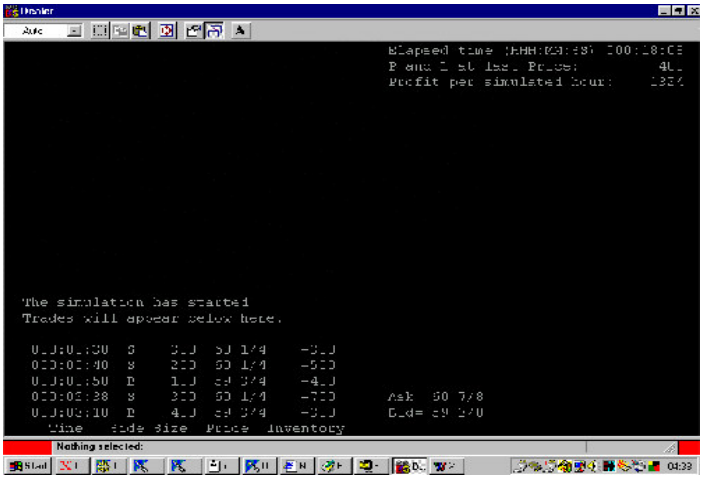
TOOLS FOR THE FINANCIAL MARKET

EDUCATIONAL MODELS

: The Wall Street Trader

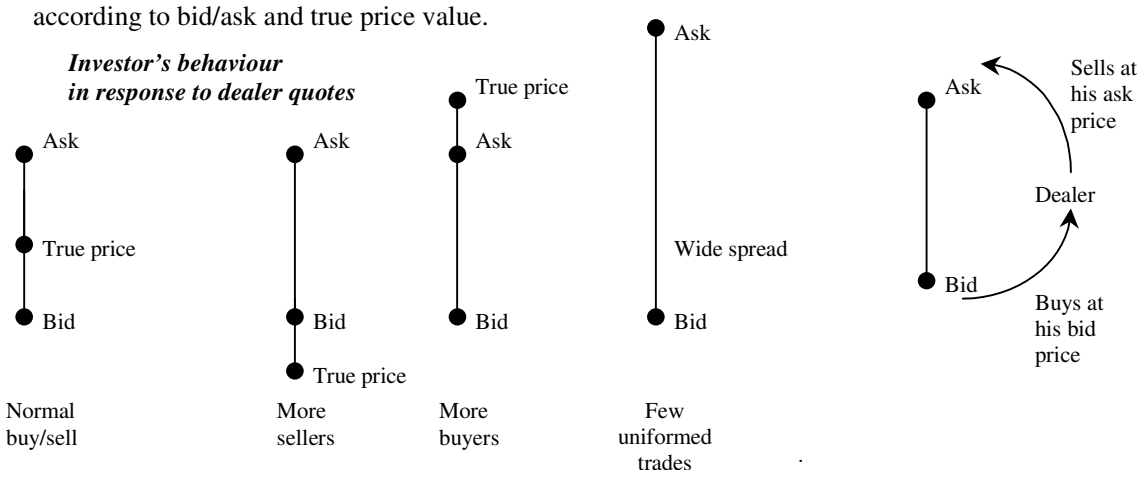
The Wall Street trader is a wimp based application game with multimedia support, to help learning about the global financial community. The game has a simulated financial database covering two years of trading history. The user, the player of the game, is the investor and he/she can buy and sell stocks and read about a company's history. Some tools are available to the investor: an analyst (to help the user understand the news), an insider (to help the user uncover hard to find facts), and a spy (to see what other investors are up to). The game has a tutorial. The news database is fictional though inspired by real events. Each time the game is restarted the events are changing so that the game can be played many times without being repetitive.

: The Monopoly Dealer Simulation



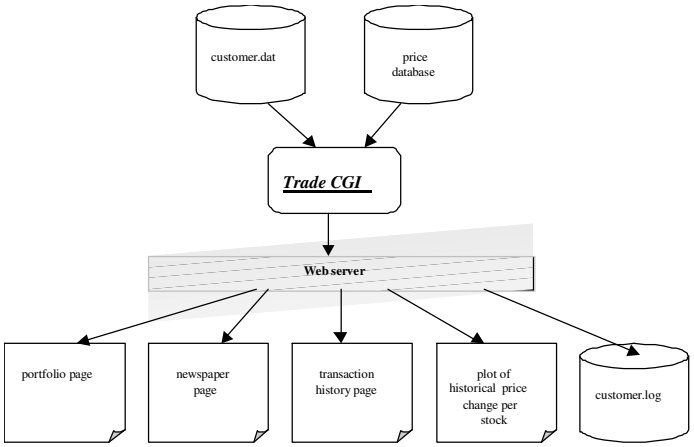
The monopoly dealer simulation is a command line application with a simple interface but a rich content. The simulation reveals the complexity of the interaction in the financial market and the difficulty in apprehending financial markets phenomena, such as the determination of the true price of a security and the impact of the investor behaviour (trader flow) on the decision making of a dealer.

The following description of the monopoly dealer[10] simulation, developed by Larry Harris, is extracted from the corresponding homepage. The program simulates trading in a dealer market in which there is only one dealer (the user of the simulation model). The user's task (the sole dealer) is to set and adjust bid and ask quotes (raise, lower quotes, or narrow and widen the spread) to maximize his trading profits. The computer model simulates traders arriving at random times to trade with the dealer (user) at his quoted prices. Larry Harris's aim in the simulation is to raise the awareness of its user (playing the role of a dealer) to the trading behaviour of different types of investors (informed/uninformed), and the true value of the security (changing through time and known to informed traders). The role of the user (dealer) is to estimate the true security value by examining the order flow. While the simulation is running, the computer estimates the user (dealer) profits by adding his cash position to the current market value of his inventory (computed using the last trade price). When quitting the simulation, the computer shows the true security value and the true profits of the dealer (user). The dealer (user) should know how to attract traders by adjusting his bid/ask quotes and spread. When the quoted bid/ask spread is wide, few uninformed traders will trade. To encourage uninformed traders to trade the spread should be narrowed. If the true security value is above the ask quotes, informed traders will buy from the dealer. They will sell to the dealer if the true security value is below his bid. Informed traders will trade more often and they will make larger trades when the dealer quotes are far from the true security value. The dealer should watch and control his inventory carefully, holding continuously less than 10,000 shares, long or short. The simulation will end if the dealer's inventory goes above 10,000 or below -10,000. Upon termination, the simulation reports executed trades. The following diagram depicts the buy/sell reaction of the informed investor according to bid/ask and true price value.



[10] http://lharris.usc.edu/trading/DealerGame\Default.htm

: Web-Based Trading Model



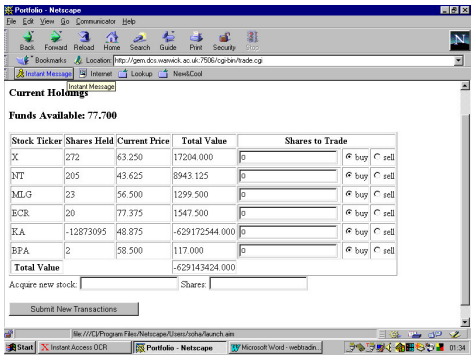
Boutell (1996) developed a web trading model using CGI (Common Gateway Interface) implementing a stock market trading system. As in online trading systems, the main features of this web-based model are to allow users (investors) to perform three tasks: 1) examine their portfolio; 2) buy and sell stocks; and 3) track the performance of stocks over time. The model does not work in real time (i.e. it has no feed of real data), however, it could be interfaced with a real database of stock market data with fast price updates and a large number of securities.

Boutell's model takes into consideration security, which is an important issue in designing any web trading or e-commerce application. Providing security means providing an appropriate authentication system. The model adopts a simple authentication mechanism to password-protect directories. It requires each user to enter a valid account name and password to access any page in that directory.

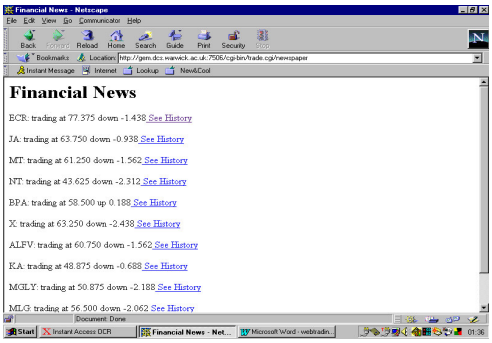
The web-trading model consists of two CGI programs. The first one generates random price fluctuations, simulating a one-day activity in the stock market. For real applications this CGI should be replaced with an interface to a source of actual stock prices. The second CGI program interacts with the user (which is the customer). It accepts user input and allows the customer to monitor his portfolio, to buy and sell shares, and to track the performance of shares. The CGI application developed to simulate stock price fluctuation accepts as input a text-based file consisting of stock ticker symbols. After running the application the database file will hold each stock ticker followed by up to 30 days of fluctuating stock prices, with the current price being the last one. The main functions of the CGI trade application is the dynamic generation of web page content from customer.dat files (each authenticated customer has a customer.dat file, e.g. the customer soha has soha.dat file), and the stock price file generated by the first CGI program. The dynamically generated web pages are: a portfolio page (listing the shares holding of a customer and giving this customer the option to buy and sell from already owned shares or to acquire new shares), a newspaper page (giving the

closing price of a share, i.e. the last generated price by the stock price generator CGI application, and the option to view a graphical plot of the price movement of each share), and a transaction history page (giving the time, date, and the number and symbol of shares bought or sold by a given customer).

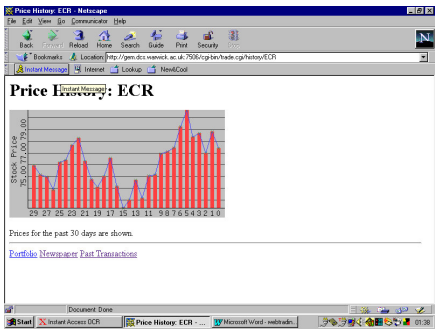
The web pages generated by the trade CGI program, are depicted in the following screenshots taken from the web trading application developed by Boutell (1996) and accessible at http:gem.dcs.warwick.ac.uk:7506/cgi-bin/trade.cgi.



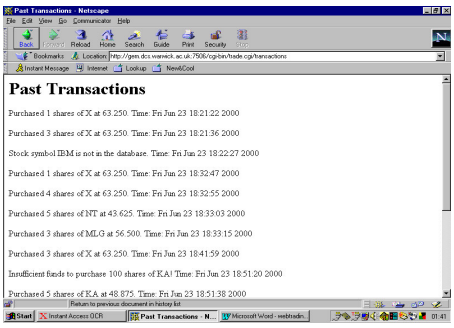
Generated portfolio page



Generated newspaper page

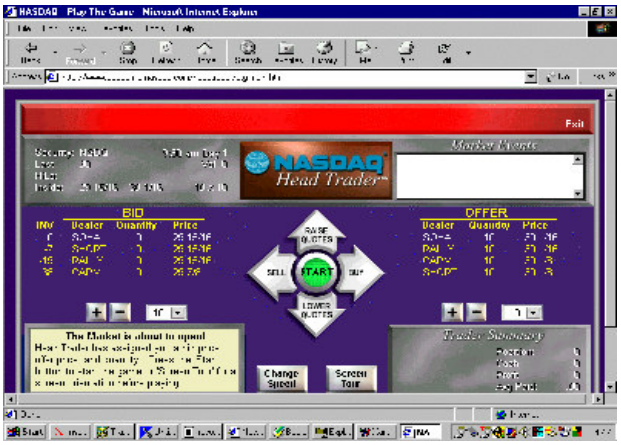


Generated graphical plot of
historical price changes for a given stock



Generated transactions history page

: Head Trader



Head Trader[11] is a web-based educational simulation developed by the Nasdaq Stock Market®. It is based on an original model and software developed by two academics in the field of trading mechanisms - Robert A. Schwartz and Bruce W. Weber[12]. Head Trader simulates the experience of a Nasdaq Market Maker buying and selling stocks in a screen-based market environment. It puts the player in the shoes of a professional trader. The game interface and information streams have been designed to be similar but not identical to the Nasdaq Workstation II used by Nasdaq' s more than 525 marketmaking firms.

In a Solitaire Play, players can compete against computerised players for bragging rights as the best sell-side trader. The player is given a chance to react to events that occur in the market such as changes in supply and demand, news, and the actions of computer Market Makers. These reactions determine the player' s success.

In Competition Play, players participate in various competitions and, in some instances, win prizes. It also allows professors and other instructors to hold private competitions for their students. The best scores for each competition are posted to scoreboards until a better trader comes along.

Upon termination of the simulation, a performance measurement, or score is displayed. The game time varies depending on the skill level selected and the amount of user interaction.

: STOCK TRAK

STOCK-TRAK[13] is an investment simulation, offering its users the opportunity to gain practical experience trading a wide range of investment vehicles. STOCK-TRAK users have

[11] http://www.academic.nasdaq.com/headtrader/
[12] at the Zicklin School of Business at Baruch College, The City University of New York
[13] www.stocktrak.com.

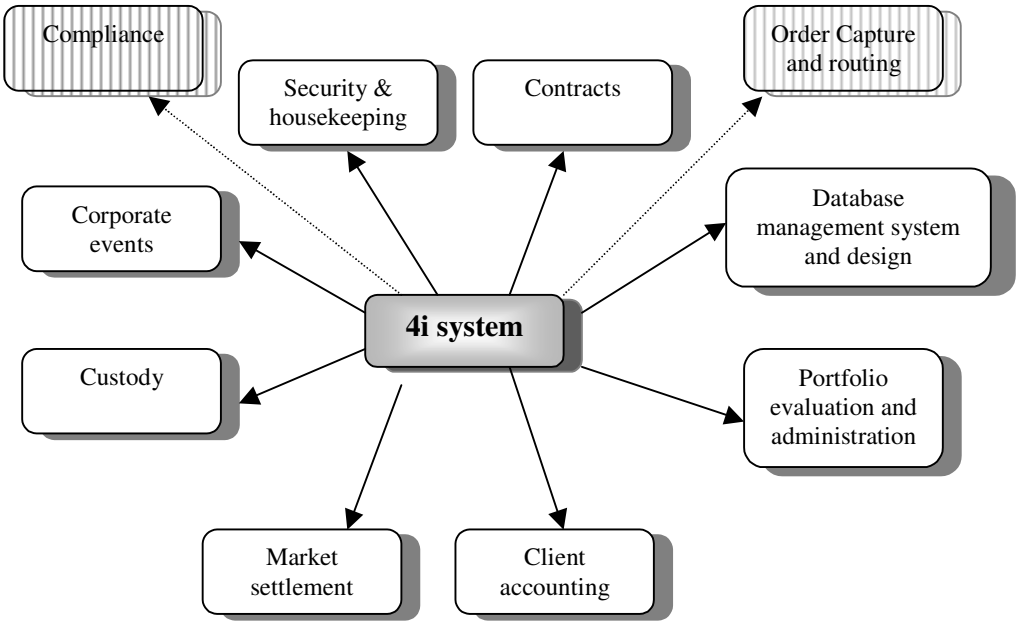
$100,000 to invest in common and preferred stocks, bonds, options, index options and futures, commodities, foreign currencies, financial futures, options on futures, spot contracts, mutual funds, as well as international stocks. Other features of the simulation include day trading, buying on margin, writing options covered and naked, as well as short selling. Interest is earned on cash balances and incurred on margin balances. STOCK-TRAK offers toll free access to live brokers, as well as twenty-four hour account access online. Users range from junior high school students to finance majors to firms that use STOCK-TRAK to train new employees.

TOOLS FOR THE FINANCIAL MARKET

TRADING SYSTEMS

: (4i) System

Trading, valuation, and management of financial instruments as used by practitioners is exemplified by the Integrated Investment Intermediary Information System (4i) developed by Consort securities systems Ltd.[14]. The system offers integrated investment management and stockbroking services. The system is WIMP based, with a GUI front-end and an SQL-Server relational database back end. The functionality of the system is detailed in the figure below.



The functionality of the 4i system

A single core database is used by all modules of the 4i system. This database maintains client / counterparty / principle and static data. Enquiries and reporting, batch and online processing, and multi currency are supported by this backend data base. Contracts are channelled to the system via the order and capturing module. The contract module allows the issuance of contracts (the layout of the issued contract can be user defined), the performance of calculations related to financial contracts, the reversal of contracts (cancellation or amendment) and settlement of the contract. The order and capturing module is designed to capture orders from a variety of sources (both manual and automatic), to validate them against specific criteria, and to direct them to the appropriate dealing system. The client accounting module is a look up module for investor, account, agent and brokers details. The results of the look up are reported through the financial reporting module. The portfolio evaluation and administration module allows the creation and maintenance of portfolios for clients. Client portfolio information comprises contracts, prices, indices, currencies, and valuations. In this module, portfolio modelling and what-if analysis can be conducted, stock modelling and asset allocation can be performed, capital gain tax can be calculated, and performance measurement and reporting facilities are also provided. The client accounting module manages the accounts of investors, agents and brokers and provides accounting reporting facilities. The market settlement modules report trades to settlement agencies and regulatory bodies, and monitor and record the progress of transaction settlement and trade execution. The custody module allows the creation and maintenance of new information records in the database. The compliance module provides reports for compliance officers to complete their tasks. The security and house-keeping module contains system configuration files storing licensing data, system program control info, and other features related to system maintenance, monitoring and control.

: eSpeed

Commercial software packages are developed to enable timely trade execution. An example of such type of product is the eSpeed[15] system that provides instantaneous, anonymous execution and trade confirmation. It offers a clear, comprehensive price display screen with real-time price dissemination.

[14] http://www.consort.co.uk
[15] www.espeed.com