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New Models of Business: Managerial Aspects and Enabling Technology

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Preface

The present Proceedings includes about thirty papers submitted to the International Workshop “New Models of Business: Managerial Aspects and Enabling Technology” organized by the School of Management at St. Petersburg State University in cooperation with the Institute of Management, Innovation, and Organization at Haas School of Business, University of California, Berkeley. The purpose of the Workshop is to provide a forum for participants from academia, government, and industry involved in research and practice in the area of business processes transformation based on advanced information technology. Considering an interdisciplinary character of the topic, the Workshop is particularly aimed at bringing together specialists in both management and technology to exchange ideas and present their research results.

The papers included in the Proceedings cover a wide range of topics, which reflect the interplay between emerging information technology and business processes. The Proceedings consists of the following parts: “New Management Trends”, “New Models of Business”, “Market Transformation”, “Business Process Re-engineering”, “Integration of Business and Technology”, and “Modeling and Analysis Tools”. Both research papers and presentations in the case study format are presented.

All the papers are published in the form presented by the authors through electronic submission process. In some cases, slight modifications have been made to bring the text into a common format.

I would like to thank all the colleagues who contributed to this volume. I am especially grateful to Viktor Taratoukhine for his assistance in organizing the meeting.

Nikolai Krivulin

New Management Trends

Cognitive Style, The Work Environment and Performance: The Case of Object-Oriented Developers

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Abstract

Although object-oriented development (OOD) represents a promising approach to information systems development, its adoption has been slow. One of the major obstacles to OOD adoption is the lengthy and costly transition of developers to the new paradigm: it takes time and there is no guarantee that the developer will successfully make the transition to the new approach (Van der Salm, 1998). One possible explanation for both the time it takes and the inability of some people to completely make the transition is the poor fit between the cognitive style of the person and the new work environment associated with OOD. Incongruence between cognitive style and work environment is expected to result in decreased performance for the developer (which, in turn, affects strain levels). This study investigates the fit between cognitive style and work environment and the resulting affect on performance. Based on a field study of 123 object-oriented developers, findings suggest a significant relationship between fit and performance as hypothesized: the greater the fit, the higher the level of performance (and vice versa).

1. Introduction

As the demand for larger and more complex systems grows, information systems professionals have realized the need for better ways to shorten development time and improve software quality (Weinberg, Guimaraes, and Heath, 1990). Many innovations, such as structured development, prototyping, CASE tools, and 4GLs have been introduced in response to this need; although no single improvement has solved all IS development problems. Object-oriented development (OOD) is one such innovation that has existed for more than 30 years, but has only recently enjoyed increased interest in its use. Although many believe OOD to be a viable solution to several of the problems facing current IS development, its adoption has been slow (Smith and McKeen, 1996).

Object-oriented development requires developers to acquire new skills that are a radical departure from the way they had previously thought of systems development. Early evidence suggests that it may take from six months (Van der Salm, 1998) to one year

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(Fayed, Tsai and Fulghum, 1996) to complete this transition. In fact, some who attempt the transition may never make it (Van der Salm, 1998). Therefore, one of the major problems facing companies today as they evaluate this decision to change technologies is largely a matter of the selection of personnel who can guide them through the change. One way to speed the transition to this new technology is to identify characteristics in people that allow them to better manage this change. These characteristics are related both to their own cognitive and personal traits and to their perceptions of the environment in which they work. Once a firm has made the decision to make this transition, the identification of such traits would provide a valuable tool in managing the transition. It would do so by providing some direction as to how to go about it. That is, identify the characteristics of the people and how they deal with change, and then identify the course of action to help them deal with the change. The purpose of this study is to examine an IS developer's level of performance resulting from a shift to object-oriented development. Decreased performance levels are expected to result from poor fit between a developer's cognitive style and their work environment created by the move to object-oriented development. This study provides the first step in understanding the transition to object-oriented development and a developer's corresponding performance.

2. Theoretical Background

2.1. Cognitive Style

Cognitive style determines how a person might prefer to solve problems, work with others and conform to rules. Adaption-innovation (A-I) theory suggests that an individual's preferred cognitive style lies somewhere on a bimodal continuum ranging from highly adaptive to highly innovative (Kirton, 1976). People who are highly adaptive differ in very specific ways from those who are highly innovative, and often the two types of people conflict when faced with situations requiring mutual action and/or change. Most people tend to score somewhere in the middle between the two extremes, but when people find themselves working with others who are far apart on the scale, the differences not only become noticeable, they become a hindrance to the work at hand. A-I theory does not presume to say that people cannot operate outside their preferences, but it does suggest that they must invoke a coping mechanism of some sort when they do. It claims that these two groups of people accept change in very different ways, that they solve problems in different ways, that they differ in how they see detail and that one group prefers more structure than the other.

All people operate within a specific paradigm that frames the way they think, act and feel. High adaptors are reluctant to venture outside their current paradigm until they can be assured that the new paradigm provides them with some net benefit (Van der Molen, 1994). At that point, they simply mold their current paradigm to fit the new one. High innovators, on the other hand, often get bored with the current paradigm and will switch to a new one much more quickly than their adaptive counterparts (Goldsmith, 1994, Van der Molen, 1994).

The Kirton adaption-innovation inventory is an instrument designed to measure a person's preferred cognitive style within the range of styles just discussed. It is a 32 item, 5-point Likert scale that ranges from a low score of 32 (highly adaptive) to a high score of 160 (highly innovative) with a theoretical mean of 95. It has been tested among some large groups and has an effective low score of 45; an effective high score of 145, and it is approximately normally distributed with an effective mean of about 95.8. It has been shown to be highly reliable and valid (cf. Bagozzi and Foxall, 1995).

2.2. Performance

The theory of person-environment fit suggests that the greater the congruence in the personal needs and abilities (i.e., cognitive style) with job supplies and demands (i.e., work environment), the greater the performance will be for workers. People carry with them certain needs they expect from their work environment as they enter the workplace and they also have certain abilities to perform a job. By the same token, the work environment must meet the needs of its workers, but any particular job can be demanding of certain skills from a worker. To the degree that needs can be supplied by the environment, strains will be lowered. Likewise, the degree to which a worker can meet the abilities demanded by the job, performance is expected to be better (Edwards and Cooper, 1990).

A scale developed by Green (1989) identifies those behaviors considered as necessary for information systems workers. Although not used as a performance measurement, it represents the first step in developing a behaviorally based rating scale, following the techniques developed by Campbell, et al. (1973), Smith and Kendall (1963) and Arvey and Hoyle (1974). The next step is to test the scale in the population for which it was designed and determine if it exhibits acceptable amounts of reliability and validity. The results of these tests indicate that it is highly reliable (coefficient alpha equal to 0.95), and it has passed several tests of convergence and discriminant validity.

2.3. Proposed Model

The proposed model is a combination of adaption-innovation theory and person-environment (P-E) fit theory. It makes use of the tenet from P-E fit that claims workers must be able to match their abilities with the demands of the job in order to improve performance levels; and the tenet from A-I theory that a work environment can be primarily adaptive or innovative in nature depending upon the type of work and the preferred styles of the people in charge. For example, accounting firms tend to attract high adaptors and engage in work that requires highly adaptive steps (e.g., highly detailed, very focused, lots of rules that cannot be broken). Research and development firms seem to attract highly innovative people and engage in work that is innovative in nature (e.g., rapidly changing designs, techniques and styles, less rigid structure and focused on a longer term, big picture objective). This study attempts to explain some of the variance found in performance levels of information systems developers who are undergoing radical change (to object-oriented development) based on the environmental demand for either adaption or innovation.

Radical change, or paradigm shift can occur to both high adaptors and to high innovators. It is how they go about accepting this change that is different (Goldsmith, 1994, Van der

Molen, 1994). Thus, if a high adaptor found himself in a job undergoing a paradigm shift, but was in a job primarily performed by high innovators, the theory would suggest that his performance levels would be very low. Conversely, the same high adaptor might be perfectly at home in an environment that demanded adaptive solutions and have much higher performance levels. The same is true for high innovators. Thus, to the extent that a person's preferred cognitive style matches the demands for innovation or adaption in the workplace, the greater the performance should be. Conversely, the greater the divergence in individual style and workplace demands, the lower the performance levels should be. The hypothesis (shown in Fig. 1 as H1) stated in the research form is:

The fit between personal abilities (cognitive style) and environmental demands for adaption or innovation for IS developers involved in a paradigm shift is directly related to performance.

We expect this relationship to bring about higher performance levels when cognitive style and work environment are perfectly matched, and for performance to decrease rapidly in a curvilinear fashion as we move away from the point of perfect fit. The model is depicted in Fig. 1.

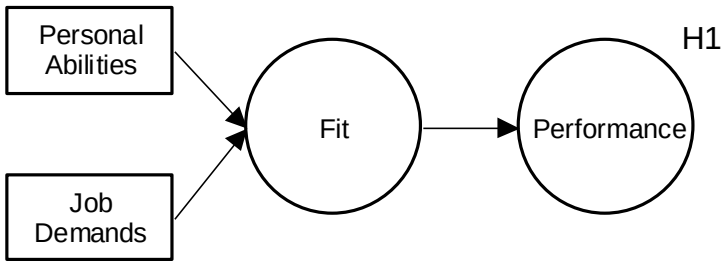

Figure 1: Fit and Performance.

3. Methods

3.1. Data Collection

This field study involved collecting perceived attitudes from 123 systems developers currently working in object-oriented systems development jobs. Subjects were asked to complete the Kirton adaption-innovation inventory, and their supervisors were asked to complete the performance scale, reflecting the performance of each incumbent. The subjects represented a variety of different industries in both large and medium sized companies in the U.S. Subjects were assembled in rooms, given a standard set of oral and written instructions, and asked to complete the survey forms. Time to complete the forms averaged about 25 minutes. Supervisors were asked to complete a performance scale for each of their workers in a different location at the same time that the subjects were completing their forms.

Scales were summed and averaged to reduce the number of variables prior to entry into regression models. Also, all scales were checked for internal consistency (reliability) using

coefficient alpha and factor analyzed for validity. Coefficient alpha ranged from a low of 0.88 to a high of 0.95 for the scales. Construct, discriminant and convergent validities were all assessed using confirmatory factor analysis and each scale showed acceptable results.

The performance scale showed three distinct factors. These factors were named soft skills, management skills and technical skills, since the indicants loaded in such a way that they seemed to describe these abstractions. Soft skills reflected how well people are able to interact with others, management skills reflected a person's ability to manage projects and lead people, and technical skills reflected the ability to solve information technology problems.

3.2. Analysis and Results

Since P-E fit issues should normally be analyzed using additive relationships (Edwards and Parry, 1993) and can be evaluated using second order regressions, the approach here is to do the same and to use response surface methodology in the analysis. The regression equation tested was:

$$Performance = person + environment + person^2 + person * environment + environment^2,$$

where performance is a variable indicating a subject's performance level as perceived by the supervisor, person is a variable describing individual preferred cognitive style (adaption or innovation), environment is a variable describing the worker's perception of what is required of him or her in the workplace (adaption or innovation) and the remaining variables are second order terms of these two.

Variable	Standardized Coefficient	Standard Error	t-value	Pr > |t|
Person	–1.34	0.95	–1.36	0.18
Environment	–2.49	1.12	–2.24	0.03
Person Squared	–0.19	0.82	–0.23	0.82
Interaction term	2.39	1.05	3.51	<0.01
Environment Squared	0.90	0.64	0.84	0.41

$R^2 = 0.12$; $F = 3.13$; $Pr < |F| = 0.01$

Table 1: Parameter Estimates for a Second Order Model.

Standardized estimates of the coefficients and the statistical tests performed on them are shown in Table 1. Because the regression is significant ($p = 0.01$), we can sustain the hypothesis and conclude that performance improves as fit improves, but performance decreases as fit moves away from its optimal condition. To analyze the curvilinear aspect of this relationship, we can form a response surface from the regression equation.

The response surface is shown in Figure 2. The performance response is shown on the vertical axis, the person variable is shown along the axis running into the page, and the environment variable along the axis running left to right. A contour map is also projected onto the horizontal plane below the surface to further accentuate areas along the surface with equal performance responses.

Although units are arbitrary in any of the variables, the independent variables were allowed to vary between –3 and +3. This created performance units from about –12 to about +40. This surface is generated from a statistically significant second order regression, whose coefficients are shown in Table 1. It represents the performance level for any particular combination of person and environment fit. There are two paths in particular that require attention and explanation. These are the diagonals that run across the surface. The first runs from the near lower corner to the back corner and the other runs from the upper right corner to the upper left corner.

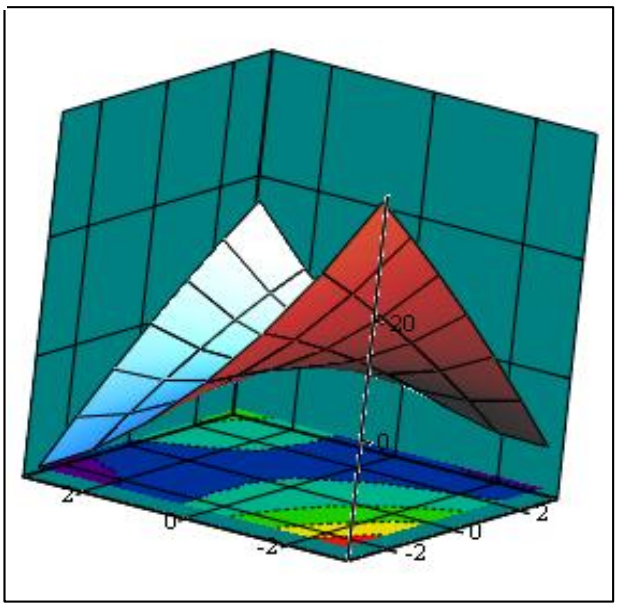

Figure 2: Response Surface for Performance Fit.

The first diagonal is important because it represents the path along which all points are perfect fit. This means that demands and abilities range from highly adaptive in the near corner to highly innovative in the back corner, but equal in every case. Notice that performance levels are maximal at each of these two corners and that performance decreases somewhat in the middle. This suggests that people who are highly adaptive and work in an environment that requires highly adaptive people and techniques and people who are highly innovative and work in an environment that requires highly innovative people and techniques will perform at the highest performance levels. People in the middle between highly adaptive and highly innovative will perform at a slightly lower level, but much greater than is exhibited by the other diagonal.

The second diagonal represents that path along which we find subjects who range from high innovators in a highly adaptive environment to high adaptors in a highly innovative environment. These are the two extreme corners where misfit is maximal. As the diagonal reaches the middle of the surface, it becomes a point of optimal fit with people and their workplace perfectly matched, but somewhere between high innovation and high adaption. Notice that at these two corners, performance levels are at their lowest. Turning the figure somewhat shows the curvilinear nature of this relationship. It shows us simply that the more we deviate from optimal fit, the lower the performance levels, and that the decline will be very rapid.

4. Conclusion

This study investigated the influence of the fit between cognitive style and work environment on performance for object-oriented developers. A field study of 123 developers confirmed the hypothesis that greater fit leads to higher levels of performance (and vice versa). These findings lend insight into why, in many cases, it takes a long time for a developer to make the transition to object-oriented development or, in some cases, fail to make the transition altogether.

A response surface map, generated from the second order regression equation, revealed the specific nature of the fit/performance relationship. An interesting feature of the response surface depicted in Figure 1 is that performance actually decreases as both the work environment and cognitive style rise at the same rate and remain equal. It then begins to rise again as these variables become extremely high. An interesting extension to this study would be to further develop reasons for this curious oddity. This effect may occur because it seems to affect people in the middle of the adaption – innovation scale who prefer innovative responses in some situations and adaptive responses in others. Additional study is needed to determine this.

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Assessing and Managing Knowledge Worker and Knowledge Assets in High-Tech Organisations

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Abstract

Capabilities and their underlying knowledge assets represent the new competitive resource for eBusinesses. The research presented in this paper utilizes a series of case studies to identify the key capabilities and knowledge assets for eBusinesses. The paper suggests the Knowledge Assets Map as a framework to identify and manage key capabilities and key assets in today's economy. Furthermore, the paper provides a list of metrics to evaluate capabilities and knowledge assets.

Keywords: Intangible Assets, Performance Management, Electronic Commerce, Intellectual Capital, Capabilities

1. Introduction

Today's Businesses rely even more heavily on their intangible knowledge assets than more traditional companies since they often have very little physical assets. The volatility in their market capitalization reflects that the assessment and evaluation of knowledge intensive eBusinesses represents a very difficult task. Knowledge, and in particular knowledge assets, represent the foundation of a company's capabilities. Capabilities in turn determine the performance of the processes necessary to execute a company's strategy.

Performance measurement and management systems provide managers with meaningful tools to understand how well their organization is performing and help them to decide what area need attention. The definition and implementation of measurement systems, which allow measuring a company's knowledge assets and therefore their capabilities, is of fundamental for eBusinesses. It is not possible to manage an organization's knowledge assets and capabilities if a company does not assess them (Roos et al., 1997).

Knowledge assessment is a topic of growing interest for practitioners as well as for academics. In fact in the last years considerable attention has been paid to the meaning, the objectives and the approaches towards organizational knowledge measurement. It is possible to identify different attempts to define knowledge assessment approaches in the management literature. These appear to be mainly focused on the evaluation and external reporting of the company's intellectual capital, trying to explain the growing gap between

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the traditional book value and the market value (Edvinsson and Malone 1997; Roos et al., 1997; Stewart 1997).

For this paper case studies are used to identify a set of key capabilities and the corresponding knowledge assets for knowledge intensive eEconomy organizations. The result of the case research are used to outline a framework, the Knowledge Asset Map, to support managers in identifying and monitoring the key knowledge assets of eBusinesses. This framework is accompanied by the definition of a set of knowledge assets metrics. These metrics are defined on the basis of both the case studies and of a review of the literature. The Knowledge Asset Map will be supplemented by an identification of the knowledge management process adopted by the case study companies to maintain and grow the knowledge assets. Finally this paper provides a framework and a set of guidelines to design metrics to assess the knowledge assets in eBusiness.

2. Evaluating Capabilities and Knowledge Assets in Today's Economy

In today's complex and turbulent business environment companies are required to be flexible, highly innovative and able to develop pro-active strategic approaches. To reach these aims many organisations have realised that knowledge and the right capabilities represent the most important factor in creating economic value since it underpins the overall firm's performance (Barney, 1991; Davenport and Prusak, 1998; Drucker, 1995; Grant, 1997; Leonard-Barton, 1995; Nonaka, 1991; 1994; Prahalad and Hamel, 1990; Prusak, 1997). Webber writes in his Harvard Busienss Review article 'What's so new about the new economy' that the revolution in information and communications technologies makes knowledge the new competitive resource (Webber, 1993).

The New Economy or Knowledge Economy is characterised by two main aspects: the fast evolution of ICT and the recognition of knowledge as a fundamental strategic lever for a company's competitiveness. However organisations are beginning to recognise that technology-based advantages are transient and that the only truly sustainable competitive advantages they have are their knowledge assets. As a result knowledge assets and their maintenance, are becoming essential resources. In order to better manage their business performance, organisations need to assess their knowledge. Knowledge assessment is mainly future oriented, while traditional measurement tends to look backwards. This is related to the understanding of knowledge. Knowledge shapes the foundation of a company's performance and its assessment provides a picture of the development capabilities of a company. This is a topic of fundamental importance, particularly for eBusinesses that have few physical assets (Leadbeater, 2000). These companies, considering the nature of their products (services), are realising that they are knowledge-intensive companies and their performance is deeply affected by their knowledge assets and knowledge processes. For eBusinesses it becomes very important to report and evaluate their knowledge dimensions that underpin their capabilities.

The knowledge assessment and evaluation of capabilities can have two main purposes: to assess the value of the company or to evaluate its capabilities to sustain future success.

Therefore it is possible to identify two different kinds of knowledge reports with separate functions:

1. External Reports That Aim to Communicate the Company's Value;
2. Internal reports, as internal managerial information, which address the assessment of a company's knowledge stock.

It is important to point out that for external reporting the traditional balance sheets alone are not sufficient any more because they take only the tangible knowledge assets into account, disregarding completely the company's intangible knowledge assets. Recently many articles and books have been written on intangible assets or intellectual capital that refer to the large difference between a company's conventional balance sheet value (the book value) and its market value (Backhuijs et. al., 1999; Leadbeater, 2000; Sveiby, 1997a and b). To explain these gaps between book value and market value different reasons have been provided. Various rationalisations claim that it is either due to knowledge, the brand or the ownership of standards, but in each of these cases it is due to the exploitation of specific knowledge.

As knowledge becomes a resource on which the business performance processes are based, a new challenge arises: how to evaluate the organisation knowledge assets and capabilities in order to manage them.

Most of the key assets and the capabilities of eBusinesses are intangible in nature. According to the International Accounting Standard Committee the intangible assets can be defined as follows: "An intangible asset is an identifiable non-monetary asset without physical substance held for use in the production or supply of goods or services, for rental to others, or for administrative purposes. It is a resource, (a) controlled by an enterprise as a result of past events, and (b) from which future economic benefits are expected to flow to the enterprise" (IAS 38, September 1998). Further interpretations can be found in the context of knowledge management. Within this discipline the intangible assets are analysed from different perspectives (Brooking, 1996; Edvinsson and Malone, 1997; Roos et. al., 1997; Stewartm 1997). For the market evaluation purpose the intangible assets are usually identified as the company's intellectual capital (Edvinsson and Malone, 1997). This approach appears to be useful for accounting purposes, as it allows separating all assets for which it is easy to provide financial evaluation from the assets that are due to their intangible nature inherently difficult to evaluate in monetary terms. Hall (1992) divided intangible assets into intangible properties and intangible resources. The intangible property can be defined as knowledge related to legal ownership, for example patents, trademarks, copyrights, trade secrets, registered designs, brands as well as computer software, contracts and databases (Petrash, 1998). Instead intangible resources are mainly formed by individual's experience and organisational routines and relational resources such as reputation, client loyalty, as well as all firm's relationships (Davenport and Prusak, 1998; Haanes and Lowendahl, 1997; Nonaka and Takeuchi, 1995; Nelson and Winter, 1982).

In the literature further methods of classifying intangible assets can be found. One of the frequently quoted classification is the model proposed by Skandia (Edvinsson and Sullivan, 1996; Edvinsson and Malone, 1997). In order to evaluate its market value Skandia proposed

to split its market value into financial capital and intellectual capital, the latter is considered to equate to the firm's intangible assets. To identify the components of their intellectual capital, it has been subdivided into know-how of the workforce, i.e. human capital, and other intangible assets embedded in the organisation itself called structural capital. Structural capital can be further subdivided into customer capital, e.g. the value of customer relations and brand, and organisational capital. The latter can be further broken down into process capital, related to the procedures and routines of the company's internal processes, and innovation capital, that represents the enablers to innovate products and processes. The Skandia approach, therefore, splits intellectual capital into the following four categories: human capital, customer capital, process capital and innovation capital.

Another largely adopted model to understand intangible assets is Sveiby's Intangible Asset Monitor (Sveiby, 1997a and b), which is also mainly aimed to evaluate intangible assets for the purpose of external reporting, i.e. to assess a company's market value. It is based on three categories of intangible assets: intangibles related to the internal structure, those related to the external structure, and intangibles represented by competencies of individuals. Internal structure includes things such as intellectual property, patents, copyrights, corporate culture, management processes, networking systems (i.e. computer and administrative systems). External structure contains relationships with customers and suppliers. Employee competencies are related to human capital that in turn take into account all the know-how embodied in the individuals working in the firm (Jordan and Jones, 1997).

In order to understand the composition of the capabilities and its underlying assets of today's eBusinesses as well as the applicability of the approaches explained above a series of case studies where conducted to analyse and identify the key assets and capabilities in the eBusiness environment. The next section of the paper will discuss the main insights of the case studies of three eBusinesses to identify the key capabilities and knowledge assets underpinning their capabilities.

3. Key Capabilities and Knowledge Assets – Case Study Insights

This section is based on case study data collected from three eBusinesses. The data was collected by semi-structured interview with the managing director and HR director of Intershop UK, the managing director of Lycos UK Ltd and the CEO of Jungle.com. A brief introduction of the case study companies is provided in the following.

Intershop is one of the world's leading suppliers of sell-side business-to-business e-commerce software solutions. They employ about 1000 people in offices around the globe and sell their products in more than 100 countries. For their enterprise customers they developed Intershop Enfinity, a complete, state-of-the-art e-commerce application that allows their customers to sell anywhere on the Internet and enables integration with existing business systems. Intershop's other products – Intershop 4 Hosting, Merchant and ePages – give Application Service Providers (ASPs) the ability to provide a complete range of e-commerce hosting solutions, ranging from entry-level storefronts to sophisticated e-commerce sites. Furthermore, service and support for Intershop products is provided through their own consulting organisation, support and education teams around the world,

and their network of over 600 affiliated professional service providers and system integrators.

Lycos UK Limited is an eBusiness that offers users a full-service Web destination complete with search tools and navigation resources, personalised services, chat, an industry leading online shopping area and free e-mail. Lycos UK Limited is part of the multimillion Dollar Lycos Network, which is the world's number one provider of electronic community and includes the second most visited "hub" on the Web. Lycos launched in 1995 as a search engine and since then steadily expanded to include chat-rooms, e-mail, online shopping, home page building tools, and many other services. Today Lycos includes the website building service Tripod and the directory service WhoWhere as well as some of the Web's most recognised sites including hotbot.com, gamesville.com and hotwired.com.

Jungle.com is a £100 Million online business with 307 employees, which is based in an industrial estate outside Birmingham. The offices are painted in jungle-green and visitors will find a selection of palm trees behind the reception. Launched in August 1999 with the largest Internet give-away jungle.com sells PCs, computer peripherals and software, as well as music, videos and brown goods. In Sep 2000 Great Universal Stores, owner of the Argos catalogue chain acquired the eTailer.

In the following the paper will discuss the themes that emerged from the case studies to form the basic structure of a capabilities framework.

3.1. Stakeholder Relationships

Interviewees of all three case study organisations stated that relationships with their stakeholders are key assets and to maintain these relationships are core capabilities of eBusinesses. Intershop has strong partnerships and strategic relationships with a global network of solution providers in order to ensure that their customers' needs are being met worldwide. Their partnerships include alliances with major system integrators, technology partners, Internet marketplaces, and hardware and software platform providers. For Lycos the relationships with external advertising companies, agencies and content providers are key assets. Jungle.com has build a strong relationship with their suppliers in order to be able to jointly drive new sales. In their Mission statement Jungle.com indicates they want to become the best for their employees (team members as they call them), customers, suppliers and investors. This also verifies the importance of alliances identified in the Value Creation Index, the result of a yearlong joint research by Ernst & Young, Forbes ASAP and the Wharton School’s Research Program, that identified the five drivers for corporate value in eCommerce firms as follows (in rank order): (1) Alliances, (2) Innovation, (3) Eyeballs (usage traffic), (4) Brand Investment, and (5) Stickiness (Minutes spent on the website) (Malone, 2000).

3.2. Human Resource

The employees with their skills, motivation and commitment was also key to all three companies that where interviewed. Intershop emphasised the joint effort of the young and energetic team that allowed creating an entrepreneurial spirit and enthusiasm as one of their

key assets. In a very similar way describes Lycos the teamwork as one of their key assets. Jungle.com states that team members (employees) are the most valuable asset and for them staff retention is most important. In particular the experienced marketing team that knows how to build a brand and the programming team that knows how to build a web page.

3.3. Physical Infrastructure

Although, many eBusinesses have very little physical assets and the majority of assets are intangible, technology is still at the very core of their processes. They have to ensure that their servers deliver the website 24 x 7 in order to achieve 6 sigma reliability. Lycos and Jungle both state that speed and reliability of their web pages is a key asset and downtime is unacceptable and too serious to not be priority.

3.4. Culture

For all three case study companies the culture in the organisation was a key asset. Culture embraces management philosophy and corporate rules. Intershop emphasised their entrepreneurial spirit and casual and enthusiastic 'start-up' atmosphere within a young team with an average age of just 27 years. Jungle.com also stresses their 'can-do attitude' among their young team. Jungle even has, besides their mission statement, a culture and value statement. Lycos, like many other start-ups, used to operate form a small and crowed office. After the recent move to a new and bigger office in central London the organisational culture has changed and people perceive their job and position in a slightly different way. Although, all operational processes of Lycos are performed in one office and this allows sharing knowledge and creates team culture; facilitate the communication processes, and enables sharing of tacit knowledge. Lycos is very determined to preserve their current culture as one of their key assets.

3.5. Practices and Routines

The often informal culture allows many informal practices, routines and workflows to share knowledge and create virtual networks. Databases and codified procedures where mentioned by all three companies as key assets. These databases include customer databases as well as Intranet databases to retrieve best practices or individuals with specific capabilities. Lycos produced a document, which contains the codified brand management knowledge of their brand experts as well as acquired knowledge from external experts.

3.6. Intellectual property

Intellectual property is an important asset for companies with little tangible assets. For Intershop their software product is a key assets, which in its nature is intangible and has to be protected by patents and copyrights. For Lycos as well as for Jungle their major intellectual property asset is the brand name of the company. For eBusinesses the brand name and the registered URL is a enormous asset as users need to type in the exact name of the URL to reach the company's web page, when they are not using a hyperlink on another website.

4. Knowledge Assets Map

The Knowledge Assets Map is based on an interpretation of the company's knowledge assets as the sum of two organisational resources: Stakeholder Resources and Structural Resources. This distinction reflects the two main components of an enterprise, its actors, who can be either internal or external to the organisation, and its constituent parts, i.e. the elements at the basis of the organisation's processes. Figure 1 illustrates the hierarchy of knowledge assets with its sub-classifications. Stakeholder Resources are divided into Stakeholder Relationships and Human Resources. The first category identifies all external actors of a company while the second represents the internal actors. Structural Resources are split into Physical and Virtual Infrastructure, which refers to their tangible and intangible nature respectively. Finally, the Virtual Infrastructure is further sub-divided into Culture, Routines & Practices and Intellectual Property.

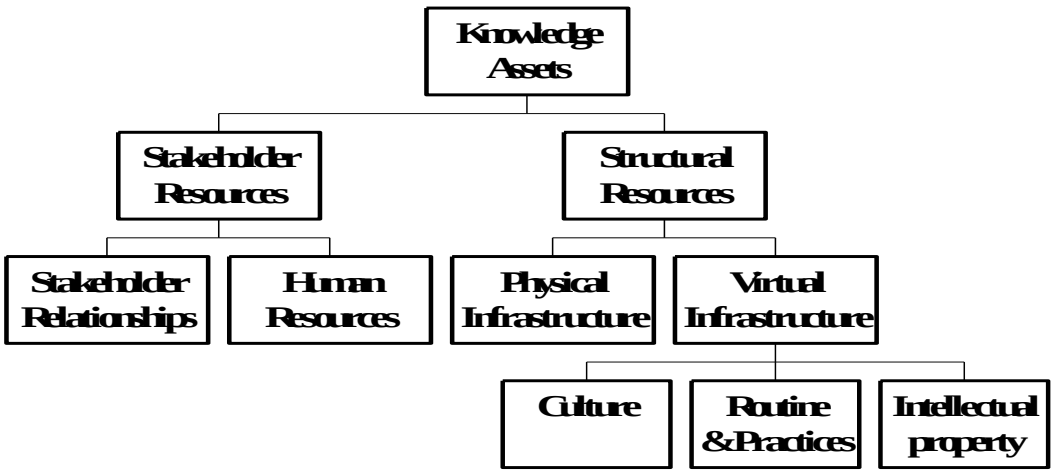

Figure 1: Knowledge Assets Map

The six categories of knowledge assets identified by the Knowledge Assets Map are defined in further detail below.

Stakeholder relationships include all forms of relationships established by the company with its stakeholders. These relationships could be licensing agreements, partnering agreements, financial relations, contracts and arrangements about distribution channels. The stakeholder relationships include also customer loyalty, company names and brand image, which represent a fundamental link between the company and its stakeholders. The brand image and perception of the organisation is particularly essential for eBusinesses. With a strong brand organisations build up trust and this is one of the most important issues for an eBusiness. In particular when customers cannot walk into a physical building and see the people working there. In the "physical world" brand is the sum of personality, presence, and performance of a given product or service, the "3Ps" (Court et al., 1997). On the Web if the company has not established a good brand image a customer can never know what kind of

company he or she is buying from and therefore may be reluctant to give away their credit card details.

Human Resource contains knowledge provided by employees in forms of competence, commitment, motivation and loyalty as well as in form of advice or tips. Some of the key components are know-how, technical expertise, and problem solving capability, creativity, education, attitude, and entrepreneurial spirit. Particular important for eBusinesses is the skill sets of employees compared to the skills the organisation requires to make its businesses. In fact, in the eEconomy this required set of skills changes more frequently with the dynamics in the market place and therefore multi-skilling of employees is an important quality and recruitment of qualified staff becomes a fundamental topic.

Physical infrastructure comprises all infrastructure assets, such as structural layout and information and communication technology like computers, servers and physical networks. All eBusinesses rely heavily on technology which makes this aspect different from the old economy. Scalability and capacity of web servers that have to deal with request peaks without increasing download times or even shutting the server down becomes a crucial issue for every eBusiness. Time to execute website updates is important for eBusinesses and system integration is especially a concern for clicks-and-mortar companies. The facilities and the equipment the company requires are essential for a young business that has yet to build up the infrastructure needed. This could include setting up call centres, distribution centres, delivery fleets as well as hardware upgrades.

Culture embraces corporate culture and management philosophies. Some important components are the organisation's values, the networking practices of employees as well as the set of mission goals. Culture is of fundamental importance for organisational effectiveness and efficiency since it provides the organisation's members with a framework in which to interpret events. (Roos et al., 1997). The culture provides organisations with a framework that encourages individuals to operate both as an autonomous entity and as a team in order to achieve the company's objectives.

Practices & Routines include internal practices, virtual networks and routines, i.e. tacit rules and procedures. Some key components are process manuals providing codified procedures and rules, databases, tacit rules of behaviour as well as management style. Practices and routines determine how processes are being handled and how workflow processes flow through the organisation. This can have huge impacts on efficiency and effectiveness of the processes that the organisation has to perform. In particular for eBusinesses practices would include security accreditation and privacy policy handling.

Intellectual property is the sum of patents, copyrights, trademarks, brands, registered design, trade secrets and processes whose ownership is granted to the company by law (Roos et al., 1997). It represents the tools and enablers that allow the company to perform its daily processes to produce results. Particularly important for eBusiness are new forms of intellectual property such as mailing lists and customer databases.

It is possible to provide a wide range of indicators for each category of a company's capabilities but the management team has the task of identifying the most meaningful indicators that help to assess their company's capabilities and assets.

Therefore, it is important to warn managers not merely to adopt the metrics proposed in the literature since most of them are general and do not necessarily address the types of knowledge that have a critical role in the specific organisation's value-added processes (Liebowitz and Suen, 2000). Managers need to start from the recognition that the knowledge assets are absolutely unique to each company and that they have to design metrics that really address and measure their key organisational knowledge assets and capabilities.

5. Discussion

The contribution of this paper is seen to be threefold. Firstly, it verifies earlier findings in the literature. Secondly, the paper shows that new approaches towards measuring and managing capabilities and key assets are needed for eBusinesses. Thirdly, the paper presents a framework, the Knowledge Asset Map, to evaluate knowledge assets and capabilities. This shows that there is a need for further research into identifying, measuring and managing key capabilities and key assets in eBusinesses.

The six categories deducted from the case studies incorporate the main categories found in the literature and verify the categories identified in the Knowledge Asset Map (Marr and Schiuma, 2001). Furthermore, the categories identified show that there is a need for this more comprehensive approach in order to capture the various dimensions of capabilities and assets in today's eBusinesses.

The case studies demonstrate that the assets and capabilities considered as most important in eBusinesses are indeed intangible in their nature which makes knowledge assets and intangible assets the new competitive resource (Webber, 1993; Leadbeater, 2000).

The research sample of this study should be extended and further research into identifying the key capabilities for eBusinesses is suggested and encouraged at this stage in order to take the area of measuring and managing capabilities and real drivers of success further.

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Managing by Measures in High-Tech Organisations and E-Businesses

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Abstract

There are numerous challenges facing managers of e businesses but key among them is what they should monitor to track whether their organisations are delivering value to their customers. What should managers of High Tech Organisations and eBusinesses measure? And are these measures any different to those that should be adopted by traditional business? This paper reports the results of an empirical study into eBusiness performance measurement, which sought to establish what eBusinesses are measuring and contrast this with what traditional brick and mortar companies are measuring. The findings of the paper have implications for both eBusinesses and the brick and mortar organisations. Most significantly, it is clear from the data gathered that performance measurement is still an issue, which challenges managers across the spectrum.

Keywords: Performance Measurement, Electronic Commerce, Key Performance Indicators, Management Frameworks, Balanced Scorecard

1. Introduction

E-Commerce changes everything! At least this is what is commonly reported in academic as well as practitioners writing. The study reported in this paper was designed to understand the impact of the New Economy with its novel business models and compressed business cycles on Performance Measurement and Management. The research sought to understand what aspects of business performance eBusinesses do track today and what they would like to measure tomorrow. Furthermore, the study wanted to reveal whether there are any significant differences when compared to traditional organisations.

Today's economy is characterised by information technology and the recognition of intangible value drivers. The revolution in information and communications technologies makes knowledge the new competitive resource (Webber, 1993). According to Atkinson and Court (1998) the development of a ubiquitous digital economy, the increased research and innovation and the improved skills and knowledge of the workforce are the three main foundations that underpin the strong and widely shared economic growth in the New Economy. Companies will have to base their competitive advantage more heavily on their intangible assets (Leadbeater, 2000). The Value Creation Index, the result of a yearlong

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joint research by Ernst & Young, Forbes ASAP and the Wharton School's Research Program, identifies the five drivers for corporate value in eCommerce firms as follows (in rank order): 1) Alliances 2) Innovation 3) Eyeballs (usage traffic) 4) Brand Investment and 5) Stickiness (Minutes spent on the website) (Malone, 2000).

The evolution of organisational performance measurement has shown some recognition of the changes that are occurring in the business environment. It was recognised that financial based performance was not enough (Johnson and Kaplan, 1987) and issues like the improvement of managing operations (Schonberger, 1986) and quality (Deming, 1986; Crosby, 1972) manifested themselves in measures driven approaches like ISO 9000 certifications, Malcolm Baldridge Quality award or the EFQM Excellence Model (EFQM, 1993). All of these approaches include a much broader range of performance measures. The increasing interest in measurement and the widespread adoption resulted in a measurement revolution which Eccles (1991) predicted in the beginning of the 1990s. Broader and better balanced performance measurement approaches like the Performance Measurement Matrix (Keegan et al., 1989), the SMART pyramid (Lynch and Cross, 1991), the Macro Process Model (Brown, 1996) and the Balanced Scorecard (Kaplan and Norton, 1992; 1996) were introduced.

Today, performance measurement is recognised as a vital management tool and is a subject on the agenda of most organisations (Neely, 1998). The increasing importance of non-financial measures is to some extend reflected in the evolution of performance measurement frameworks. Knowledge as a competitive advantage has two-fold implications for organisational performance measurement. Firstly, the performance measurement system used in organisations has to deliver data on all critical aspects of the business in order to provide valuable management information. Secondly, the performance measurement system must be able to measure organisational knowledge assets and capabilities since they represent a critical success factor (see also Marr and Schiuma, 2001).

The survey for this study was designed around the five facets of the Performance Prism (Neely and Adams, 2001) a three-dimensional performance measurement framework which adopts a stakeholder view of performance. Besides taking into account stakeholders such as customers, investors, employees, partners and suppliers the Performance Prism also considers measures of strategy, processes and capabilities. The Performance Prism represents a very comprehensive approach toward organisational performance measurement which was the reason to base the study on the facets of this framework.

2. Methodology and Research Sample

An electronic e-mail survey was utilised to conduct the data collection. The e-mail included a cover letter as well as the attached email survey. The electronic survey was sent to executive managers and was designed to enable participants to fill in the survey easily by mouse clicks and keyboard (the option to print the survey and send it back by post was given as well). The sample selection consisted of cross-sectional multinational companies and was taken from contact databases of Accenture as well as of Cranfield School of Management.

Initially 700 companies that fulfilled the criteria where contacted of which 66 companies responded with a completed survey. Follow-up emails were sent to those that did not respond to increase the sample size to 75 (25 companies in each category). Due to scalability issues the collection stopped with the reach of a sample size of 75 which was realised after the follow-up email. This resulted in a final response rate of 10.7%. 15 Follow-up in-depth interviews were conducted with selected respondents (5 in each category) in the UK and the USA to further explore the issues examined in the survey.

The various types of companies were identified by the extend of revenue generated through the Internet. Bricks-and-mortar companies are traditional 'blue-chip' companies that generate no revenue through the Internet. Companies were classified as clicks-and-mortar companies when they generated more than 10% but less than 80% of their revenue through the Internet. Companies categorised as dot.coms generated 80% or more of their revenues through the Internet. The targeted dot.coms were well-established Internet companies; the survey did deliberately not include recent start-up companies.

3. Research Findings and Insights

The research revealed some fascinating patterns about what was and what was not measured by each of these three types of business. The first and foremost thing to note is that virtually everyone who replied to the survey said they were actively seeking improvements to their measurement systems. Despite the immense time and effort that has been devoted to improving measurement systems in organisations in recent years, management teams still feel they need further help. 96% of bricks-and-mortar, 96% of clicks-and-mortar, and 100% of the dot-coms said they wanted to improve their measurement systems. In another question the survey respondents were asked *how* they wanted to improve their measurement systems and what stopped them from making these improvements.

In terms of improvement priorities the contrast between traditional businesses (bricks-and-mortar) and dot-coms is stark. Traditional businesses are much more concerned about developing balanced measurement systems and moving into more sophisticated analysis. Dot-coms, on the other hand, are still striving to establish specific technology-related measures associated with issues such as "web-page stickiness" and "click-stream patterns". While all of the respondents appear to have concerns about the process of capturing data, it is also interesting to note that the dot-coms are much more concerned about how to use technology to access data, than either the bricks-and-mortar or the clicks-and-mortar businesses.

Concerning barriers to improvement there was considerable agreement, with time being identified as the number one barrier across-the-board. Other frequently cited barriers include availability of data, availability of technology, the cost of developing and implementing measurement systems and the frequency of organisational change. The following sections cover a summery of the responses by each facet of the Performance Prism.

3.1. Stakeholder Satisfaction

The first question asked of the survey respondents was: "Do you measure customer, employee, investor, supplier, alliance partner and regulator satisfaction?"

Customer Satisfaction: Well over 70% of respondents from the three categories of companies – traditional, clicks-and-mortar and dot-coms – claimed to measure Customer Satisfaction.

Interestingly, despite their relative youth, a higher percentage of dot-coms claimed to measure Customer Satisfaction (83%), than bricks-and-mortar (74%). This relates back to the idea that one of the most important things that dot-com businesses are concerned about is 'the customer experience' and customer satisfaction.

Employee Satisfaction: The percentage of companies measuring employee satisfaction is high across all three categories, although it seems that dot-coms are less concerned with their Employee Satisfaction compared to traditional and clicks-and-mortar companies. Additional proof that Customer and Employee Satisfaction are important in all kinds of businesses can be illustrated by the fact that 100% of those who do not currently measure Customer or Employee Satisfaction felt that they should.

Investor Satisfaction: At first sight the results for Investor Satisfaction are even more startling, with 56% of dot-coms claiming to track this, as opposed to 39% of traditional companies. On reflection, however, it is probably extremely important for the dot-coms to track investor satisfaction in the short term, as they have to maintain investor confidence and goodwill if they are to continue to attract the funds necessary to finance their aggressive 'land grab' strategies. A hundred percent of dot-coms who do not currently measure investor satisfaction felt that they should. This compares with 50% bricks-and-mortar and 80% of clicks-and-mortar companies. This clearly shows that investors' satisfaction is valued as much more important among dot-coms and clicks-and-mortar companies, perhaps because they rely so much more on the accessibility of venture capital and corporate finance.

Alliance Partner Satisfaction: Another surprising observation is the relatively low level of measurement of Alliance Partner Satisfaction, especially amongst the dot-coms (28%). Given that many of the dot-coms are now finding that they either have to enter into joint ventures or establish their own physical infrastructures, it is surprising to see them paying so little attention to the satisfaction of the alliance partners upon whom they are often incredibly dependent for revenue or for services. While less than 30% of traditional, clicks-and-mortar or dot-com companies measure whether their alliance partners are satisfied, there are significantly more dot-coms (85%) that feel that they should measure Alliance Partner satisfaction, compared to 63% of clicks-and-mortar and 67% of bricks-and-mortar. This indicates that the dot-coms do recognise the importance of their joint ventures and alliances, but have not yet incorporated this into their management systems.

Regulator Satisfaction: The lowest level of measurement under the stakeholder satisfaction facet for dot-coms is Regulator Satisfaction (22%), which might be explained by the lack of regulators in the global web environment. In theory at least, companies can move their

server – and, by so doing, the legal entity – around the globe in order to avoid regulators which are based within a legal system of a certain country or region.

3.2. Strategies

In the section of the survey concerned with strategies the respondents were asked whether the measures they currently used helped them to establish:

- Whether they had the right targets?
- Whether they had the right strategies for achieving these targets?
- Whether their strategies are understood throughout the organisation?
- Whether their strategies are being implemented?
- Whether their targets are being achieved?
- Whether their strategies need changing?

Traditional companies appear to be less convinced than clicks-and-mortar companies and dot-coms that their strategy measures help them confirm that they have the right targets – 43% of traditional companies, compared to 61% of dot-coms.

However, this contrasts with the fact that traditional companies appear to be the most confident in the measures they have, which allow them to measure whether their targets are being achieved – 87% of traditional companies, compared to 78% clicks-and-mortar and 83% of dot-coms.

On the whole, dot-coms and the clicks-and-mortar companies appear to be far more certain than traditional companies that their measures help them to decide whether the strategies they are pursuing are the right ones: 61% for dot-coms and 67% for clicks-and-mortar, compared with 30% of bricks-and-mortar companies.

Traditional companies are also less sure than the others that their measures help them to establish whether their strategies are being implemented. In fact, only 48% of traditional companies are sure compared to 56% of clicks-and-mortar and 72% of dot-coms.

Perhaps, the most striking pattern is the percentage of the different companies that claim that their measures enable them to tell whether their strategy needs changing. Only 22% of traditional companies claim that their measures tell them whether their strategies need changing, whereas this compares with 41% of clicks-and-mortar and 78% of dot-coms.

3.3. Processes

In the processes section of the survey, the respondents were asked to indicate whether they felt their existing measures helped them to establish the efficiency and effectiveness of their four key processes. The respondents answered whether they had measures in place to track:

- Whether the processes for developing new products and services are efficient?
- Whether the processes for developing new products and services are effective?

- Whether the processes for generating demand are efficient?
- Whether the processes for generating demand are effective?
- Whether the processes for fulfilling demand are efficient?
- Whether the processes for fulfilling demand are effective?
- Whether the processes for planning and managing the enterprise are efficient?
- Whether the processes for planning and managing the enterprise are effective?

Generally, the dot-coms are more confident than any other group that the measures they use to track their processes help them answer the questions that need to be answered. The dot-coms are particularly more confident in the measures they use to assess whether their generate demand processes are effective, and their fulfil demand processes are efficient and effective. 67% of dot-coms actually measure whether their processes for generating demand are effective which compares to 44% of clicks-and-mortar companies and only 26% of traditional companies.

Across-the-board, the measures that people are most confident in are those used to assess their fulfil demand processes. Although the use of these measures is relatively high (versus most other business processes) across all company types, it is somewhat surprising that it is not even higher. Indeed, it is somewhat concerning too, given the generally adverse demand fulfilment publicity that eBusinesses have generated, that they are currently more concerned with measuring their efficiency than their effectiveness in this area.

Interestingly, despite their apparent high regard for their existing measurement systems (relative to the other two groups), the dot-coms are also generally the ones who most want process measures. Of those companies that do not currently have measures in place to allow them to assess the efficiency and effectiveness of their processes, it is the dot-coms who are the most convinced that they should have such measures in place.

3.4. Capabilities

Under the capabilities section, the questions asked were do the measures you currently have in place allow you to establish whether:

- The technologies the organisation requires are in place?
- The people skills the organisation requires are in place?
- The infrastructure the organisation requires is in place?
- The best practices the organisation requires are in place?

Once again, it is the dot-coms who are most confident that they have the necessary measures in place, with 83% of them reporting that they have measures which allow them to establish whether they have the right technologies in place. This compares with only 48% of click and mortar companies and 43% of traditional companies. This is somewhat obvious, considering that a very large part of a pure-play's business relies on technology. If dot-coms do not have

the correct and efficient technology in place, then they cannot do business. The most interesting finding regarding capabilities measures was that 92% of dot-coms and 83% of clicks-and-mortar companies either agreed or strongly agreed that their current technology measures were useful whereas only 50% of traditional companies did so, 40% where not sure and 10% even disagreed.

Surprisingly, only 61% of dot-coms, 53% of clicks-and-mortar and only 41% of traditional companies felt that they had measures in place that allowed them to track whether they had the right people skills available. This is in contrast to the stakeholder satisfaction measures which show that companies are concerned about employee satisfaction, however, they do not appear to be concerned about whether they are satisfied with their employees' capabilities. Furthermore, less dot-com companies (71%) that currently do not have measures to track whether they have the right people skills in place think they should, compared to 88% of clicks-and-mortar and 100% of bricks-and-mortar.

3.5. Stakeholder Contribution

The notion of stakeholder contribution requires managers to recognise that they have wants and needs from their stakeholders that may be fundamentally different to the wants and needs of their stakeholders. In this section of the survey, the respondents were asked whether they thought their existing measures allowed them to assess whether they were getting what they wanted and needed from their stakeholders.

The most striking feature about this section is the fact that 89% of dot-coms claim to measure whether they are getting what they want from their customers, while only 26% of bricks-and-mortar companies and 41% of clicks-and-mortars do. In fact, more dot-coms measure whether they are receiving what they want from their customers (89%) than whether their customers are receiving what they want from them (83%).

High across all segments are the percentage of companies that have measures in place that allow them to track whether they get what they need from their employees. However, very few of all companies have measures in place that helps them to assess whether they are getting what they need from their investors. Even dot-coms, which heavily rely on their investors, do not measure whether their investors fulfil their wants and needs in the expected way.

The data about companies that say they are not currently measuring whether they receive what they want from their stakeholders, shows that dot-com companies are more concerned about measuring whether they receive what they want from their customers (100%), than are the clicks-and-mortar (75%) and the traditional companies (88%). For Investor contribution it is even more significant. 100% of dot.coms feel they should measure whether they are getting what they want or need from their investors, while only 50% of either traditional or clicks-and-mortar companies feel the same way. More dot-coms put effort into measuring investor satisfaction than they do into checking whether they are getting what they want from their investors, compared to a much more balanced approach for the traditional companies. Again, this could be because it is proving to be increasingly difficult for dot-coms to get investment. For all other stakeholders, more dot-coms are prone to check

whether they are getting what they want from their stakeholders than check whether they are delivering stakeholder satisfaction.

4. Research Implications of the Survey Findings

The first major conclusion of this study is that eBusinesses seemed to be highly attuned to the more comprehensive enterprise measurement agenda set by the Performance Prism. In each facet of the Performance Prism the dot.coms and the clicks-and-mortar companies were the ones that more often already had measures for measuring the sub-facets in place or were more eager to do so in comparison to traditional bricks-and-mortar companies. This might be because the Performance Prism seeks some alternative criteria not specifically addressed by other commonly applied frameworks which many traditional companies might be more accustomed to using.

The data also suggests that the dot-com group of companies believes that they are better equipped to manage their business with the measures they are using than either of the other two groups – although they admit that they could and should do an even better job. There are two possible explanations why this might be the case:

One reason for this might be that many dot-coms are very young businesses that essentially do not have a very complicated business model that has evolved over a long period of time. They often pursue simpler strategies and have less complex product and service offerings. By creating organisations that are more virtual with fewer people and management layers, complexity is reduced but inter-relationships become more important. Furthermore, many of the dot.com companies had to introduce a broader range of measures in order to obtain the vital funding or to accompany their IPO.

Another reason might be that dot-coms do not have to handle huge legacy systems and imposed performance measurement practices dictated by their parent companies in the name of standardisation. This can be a serious problem for traditional and clicks-and-mortar companies. But, since they seem to be very keen on measurement, dot-coms will in future have to be careful not to build up a plethora of measures with lots of obsolete metrics. They will have to align their measurement system to the evolving strategy – which, in turn, will be dependent on competitive pressures and movements in stakeholder wants and needs – and change the measures accordingly, while simultaneously eliminating the measures they no longer need.

Although dot.coms and clicks-and-mortar companies feel they do a better job than traditional companies, the vast majority of respondents – dot-coms (100%), clicks-and-mortar (96%) or bricks-and-mortar (96%) companies – indicated that they would like to do a better job of managing with measures than they do today but lack the time to identify a suitable framework of measures. Hence, this study reveals scope for developing more comprehensive and better integrated performance measurement systems as well as new metrics in the areas where very few people measure today but many expressed a need to measure tomorrow.

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Leadership Challenges: The Management of Information and Communications Technology

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Abstract

This paper discusses, in the context of the UK National Health Service (NHS) modernisation and clinical governance agenda, the crucial role that information and communications technology (ICT) has to play. The NHS will contain some of the largest, advanced and most complex information systems and services in the world but it is debatable whether we have the strategic and operational skills to lead and deliver the ICT agenda in the NHS. The paper explores the leadership and management issues associated with the role and contribution of ICT in health, and puts forward the view that there are significant challenges ahead for ICT leadership and management across all sectors. A description of current processes in the Centre for Health Leadership Wales (CHLW) to address these challenges is outlined, together with brief examination of required competencies, training and education providers and a pre-requisite continuing professional development (CPD) framework. This paper will present case studies of work including an emerging CPD framework and development of a supporting web site.

Keywords: Leadership; Information and Communications Technology (ICT); Continuing Professional Development; E-Learning; National Health Service (NHS).

1. Introduction

Information and communications technology is pervading the developed world. In the UK, the number of personal computers at home is increasing year on year (Office of the E-envoy: 2001) and both the private and public sectors are embracing the core contribution of ICT, whilst trying to keep apace with new developments. This paper puts forward the theory that there are significant, new leadership challenges to be addressed in order for ICT to be used to best effect. Leaders, particularly Directors responsible for ICT, need to have an appreciation of how technology works but more importantly, they need to be able to see its potential and be able to create the right culture to empower individuals in the organisation to use and exploit ICT for organisational benefit. The process currently being undertaken by the Centre for Health Leadership Wales to respond to such a challenge is described, including an outline of an emerging, pre-requisite continual professional development

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framework and supporting web site. This work is set in the context of the UK National Health Service although it is contested that this view is transferable to other sectors.

2. National Health Service and Information and Communications Technology

Established in 1948 as a service intended to be comprehensive in terms of the services it offers, as well as universal in its coverage of the population, the NHS is the largest organisation in the UK. It employs almost one million people and its budget in 1999-2000 was approximately £46 billion. The NHS is currently undergoing fundamental change with the effects of devolved government in Scotland, Wales and Northern Ireland compounding this. Current UK labour government policy is directed at modernising the NHS. With an overriding objective to improve health outcomes in the UK, the desire is for change in the delivery of services including more and better paid staff using new ways of working; reduced waiting times and high quality care centred on patients and improvements in local hospitals and surgeries (Department of Health, 2000). As the UK Prime Minister highlights in his preface to the English NHS Plan:

"At every level there will be radical change. It will, of course, take time to achieve it all. But, taken as a whole, it does offer the genuine opportunity to re-build the NHS for the 21st century, true to its priorities but radically reformed in their implementation" (Department of Health, 2000).

A significant part of the drive to modernise health, is the importance of governance, particularly clinical governance. Based upon several components (see Fig. 1), clinical governance can be defined as "a framework through which NHS organisations are accountable for continuously improving the quality of their services and safeguarding high standards of care by creating an environment in which excellence can flourish" (Welsh Office, 1998).

Figure 1: Elements of Clinical Governance.

This whole drive for change offers a significant challenge to all within the NHS and reflects a wider pattern of change across public and private sectors in the developed world, as we move towards a more global economy, flexible workforce and technology driven society.

The requirement for information and communications technology is fundamental to this change. Within the NHS it is becoming increasingly vital to be able to access the information and evidence required to modernise services and deliver clinical governance. The right ICT infrastructure needs to be in place to ensure for example, that the clinician can access the right information, at the right place and at the right time. NHS Information Strategies outline government commitment to the critical role of ICT in health care delivery (Welsh Office, 1999; Department of Health, 1998; Scottish Office, 1998) and highlight commitment to significant investment in ICT. Should the strategies deliver, the NHS will contain some of the largest, advanced and most complex information systems and services in the world, including:

- Lifelong electronic health records for every person in the country;
- Round-the-clock on-line access to patient records and information about best clinical practice, for all NHS clinicians;
- Genuinely seamless care for patients through GPs, hospitals and community services sharing information across the NHS information highway;
- Fast and convenient public access to information and care through on-line information services and telemedicine;
- The effective use of NHS resources by providing health planners and managers with the information they need (Department of Health, 1998).

3. Leadership Challenges

If one follows the views of strong advocates of leadership (Kanter, 1989; Stewart, 1989; Kotter, 1990; Bennis, 1998) good leadership is essential to the management of change and therefore the success of organisations. The leadership challenge offered by the management of ICT in organisations is a significant one. Lincoln et al. (1993) highlight unique problems associated with the management of ICT. ICT skills and attitudes are difficult to manage with new specialties emerging all the time and the diversity of highly technical skills. The wide variety of skills, jargon and work practices causes co-ordination problems, making it often difficult to achieve consensus amongst ICT professionals. The interaction of ICT with the rest of the organisation can also be problematical as ICT becomes more central to business requirements and ICT professionals need to interact successfully with users.

Some of these challenges can be neatly illustrated from experience within the NHS, where it is advocated, there is a general lack of experience and skill in being able to clearly and convincingly articulate the patient and clinical benefits that can ultimately emerge from ICT investments (BJHC, 2001). This often makes the business case for investment difficult to justify. To add to these difficulties, the development of ICT in the NHS has a chequered history with several well-known case studies of difficult and failed ICT projects. Researchers at Brunel University (Packwood et al., 1991) evaluated a major NHS ICT programme, the Resource Management Initiative (RMI), and published results in 1991 (Packwood et al., 1991). The conclusions drawn from the six pilot sites across England were

that after three years, there were no measurable improvements in patient care and the cost of implementing the initiative was nearly twice as high as originally expected. Such experiences have served to make the task for ICT Directors of convincing NHS Boards to invest significant amounts of resource in ICT very difficult and often impossible when competing with other health priorities.

4. New Competencies Required

The leadership challenge offered by the management of ICT in the NHS is therefore a significant one, which requires Directors to develop new competencies and skills to ensure success. The leadership role of the ICT Director is crucial. For the purposes of this paper, the ICT Director is the Executive role considered here, although this is by no means to diminish the importance of other roles, such as the Chief Executive Officer and other Executive Directors, in coming to grips with this challenge. They also have a very significant role to play in understanding, supporting and empowering others to take forward the ICT agenda and some of the processes outlined below are as equally significant to them and the delivery of their roles.

ICT Directors are increasingly being appointed at Board level in the NHS to lead, develop and deliver the ICT agenda. To be successful however it is argued that a new type of leader is required, a hybrid that can communicate well with users and demonstrate how ICT is helping to achieve organisational objectives. They also need to be able to communicate effectively with senior management, ensuring that they are informed of how ICT can and is contributing to health outcomes, and to tell of its success. It is debatable whether many ICT Directors have the strategic and operational skills to lead and deliver ICT developments in the NHS and there is evidence to suggest that this is not just a problem within the health sector nor indeed the UK, several authors (Levine et al., 2000; Lincoln, 1993; Ennals, 1993) highlight the current inadequacy of many Executive Directors to grasp this challenge. ICT Directors need to have an appreciation of how technology works, but this is not the solution, they need to be able to see the potential of technology and crucially, good leaders need to be able to create the right culture to empower individuals in the organisation to drive ICT for business success. As Packwood et al (1991) highlight in their research:

"If RM [Resource Management] is to work, it has to become (the major) part of the normal process of the management of the hospital … its development and implementation need to be positively and vigorously encouraged and supported by the UGM [Unit General Manager] (or Chief Executive). This means, not least, that in decentralising responsibility, the UGM and central management function has to be willing to devolve power" (Packwood et al., 1991).

The NHS is looking to develop its leaders as a central part of its reforms. This is manifest in the recent establishment of new Centres for Health Leadership in both England and Wales. Within NHS Wales, the leadership model promoted in several of its programmes is that of "transformational leadership" based on the work of those such as (Bass and Avolio, 1993). Transformational leadership aims to support and develop leaders who can motivate and inspire the organisation to change and move forwards, whilst ensuring that the core business

is not compromised and this offers a useful model for the new ICT Director. The ability to deal with change is supported by leadership qualities such as credibility, vision, empathy and the ability to create trust. The ICT Director of the future will also need to develop an amalgam of health experience as well as ICT experience and will probably acquire ICT expertise during or following their experiences in the wider health context. For example within NHS Wales there is a pattern emerging of ICT Directors who have previously been general manager or clinician and it is thought that this should allow the ICT Director to more effectively:

- Define and determine the information needs of local health strategy;
- Integrate ICT into health strategy;
- Assess and evaluating ICT performance within a health context.

Generic	Specialist
Communication	Information modelling and forecasting
Appraisal	Monitoring professional practice
Service planning	Accessing evidence and research
Time management	CD ROM and online database searching
Leadership	Information retrieval techniques
Performance Management	Intranet and Internet development
Project and Programme management	Developing Search Protocols
Mentoring	Knowledge management
Marketing	Establishing Information pathways
Influencing, negotiation and networking	Health Informatics
Workforce planning	Critical appraisal
Financial management	Internet searching
Involving the Public	Advanced IT skills
Understanding better the wider context of health care	
Managing change and conflicting	

Table 1: Generic and Specialist Competency Areas.

So what does the competency set of the future ICT Director look like in order to lead and manage such a challenging agenda? The CHLW is working with Directors of ICT and other professionals to identify an agreed working list of needs and competencies, an overview of training and education providers and a first stage mapping exercise to highlight gaps, issues

and opportunities for local and corporate action. Results to date show that the following generic and specialist competency areas have been identified:

In terms of education and training provision to meet this required skills set, the NHS is working with providers to ensure that courses and programmes are being developed to support the attainment of such new skills and competencies. Consideration is currently being given to the development of ICT graduate development and ICT leadership programmes, together with significant developments in academic qualifications such as the Professional Awards in IM&T (Health) (NHSIA, 2001). The awards offer a set of qualifications, which provide a professional framework across health informatics specialist areas and levels of management. For ICT Directors, the masters' degree contains three modules linked to the development of leadership competency and skills:

- Strategic role of ICT in the business of health care;
- Environmental impact analysis in the context of ICT and health care organizations;
- The role of strategic ICT interventions in organisational development.

5. Continuing Professional Development

It is proposed further that in order to develop the aforementioned leadership competencies and skills, this needs to be carried out within a continuing professional development environment and one that provides a pre-requisite framework. The UK Government sees CPD as integral to its agenda for change in the NHS and defines CPD as a process of life long learning for all individuals and teams that meets the needs of patients, delivers the health outcomes and healthcare priorities of the NHS, and which enables professionals to expand and fulfill their potential (Department of Health, 1999).

The Centre for Health Leadership Wales (CHLW) is working in partnership with the Institute of Healthcare Management, the National Assembly for Wales' Human Resource Directorate, and academic institutions across the UK to develop a practical CPD Framework that caters for the needs of those charged with leadership and management responsibilities, such as ICT Directors within the NHS. The project is providing a strategic focus for CPD and its aim is to create a robust, flexible and accredited CPD Framework that enables entry and progression along a variety of pathways (Herepath, 2000). The CPD Framework will be supported by a common currency, developed in association with academic partners, which rewards progress, is credible to all professional groups, and encourages the concept of transferability. The project is scheduled to run over a period of two years and a pilot programme has been established to test the feasibility and acceptability of the proposed CPD Framework in six sites across Wales. The intention is to roll the new system out in 2002. It is anticipated that local and national training and education for ICT Directors will be delivered within such a framework.

The impact of the CPD Framework will be enhanced by the development of a CPD Web Site. The time for individual learning and CPD has to compete with organisational demands, but technology has a key contribution to make here. E-learning, that is electronic learning,

allows for the use of technologies such as the Internet, email, and video-conferencing to support continuing professional development and the opportunity to disseminate best practice to healthcare leaders. The CPD Web Site on CymruWeb (the NHS Wales' intranet) will allow ICT Directors, and others, to access to a wide range of resources that support continued development including links to education, professional resources, literature and research, and personal development support and advice. Fig. 2 offers a schematic of the web site which has already delivered a home page guide; help facility and resource centre, which includes hyperlinks to other key NHS sites, professional groups, knowledge bases and library services (Treharne, 2000).

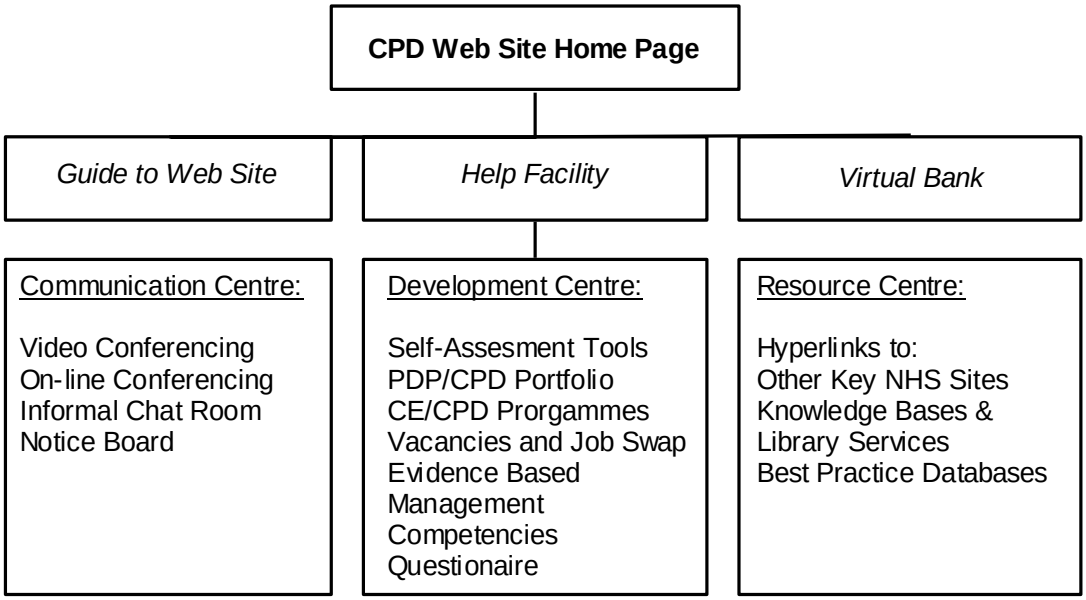

Figure 2: Schematic of CPD Web Site for NHS Management in Wales.

6. Conclusion

This paper puts forward the theory that there are significant, new leadership challenges to be addressed in order for ICT to be used to best effect in organisations. Within a UK NHS context, the view is expressed that leaders, particularly ICT Directors, need to have an appreciation of how technology works but more importantly, they need to be able to develop transformational leadership skills in order to create the right culture to empower individuals in the organisation to exploit ICT for positive outcome. The processes currently being undertaken by the Centre for Health Leadership Wales to develop such leaders within the context of a continual professional development framework is aimed at addressing the challenge. It will be interesting to reflect on the impact of this work over the next 2-5 years, in particular, how successful it has been in improving ICT Directors' leadership competencies, and ultimately the degree to which this will have ensured that ICT developments are directly supporting the delivery of health objectives in the UK.

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New Models of Business

Multi-Agent Models of Networked Organisations

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Abstract

A model consisting of thousands of intelligent agents has been developed by authors and their collaborators at Uxbridge, UK and Samara, Russia and applied to the simulation and governance of networked organisations. The model is based on the notion that organisations participating in a highly dynamic global economy should be structured as complex adaptive systems featuring self-organisation and evolution.

Key words: Complex adaptive organisations; multi-agent models; dynamic simulation.

1. Introduction

The inadequacy of deep management hierarchies in the highly dynamic global economy has been well researched and documented (Drucker, 1993). The very essence of this model – a short span of control, clear lines of reporting, economy of scale and division of labour, features which contributed to the accumulation of wealth in the industrial West under stable market conditions, are seen now as severe disadvantages preventing corporations to respond flexibly to ever changing demand and supply. Consider the principle of the division of labour, which naturally led to a functional organisation. Since it takes time for each function, in turn, to contribute to the product development process, the consequence is a long concept-to-market lead-time.

So what is to be done? A strong movement of "Business Process Reengineering", triggered by a paper in Harvard Business Review dramatically entitled "Engineering Work: Don't Automate, Obliterate" (Hammer, 1990) advocates that, in order to achieve competitive edge under new market conditions, it is necessary to remove departmental boundaries and reorganise corporations into multi-disciplinary business process oriented units. For example,

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bringing traditionally separate functional units of marketing, design, purchasing and process planning into a multi-disciplinary unit responsible for the entire process of product design and development, and conducting numerous product development task concurrently, rather than sequentially, would drastically reduce concept-to-market lead-times.

A very large number of corporations took up the advice and reengineered their organisations without achieving any perceptible improvement in performance. The dynamics of markets was too powerful even for process-oriented businesses. Nevertheless, the introduction of multi-disciplinary teams working concurrently on related activities within a business process was, clearly, a move in the right direction. But this was just a small step towards an acceptable solution. The main issue of co-evolution of organisations in the dynamic, unpredictable, continuously changing global marketplace, was almost completely overlooked by high priests of Business Process Reengineering.

In parallel, researchers in management theory have developed a useful concept of the Learning Organisation (Argyris, 1995). A Learning Organisation "comprises: shallow hierarchies, small power distances, interdisciplinary teams of well educated employees, process-oriented organisational units and global partnerships between independent companies along and across value chains" (Rzevski and Prasad, 1998).

As stated in the above paper, "It is useful to define Learning Organisation by the manner it interacts with its environment. A Learning Organisation is capable of learning about (and from) its environment and adapting itself to it. Advanced learning organisations are, in addition, capable of changing their environments with a view to achieving desired goals. A competently designed organisation can exhibit more intelligent behaviour than the sum of intelligence of its employees. This enhanced intelligence obtain through the rich interaction of people who constitute the organisation is named the Emergent Intelligence."

2. Complex Adaptive Systems

The idea of a learning organisation naturally leads to an examination of similarities between natural physical or living systems and business organisations. A very important and influential work in this area is done under the general title of Complex Adaptive Systems. The pioneers in this area were physicists, particularly I. Prigogine, a Russian Nobel prize winner working in Brussels (Nicolis and Prigogine, 1989), but at a later stage many substantial contributions came from Santa Fe Institute in New Mexico (Holland, 1995; Kaufman, 1995; Holland, 1998).

Complex Adaptive Systems are characterised by co-evolution. They typically coexist with other complex systems and attempt to maximise their performance in respect to those systems that they interact with. Since all co-existing systems try to improve their performances concurrently, they create an ever-changing environment. Complex Adaptive Systems maximise their performance when they operate at "the edge of chaos", the expression that denotes a state of permanent change. Uncertainty must be sufficient to enable a free flow of information but certain stability (predictability) must be present to enable formation of messages. The processes of co-evolution are irreversible.

A Complex Adaptive System could be modelled in terms of Autonomous Agents interacting in groups according to local rules. Out of these local interactions there emerges a global behaviour that appears stable – the Emergent Behaviour. Week interactions between Agents result in inferior performance – nothing emerges. A large number of links produces an improvement in performance but when the number of links increases beyond a critical point, the system tends to disintegrate into chaos. Hence the notion that the best performance is at the edge of chaos.

3. Networked Organisations

The authors are studying new organisational structures for businesses based on principles of Complex Adaptive Systems. The idea is to network Autonomous Agents (human or artificial) into units, which in turn are mutually interconnected. Uncertainty is brought in by making the interconnections semi-permanent and introducing unpredictable changes.

Consider an example of a company whose mission is to develop and market highly advanced software. The main assets of this organisation are highly specialised knowledge workers and a sophisticated Information Technology infrastructure. The core activities are software technology development and its continuous improvement.

Quite clearly, to achieve commercial success there is a need for a number of non-core activities such as marketing, selling, writing contracts and other legal documents, paying salaries and accounting. A Networked Organisations would tend to establish partnerships with organisations capable of carrying out these activities in a cost-effective manner rather than employ resources needed for this purpose. So far there is nothing new here. Outsourcing is a well-established practice.

But now comes the bit that is novel. To achieve complexity required for maximum performance (edge of chaos) the links with partners must be semi-permanent and there must be a certain redundancy present. The rational for this is as follows. Since the markets are highly volatile, there is a considerable uncertainty as to capacities required for non-core activities and there must be therefore a partnering arrangement in place with a large number of companies or individuals just in case that some of them will be fully engaged when the service is needed.

Since all these semi-permanent partners operate in the same highly volatile environment, it is in their own interest to be interconnected with many potential purchasers of their services. The theory says that at certain number of connections there will be an optimal performance for all co-existing in the environment, which is, of course, the Global Economy.

We must remember though that not every one will get their game right – there will be always companies which will underperform because of a week interconnectivity and those that will slide into chaos and disappear because of too many links. New companies will be formed and they will join the market and compete for the requisite number of connections. Global Economy will perform as the natural ecology.

4. Multi-Agent Models

We have developed software agent models of networked organisations as described above. In a nutshell, a software agent is a C++ object with certain advanced characteristics. For example, it can communicate with other agents, as well as with users, and can interpret meaning of messages. Agents collaborate and compete with each other, depending on the particular situation, but, in any case, they always work as a team. All the rules, according to which agents work, are stored in the so-called Ontology, which represents the repository of knowledge on the particular domain under consideration. The important feature of our Ontology is that it can be modified by software users without any knowledge of programming.

To simulate the operation of a networked organisation, it is necessary to assign an agent to each resource in the organisation, and in all partner organisations connected into the organisational network, and to every enquiry or order arriving from customers. Through the process of negotiation among agents representing the demand and those representing the supply, a schedule is derived for the business processes required to make a proposal in response to every inquiry, or fulfill each order. Given a known distribution of orders and enquiries the system can be used for assessing the suitability of existing resources to meet the projected demand. The software is designed to accommodate thousands of agents working in parallel and is therefore capable of simulating sizable networks and exhibiting emergent properties. A working simulation will be available at the conference.

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Conflict Management in e-Engineering. The Methodology and Applications

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Abstract

The main objective of this paper is the theory and practice of computer supported collaborative design in the field of support of consistency checking process. First part of this paper describes an analysis of existing methods and techniques addressing the problem of mismatch control in collaborative design environment. The second part represents the methodology of Intelligent Distributed Mismatch Control (IDMC). The proposed general methodology consists of two sub-models: process model of IDMC and structural model – conceptual multi-agent framework for IDMC development. The third part demonstrates the application of proposed methodology for aerospace collaborative design.

Keywords: E-engineering, Conflict management, Mismatches, Intelligent Distributed Mismatch Control

1. Introduction

Computer Supported Collaborative Work (CSCW) as a part of distributed collaborative design process, Concurrent and E-Engineering (Prasad, 1995; Unan, 1992, EDID, 1995) promises to resolve most of the difficulties by replacing the paper and tape and physical meetings based methods by electronic communication and electronic meetings and provide a basis for virtual design environments (Prasad, 1995; Matta, 1997).

This is important, because for many years the design and manufacture of major European complex products, such as satellites, airplanes and cars has been distributed across the continent. As the result of globalisation and future distribution of design and manufacturing facilities, the cooperation amongst partners is more challenging. The design process tends to be sequential and requires centralised planning teams and/or a great deal of travel to/from distributed designers.

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In a virtual team designer work together and use an Internet/Intranet for communication. The design is a multi-disciplinary task that involves several stages. These stages include input data analysis, conceptual design, basic structural design, detail design, production design, manufacturing processes analysis, and documentation. As a result, the virtual team, normally, is very changeable in terms of designers' participation. Moreover, the environment itself changes over time. Consequently, as the result the number of design mismatches are greatly increased.

A methodology of Computer Supported Collaborative Design (CSCD) is needed for future progress. In this paper we focus on one aspect of CSCD: mismatch control during the detail design stage.

The mismatch detection during detail design stage is important, because the number of mismatches in the early stages of detail design will have huge last implications. This is particularly true for large–complex products such as aeronautics or automotive industry.

The decision is to use Artificial Intelligence (AI)/Distributed AI tools, particularly multi-agent systems and techniques to provide automatic and semi-automatic mismatch detection and resolutions (Klein, 1992; Beckoum, 1997; Taratoukhine, 1999).

Many of the recent developments in the field of conflict management have been investigated and described by Matta, Lander, Klein and others (Matta, 1997; Lander, 1997; Klein, 1992; Easterbrook, 1991, 2000; Bechkoum and Taratoukhine, 1999).

According to (Lander, 1997) there are several ways in which conflict can be managed: such as Avoidance – Avoid conflict by sharing information about local constraints and priorities; Conflict classification – Build taxonomy of conflict types. Associated with each conflict type is a specific piece of conflict resolution advice; Negotiation – Techniques in this area include bargaining, restructuring, constraint relaxation, mediation, and arbitration.

Below developments of conflict management methods are represented. The analysis of current development in conflict management for CSCW suggests that most of these methods and frameworks (Klein, 1992; Matta, 1997; Easterbrook, 1993) are paid more attention to social and psychological aspects of communications between members of team, but not to problems of communications between artificial agents and development a general methodology of conflict management/intelligent control, based on Distributed AI.

The main objective of this paper is to propose a framework for the development of an Intelligent Distributed Mismatch Control (IDMC) methodology. This will be based on the integration of two approaches of conflict management – classification and negotiation. In our case, the classification and negotiation processes are associated with multi-agent architecture of IDMC.

In this context, the investigation of methods and principles of organisation is as follows:

- Development methodology of Intelligent Distributed Mismatch Control (IDMC). The proposed general methodology should include:
    - Process model of IDMC. Model of taxonomy of mismatches.

- Structural model – conceptual multi-agent framework.

- The next step is an application of proposed methodology for CSCD process.

2. Methodology

In order to define an IDMC methodology, the two connected sub-models/levels of formalisation are used. The first model is process model of IDMC and the second is structural model – conceptual multi-agent framework, but first of all, we need to define a terminology of consistency checking process.

2.1. Process Model

In our understanding, the mismatch control is a process of detection and resolution of design mismatches based on, the on capability of multi-agent framework and communication between agents, communication and resolutions schemes and distributed knowledge-base organisation. The process model of IDMC is represented as follows.

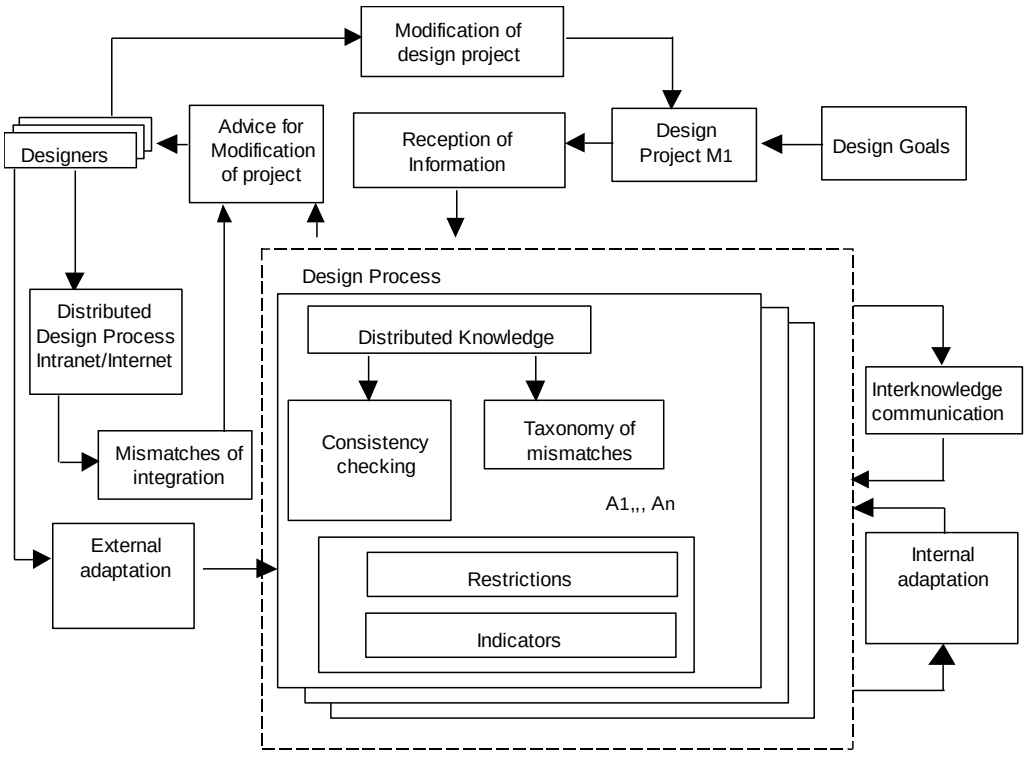

Figure 1: Process Model of IDMC.

The Design mismatches are inconsistencies between design goals G_i and current design project $M_1(t)$. Obviously, the goals of design are a set of parameters (for design project)

and predefined restrictions for these parameters. We propose that concurrency attributes are a basis for definition of restrictions for parameters and structure of design project.

The design mismatches at the detail stage of design are inconsistencies between parameters restrictions defined according to concurrency attributes, current parameters, and/or the structure of current design project $M_1(t)$. IDMC uses a concept of distributed artificial intelligence – agents. Agents are represented as "virtual designers" who have internal abilities to receive information, to identify design mismatches and to prepare advice for the designer to find the best modification to resolve the mismatch.

Design knowledge model – M_2 is used as a personal assistant for the designers D in the design team, and helps to detect design mismatches and find the best modifications required. The design mismatches are detected using a vocabulary of indicators and taxonomy of design mismatches and resolved using a model M_2 i.e., a distributed model of designer's knowledge. With A_i representing an agent, we have:

$$M_2 = \{A_1, A_2, \ldots, A_i, \ldots, A_n\}.$$

As can be seen, each agent is represented as part of design assembly and has knowledge about assembly part's geometrical configuration (structure), materials and other parameters:

$$A_2 = \{W_1, W_2, \ldots, W_i, \ldots, W_n\}.$$

Each agent is represented as single knowledge-base which contains a set of words of designer to provide a knowledge about different aspects of design, a project, and concurrency attributes. Each designer world is represented as:

$$W_i = \{K(M_{str}), K(M_{par}), K(R), K(I)\},$$

where K means knowledge, R – design restrictions, I – indicators, W_i – «i» designer world.

According to Fig. 1 the definition of complex taxonomy of design mismatches is important for the classification and resolution of design mismatches. The development of taxonomy of mismatches is described in next section.

2.2. Design Mismatches. Classification and Taxonomy

Important developments in this area include models reported by (Klein, 1997; Matta, 1997; Castelfranchi, 1996), but these taxonomies, in general, are more oriented towards the conceptual stage of design process.

We propose a conceptual framework for the development of taxonomy for detail stage design.

First, we classify design mismatches according the to level/types of information needed for their detection. We have:

- Syntax level – ordinary geometric mismatches (size, diameter, geometric type, parts orientation,…);
- Semantic level – complex assembly mismatches – analysis of geometric and materials characteristics for checking assembly possibility;
- Pragmatic level – the complex mismatches are connected to design/concurrency attributes, such as a mismatches of manufacturability, manability, costability, serviceability, etc.

Accordingly, we can define: mismatches of integration and concurrency mismatches. Mismatches of integration are assembly mismatches that are necessary to ensure the design at the integration phase.

Using the proposed model of taxonomy it is possible to define a real taxonomy, for a known field of implementation (i.e., aerospace, automotive, electronics), and a number of concurrency attributes – $A_1, \ldots, A_n$. Of course, the development of taxonomy is a complicated and long process which included a definition of critical parameters, indicators, restrictions and attributes and based on knowledge engineering components, as interviews and questionnaires. The full taxonomy DFA/DFM mismatches was described in (Taratoukhine, 1999).

Within the proposed taxonomy critical parameters are identified. It is the variation of these parameters that causes a mismatch. For example, the bolted connection requires consistency between such parameters as thread minor diameter, minor diameter and pitch (for bolt head type and assembly tools type). For aircraft wing box bolt and nut – diameter, length and size, etc. Weld connections require consistency between types of materials and the material thickness, as well as the geometric parameters of material.

For the mismatch detection process to be more successful, not only we need to represent a wider variety of mismatch types but we also need to represent geometric information as well as information about the material which the parts are made of. This taxonomy is restricted by Design For Assembly (DFA)/ Design For Manufacturability (DFM) mismatches. According the taxonomy development process the criteria of classification should be considered. In our case we have a main criterion – design for assembly/manufacturability, and additional criteria as types of connections and indicators (critical parameters M_{par}^{cr}).

The next section describes a formal description of structure of multi-agent framework and dynamics of multi-agent framework.

2.3. The Structural Model. A Multi-Agent Framework

This section reviews briefly the agent framework and the components within. Using a multi-agent approach the representation of the required knowledge is distributed amongst several "specialised" independent knowledge bases, or agents.

The architecture assumes that the design knowledge is encapsulated within the different members of the agent community.

The conceptual framework (CF) may be presented formally as follows:

$$CF = \{AP_1, \ldots, AP_t, \ldots, AP_n\},$$

where AP_t is the t th Assembly Part, $t = 1,2,\ldots,n$.

$$AP = \{DA_1, \ldots, DA_i, \ldots, DA_m, CA_1, \ldots, CA_j, \ldots, CA_k\},$$

where DA_i is the i th Design Agent (D-agent), $i = 1,2,\ldots,m$; CA_j is the j th Control Agent (C-agent), $j = 1,2,\ldots,k$.

Agents exchange information using messages with syntax and semantics defined by the communication protocol. The context of these messages can include declarative and procedural knowledge. A reactive agent is an entity that may be represented by an independent program that knows everything about itself including its relationships with other agents. The principle of emergence states that intelligence in reactive agents emerges from interaction of agents among themselves and with their environment. The principle of situatedness states that intelligence of a reactive agents is situated in the world and not in any formal model of the world build in the agent.

In our case DA_i (D-agent) is a reactive agent, which negotiate with other design agents using design' schedule (assembly sequence) and scheduling preferences generated and supervised by the Control Agent (C-agent).

The next section describes inter-agent relationship within framework and communication between agents. The general structure of conceptual framework communication and adaptation schemes is shown in Fig. 2.

3. Application of Methodology

The development of tool for mismatch control is required using the methodology described above. The proposed software – Intelligent Distributed Mismatch Control System (IDMCS) is developed and is outlined below.

3.1. IDMCS

The ZEUS toolkit (Hyacinth and Nwana, 1998) was used for the development of IDMCS. The toolkit provides classes that implement generic agent functionality such as communication, coordination, planning, scheduling, task execution and monitoring and exception handling.

IDMCS analyses designer requirements to the design project given in the form of design information and processes at the layer of the distributed knowledge base. The system is designed using JAVA 1.2.1 in the Windows NT environment using ZEUS agents building toolkit. In order to retrieve/manipulate CAD data on interface from/to PARASOLID geometric kernel is needed and will be the purpose of future work.

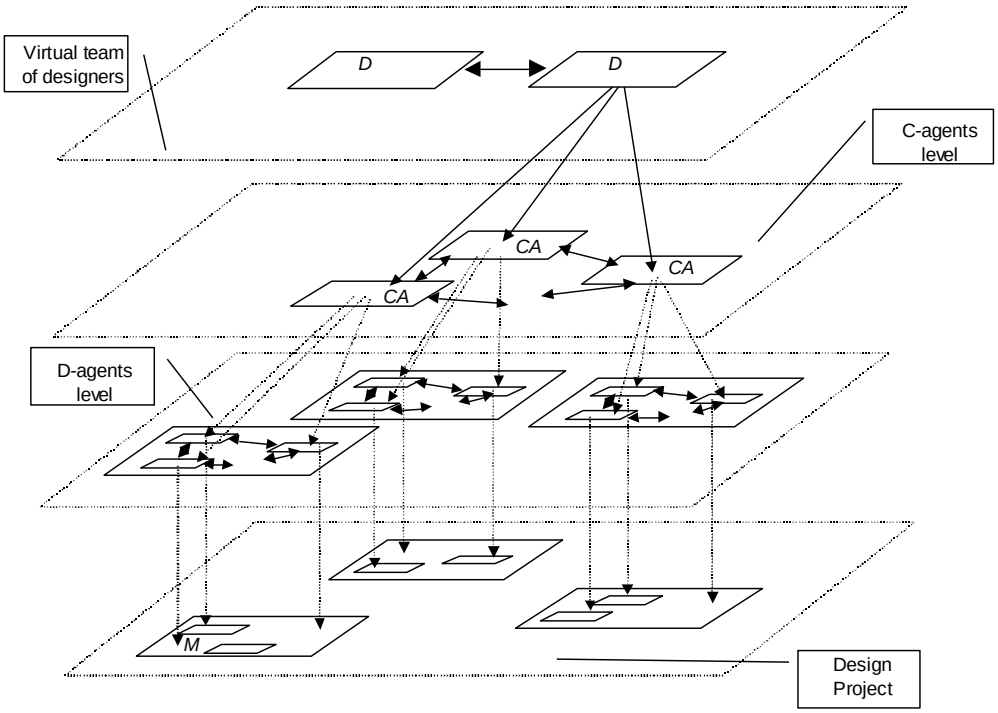

Figure 2: Dynamics of multi-agent framework.

3.2 Case Study

One of the key challenges for Europe is to maintain and develop the European Aerospace sector as a world competitive industry. The European Commission (EC) has fostered several collaborative research initiatives in aeronautics yielding a number of successful projects. In the Fifth Framework Programme of the EC the financial support dedicated to the Aerospace industry alone is set to euro 700 million.

Unfortunately the current CAD/CAM/CAE systems do not support the mismatch control process described here. We are using the IDMCS described above for distributed aerospace design support.

We are using IDMCS and DFA/DFM taxonomy for development for a distributed knowledge-based design support system which detects geometric and material irregularities at the assembly stage of aerospace design. The IDMCS provides mismatch control during wing-box assembly process, using an initial set of data from aircraft design sources (Nui, 1999) and AIRBUS design engineers (AIRBUS, 1999).

When designing using IDMCS, the following steps are being performed: (1) analysis of assembly parts – assembly checks of stringers, skins, spars etc., (2) evaluation of assembly possibility – Collision and Tolerance Analysis, (3) manufacturability analysis, (4) choosing

the alternatives for mismatch resolution, and (5) semiautomatic mismatch resolution and generation of results. At the present time, a research version of IDMCS is developed and experiments are under progress.

4. Conclusion and Future Work

A novel approach for Intelligent Distributed Mismatch Control as part of Computer Supported Collaborative Design is developed in this paper.

The methodology of Intelligent Distributed Mismatch Control (IDMC) is outlined. The general methodology is represented as of two sub-models: process model of IDMC and structural model – conceptual multi-agent framework.

Development of IDMCS was outlined as well as the possibility of using IDMCS for aerospace design.

The future developments of methodology will be in the field of formalisation of the process of dynamics of conceptual multi-agent framework, based on Automata/Petri Nets, that will provide a mathematical foundation of adaptation/learning schemes; and to solve a practical problem – future development of tools for automatic/semiautomatic mismatch control in Computer Supported Collaborative Design.

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Towards Virtual Logistics

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Abstract

The paper introduces new ideas and concepts, which provide a framework for further development of the theory of virtual logistics. Specifically, the concepts of virtual stockholding, virtual storage, virtual distribution channels, virtual trading systems, and virtual delivery and transportation systems are discussed.

Keywords: virtual logistics, distribution channels, transport systems, supply chains

1. Introduction

In this paper, the concept of virtual logistics is considered. Logistics present a important sphere of business activity, which deals with four flows: goods, information, people (workers) and financial assets. Each of these flows allows for "virtualization" to variable degree. The concepts of virtual information and financial flows have been are well understood whereas "virtualization" of goods and workforces flows has yet to be analyzed. In the case of workers flows, we have got unrolled ideas of remote work (telework). The sphere of financial flows is nowadays more advanced. The aim of this paper is to extend ideas underlying the concept of virtual financial flows to physical flows of commodities and row materials in logistics. We consider elaboration of the above idea as a contribution towards development of the general concept of "virtual logistics".

2. Evolution of Financial Systems Towards Virtual Financial Flows

Initially, financial assets took the form of physical things. Money circulated in the form of precious metals (e.g., gold and silver or their substitutes). Money was compact and had definite location. The owner could definitely be identified as a person who is connected with compactly definite place of money protection e.g., storage. Associated with "physical" money was considerable cost of storage and protection against theft, losing or accidents.

Rising of banks offered new potentials for owners and investors. Specifically, banks provided them with better utilisation of assets, allowing of increasing volume with time. Together with introduction of paper money, banks could create new capitals often considerably above of possessed reserves. Not considering possible threats, new financial system operating with "nonphysical" (virtual) money proved to be quite comfortable and effective. Today, one can treat moneys as virtual gold (or silver). From time to time, gold or

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silver come into being in physical manner, if clients wish it. In this case, money returns to its traditional form.

Virtual logistics applies the above idea to other processes and products. This means, in particular, that goods can be lent when they are not used. This offers considerable opportunity for organizations to rearrange existing and create new efficient logistics systems.

3. Development of Virtual Logistics Systems

New virtual logistics systems have to operate together with traditional logistics systems. The basis for virtual logistics systems is separation of possession function from physical objects. Function of possession of a commodity makes itself evident only at the instant of sale (exchanges). Possession and inspection of goods should be diffuse, and the system should provide for remote manipulating them.

In virtual logistics, flows of information have to be separated from physical flows, and circulate between computer information systems through communication ways provided by Internet, intranet, and extranet.

3.1. Elements of Virtual Logistics Systems

A virtual logistics system normally involves several interconnected subsystems including:

- Virtual stockholding;
- Virtual storage;
- Virtual distribution channels;
- Virtual trading systems;
- Virtual delivery and transportation systems.

3.2. Virtual Stock Management

In a financial system, the working capital of banks can be sufficiently greater than the volume of their own capital (often in twelve times greater or even higher). This appears to be possible because of low probability of simultaneous withdrawing all deposits.

Virtual stock management can exploit similar mechanisms. In classical stockholding, different wholesale firms normally keep goods. In an example depicted in Fig. 1, there are six wholesale firms with their warehouse as the places for physical storing goods. In this situation, there are no information flows between the firms, and a common stock management is not possible.

In the case of virtual stock management (Fig. 2), goods are accumulated in one common warehouse in which owners keep their own stocks. In fact, using the common warehouse allows of having smaller physical reserve than in traditional stock management (in our example, the central warehouse physically keeps 4 objects). Note that the amount of goods

reserved can be reduced only if all the firms can get equal access to the information about the reserve, and to goods stored in the common warehouse.

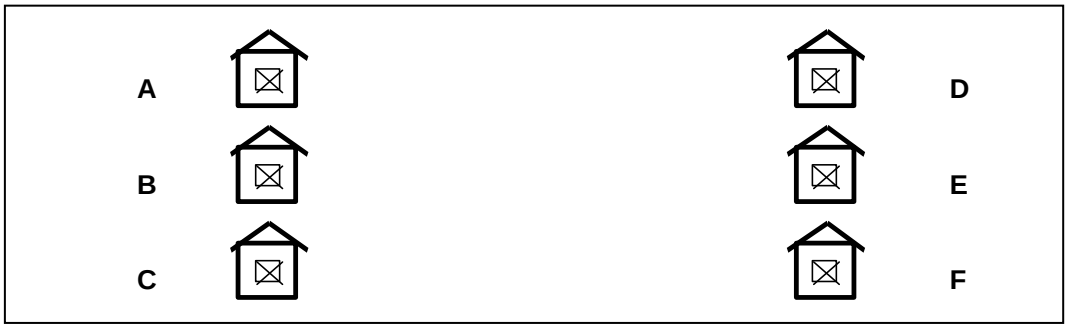

Figure 1: Traditional stockholding.

The management based on the virtual approach brings the following advantages:

- Lower costs of reserve storage because of diminution of goods reserved;
- Smaller storage space occupied in warehouse;
- Possibility of general costs diminution as a result of centralization and specialization of storage, and utilization of economies of scale.

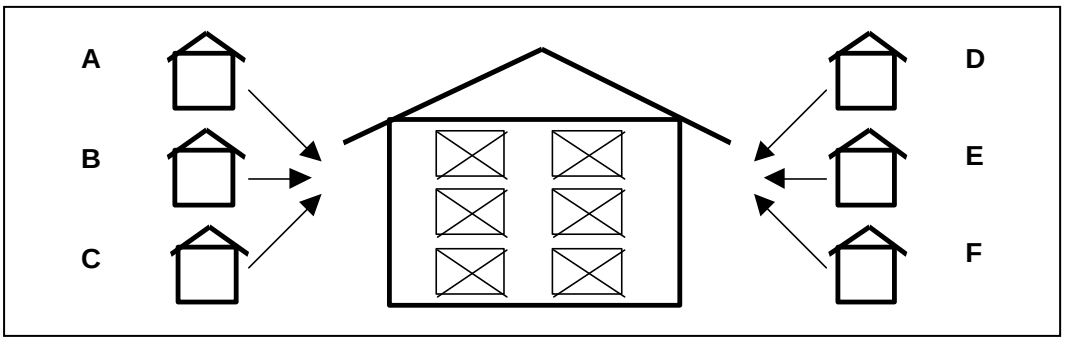

Figure 2: Virtual stockholding.

Virtual stock management seems to be more applicable to such commodities as food, spare parts, and consumer goods. In some cases, this offers the prospect of changing warehouses from centers of cost to centers of profit. In any case, virtual stock management provides for considerable saving in level of stock.

3.3. Virtual Warehouses

Traditional systems of storage demonstrated tendencies toward centralization. Storing goods in one place allowed one to easily get full information about stock level. However, new

inquiry systems make this advantage insignificant since information about scattered stock can be easily accessed as if the stock were concentrated in one place.

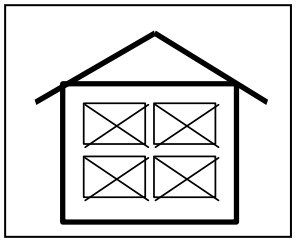

Figure 3: Conventional warehouse.

Differences between the virtual and traditional manners of storage organization are shown in Fig. 3 and 4.

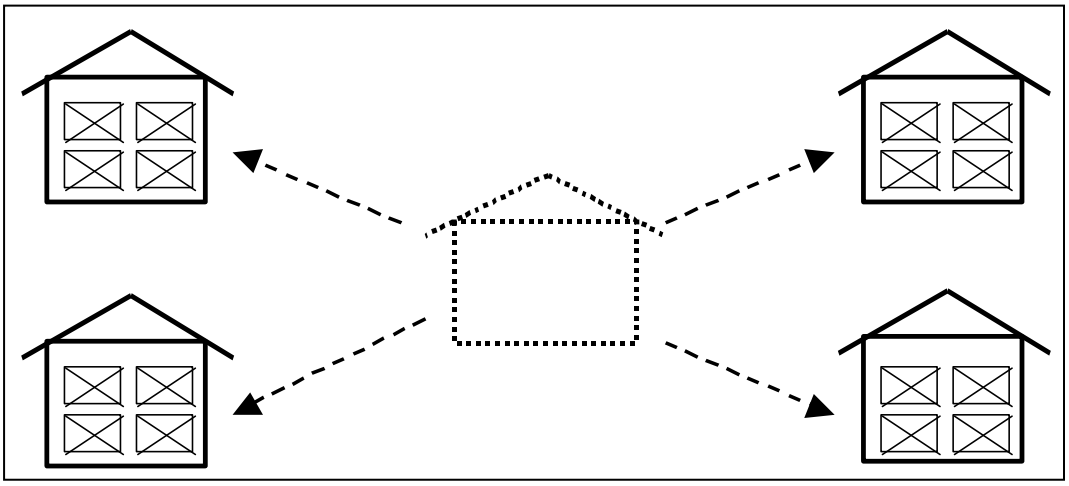

Figure 4: Virtual warehouse.

The advantages of virtual warehouses can be summarized as follows:

- Arrangement of storage facilities closer to the market place;
- Arrangement of storage facilities closer to the producers;
- Diminution of risk of not realized sale;
- Enlargement of the list of products being offered;
- Diversification of products and services.

3.4. Virtual Distribution Channels

In many cases, the purpose of safety stock is to meet unexpected or unforeseen demand. Usually, this reserve is kept in the form of finished goods as close to the markets as possible. In such cases, the time of reaction to disturbances of demand is shortest.

Another way is to hold in reserve products in unfinished form as partly performed goods in production sector rather than final products. In this case, the places of stock storage appear to be distributed along all the chain of delivery from producer through distributors to points of retail sale.

With an appropriate information system, the above components can be combined into a system of virtual delivery channels. Note that the centre of the system gravity is pushed toward producers as well as raw materials and semi manufactured articles.

This system of virtual delivery channels has the following advantages:

- The life cycle of semi processed materials is longer than that of finished goods, and these materials are less susceptible to destruction;
- The semi processed materials allow of using space of warehouses more efficiently since they are normally more compact in form;
- The unfinished products and semi processed materials normally offer better resistance to stale;
- The unfinished products are less susceptible to thefts.

Finally, since inventory cost for unfinished products and semi processed materials is lower than for final goods, the systems of virtual distribution channels appears to be less expensive than conventional distribution systems.

3.5. Virtual Sale Systems

When shares are traded in a stock exchange, only the ownership rights are changed from one person to another without physical dislocation of shares from sellers to buyers. On the other hand, purchasing of products normally involves physical displacement of commodity from sellers to buyers. Displacement of commodity is one of the main functions of logistics. It can present a difficult problem especially when a customer wishes to receive or consume commodity immediately after purchase. Specifically, if the distribution channels operate inefficiently, displacement of commodity can result in lengthening of delivery time, destruction or loss of commodity, and wrong delivery assortment.

In virtual sale systems, the act of sale is separated from delivery or transport operation. When tradesman A sells a commodity to tradesman B, he only delivers rights of property whereas the commodity remains at the same place (in a warehouse). Sale of commodity does not occur with its physical displacement.

3.6. Virtual Systems of Delivery and Transport

Let us consider the following example. A foreign tourist intends to withdraw money in a local bank. The local bank comes into contact with tourist's home bank and then get remote access to his or her account.

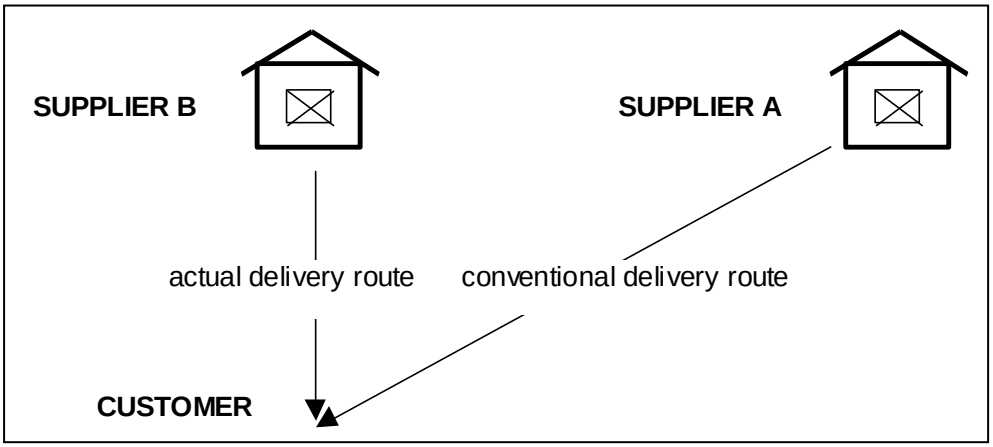

Figure 5: Substitution of transport for trading.

Virtual transportation of products works in a similar way. If the distance between a product and a market is too large, then replacement of transport operation with forwarding sale has to be performed (Fig. 5).

4. Introducing Virtual Logistics into Business Practice

In order to initiate virtual logistics programs, an organization can perform the following steps:

1. Elaboration of Internet applications, which provide for access to information about supplies;
2. Standardization of logistics systems used by the organization and its suppliers;
3. Elaboration of monitoring techniques to evaluate quality of logistics system elements (exactitude, reliability and accessibility of logistics supplies);
4. Introduction of legal settlements system including warrant payment rules, and responsibility of users.

Among other results, introducing the virtual logistics system should provide for the following advantages:

- Standardization of transportation operation;
- Standardization of vehicles sizes;
- Standardization of production processes;

- High degree of modularity of productive processes;
- Standardization of products and devices;
- Synchronization of logistics operation.

5. Conclusions

Virtual logistics is based replacement of physical turnover with information flows. As the first step, systems of virtual logistics seem to be developed by large organizations for products of high values and little volumes, including cars and plane parts, pharmaceutical products, etc. Then the systems will be implemented by medium and small enterprises.

Virtual logistics will enlarge upon many logistics operations to allow of reducing the time of delivery and the time of processing of customers' orders. It is expected that many complicated and expensive products will become more accessible.

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Marketing Issues

BASIS: A Sales Orientated Marketing in the Newspaper Sector

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Abstract

In the German newspapers' market, BILD published by Axel Springer Verlag presents the largest daily paper, which is distributed among about 112,000 sales outlets, and not available through subscription. To meet the challenges of the diversified and rapidly changing national market, the BILD distribution department has developed a new marketing information system, BASISregio. The system, which is actually a powerful OLAP tool, incorporates sales information on each retailer at every sales day, combined with geographic and socio-demographic data. It provides for efficient and easy ways of performing comprehensive analysis of data, and offers means to generate reports, including geographical maps based graphic representation.

1. Introduction

Founded in 1946, Axel Springer Verlag is one of Europe's largest media companies, with administrative headquarters located in Hamburg and Berlin. In 1999 Axel Springer Verlag and its 12,500 employees generated total sales of DM 5,2 billion. The company's core business lies in the print segment. In addition to publishing a broad spectrum of newspapers, magazines, specialist titles and freesheets (both in Germany and abroad), Axel Springer Verlag owns a number of book publishers and operates its own printing plants and distribution organizations. The company is also actively involved in the electronic media (teletex, value-added telephone services, online services) and holds participating interests in TV and radio stations as well as TV production companies.

The strategy for the coming years can be summed up as "from a German print publisher to an international media company". In concrete terms this will entail an increased involvement in the TV and print media markets, in Germany and in other countries.

BILD is Germany's biggest daily newspaper. With its direct, unmistakable style it makes daily contact with an audience drawn from all sections of the population. Its unrivalled closeness to the readers and its great commitment in all areas of life have made it the popular daily read for millions of people.

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BILD is printed in eight printing plants in Germany. Every morning 5,5 million copies were distributed to about 100 print wholesalers, which deliver 112 thousands retailers. Up to 10 pm, 75% of the circulation is sold. All together every day 4,6 million copies were sold and the wholesaler had to collect 900 thousand returns.

High circulation figures and the loyalty of readers do not happen by chance, nor can they be bought: we have to earn them – day in day out.

2. Market Information and New Data Model

The BILD distribution department realised, that the sales market is changing. For example, in the future we will have fewer Germans, more foreigners, fewer ”young” persons (up to 40 years) and more ”old” persons (60 years and over). Besides this, the purchasing behaviour as well as the information and leisure behaviour will change. The consequences for the distribution are greater fluctuations in purchasing frequency, time of purchase and place of purchase. To meet these challenges the distribution department needs more information of the sales market and new instruments to work on the sales market. The strategic goals are consolidating and expanding the current market position and securing sales even under changing market conditions.

External influences and our market management have an impact on the sales market. The external influences are competitors, socio-demographic and socio-economic changes, technical developments (like electronic newspaper) and the political situation. We started to collect these data, especially the socio-demographic and -economic characteristics.

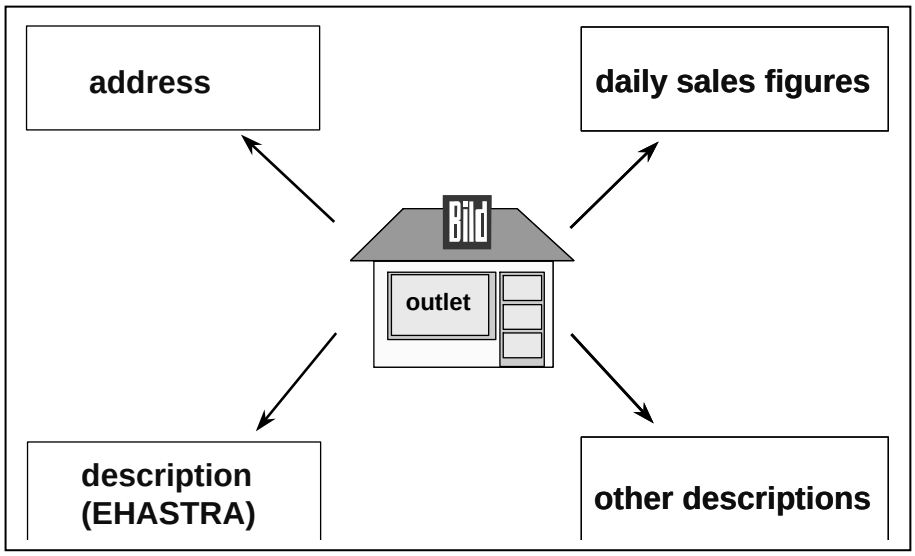

Figure 1: Description of sales outlet.

On the other side our market management influences the BILD sales situation: distributional measures, advertising, editorial content and special measures to increase the circulation like editorial games to win a journey or money.

Definitely we had to collect the complete sales data from our distribution market.

In 1995-1996 we started to think about a complete new and comprehensive data model. After same experiences we decided, that the BILD sales outlet had to be in the focus of our interest. Besides the address of the store we get the description of the outlet: e.g. the type of business, the opening times, the size, the average weekly turnover with press articles and so on (Fig. 1).

The most important information is the daily sales figures. Beyond this we are collecting promotional measures.

2.1. Daily Sales Figures

The BILD distribution department receives weekly the complete figures from each of the 112,000 outlets (see Fig. 2).

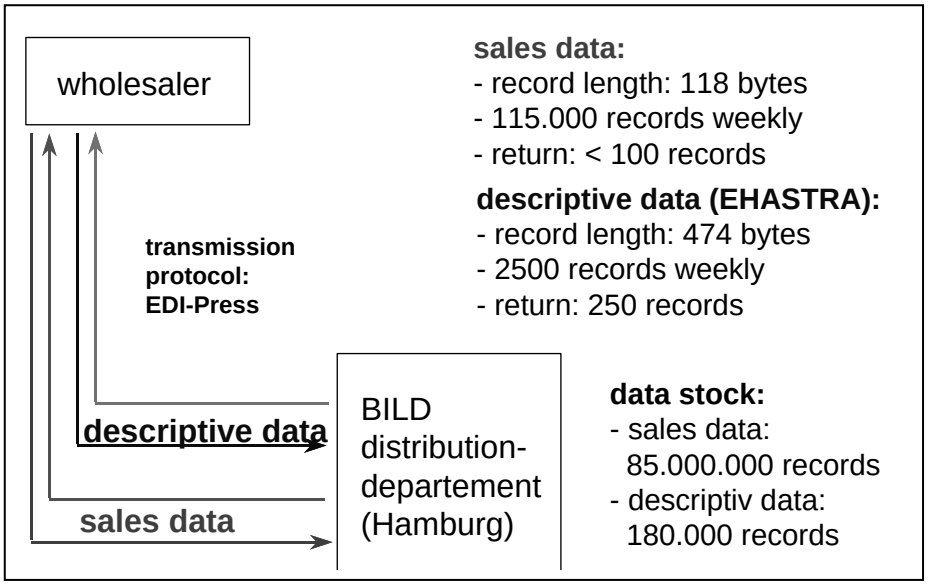

Figure 2: Data-transfer (sales outlet).

The data flow is so organised, that it cost only little manpower to get all the records in our system. We insist on a complete and correct data delivery. So we send obviously incorrect data back to the source.

2.2. Local Sales Market Information

The districts in Germany are hierarchically structured. The federal republic is divided from 16 federal states to 1,3 million street sections. We decided to allocate each outlet to one of

the 31,614 micromarkets. We possess a special software tool which perform this process automatically. Unfortunately, we received delivery addresses and not post addresses. So we have still a remaining rest of 800 addresses we could not geocode yet. Hence, our representatives have to go with a gps-system to the outlets to determine the coordinates.

835 cities with about 60% of the population of Germany are subdivided in mikromarkets.

The company named 'Claritas' provides us with topical socio-demographic data. We can describe each micromarket with the basic characteristics like size, population spending power, foreigner. The population is described in terms of age or education.

Claritas constructed several classifications. The milieu-typology gives us information about the inhabitants, if they e.g. belong to the traditional working class or more to the established milieu. The regional types divide Germany in conurbation areas, urbanized regions and rural regions. We can also distinguish between core cities, middle centres and catchment areas. Besides this the holiday regions are marked.

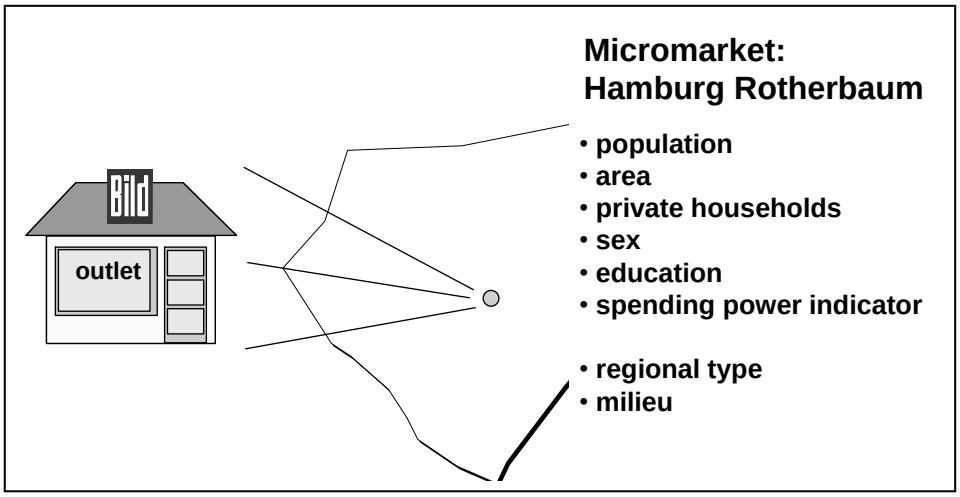

Figure 3: Local sales market information.

2.3. Database Model

We collect our data in a relational database model. This model serves as single point of consolidation, so that the data will be temporally and spatially comparable. Referential integrity is ensured. On the one hand data comes from several sources like Claritas or wholesalers. On the other hand data flows out to our starscheme to be used by several datacubes. These cubes provide data for our different applications.

3. Sales Market Management and Information System

The whole system (data management and application) is called BASIS, the BILD Sales Market Management and Information system (Fig 4.).

The BILD distribution department developed several different applications.

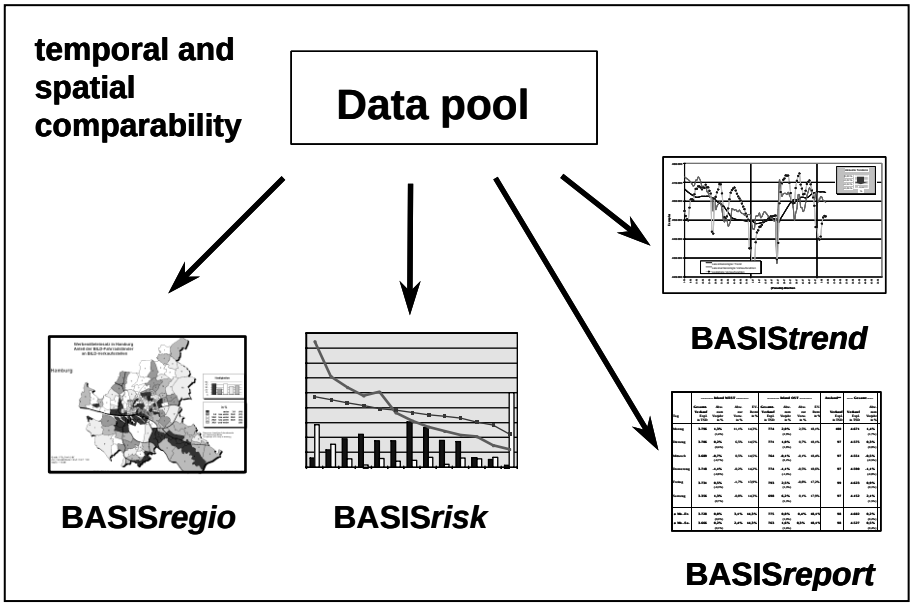

Figure 4: BASIS.

BASISregio gives us the possibility for an easy and comprehensive data-exploring. It consists of a combination of standard-software: EXCEL, the OLAP-software COGNOS POWERPLAY and the mapping-software MAPINFO.

BASISrisk helps us to check the quality of distribution. Each wholesaler has the task to deliver the retailer. The problem is to find the right amount. On the one side too many copies would cause too many returns, on the other side too less copies would cause lost sales. To find the right amount is a multidimensional problem. Prof. Kurotschka and Prof. Krivulin help us to develop optimization systems.

Besides this we will develop a system, which will tell us as soon as possible, if we have difficulties in our sales market. We want to detect regions or groups of outlets with declining sales figures.

A comprehensive reporting system completes our information system.

3.1. BASISRegio

We produce three editions of BASISregio. The main version is used in the headquarter of the BILD distribution department and contains all data (Fig. 5). The regional version is assumed for our regional distribution departments and the data cube comprises only the information of their area. Finally the wholesaler get their own version and their own data.

The button „Standardreport“ offers a lot of prepared reports (26), which allows an overview over an complete distribution region. These reports were presented in EXCEL.

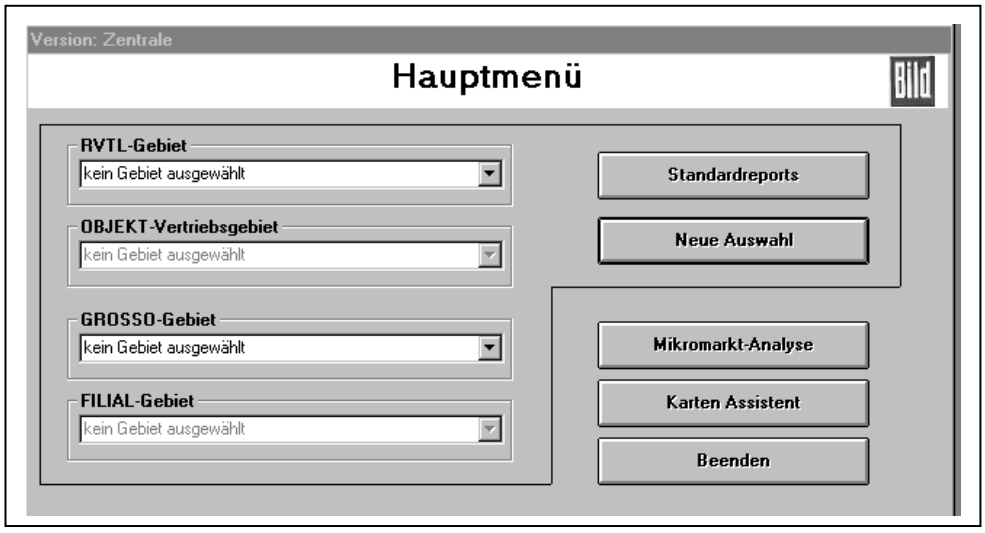

Figure 5: BASISregio.

If you press the button „Mikromarkt-Analyse“ you will change to the OLAP (on-line analytical processing) program COGNOS POWERPLAY (Fig. 6). Individual selection of units and characteristics generates in a matter of seconds comprehensive data evaluation.

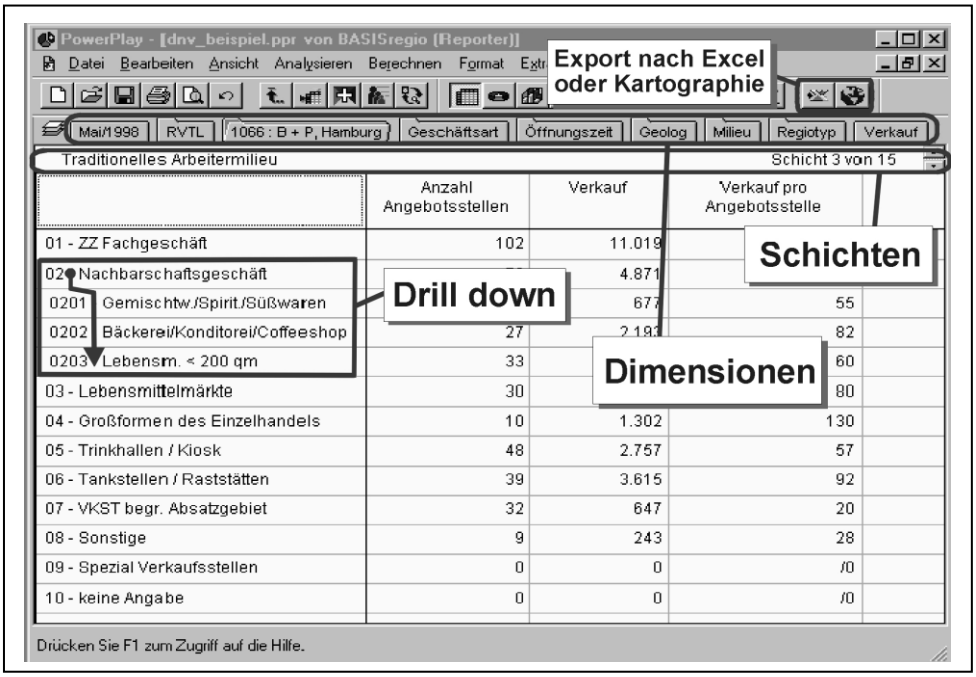

Figure 6: PowerPlay.

In the „Karten Assistent“ is it possible to present the information in a map.

The „Standardreport“ gets the data from the data cube. The chosen report prepares the selected data as a list as well as a bar-chart. The reports shows the values of the selected region and also comparable figures.

A multidimensional data exploration is in POWERPLAY possible. With a mouse click (drill down) you can refine the information to subgroups. The information can be filtered by different levels (Schichten) and by the dimension tab. It is possible to transfer the selected information to EXCEL or to the mapping program.

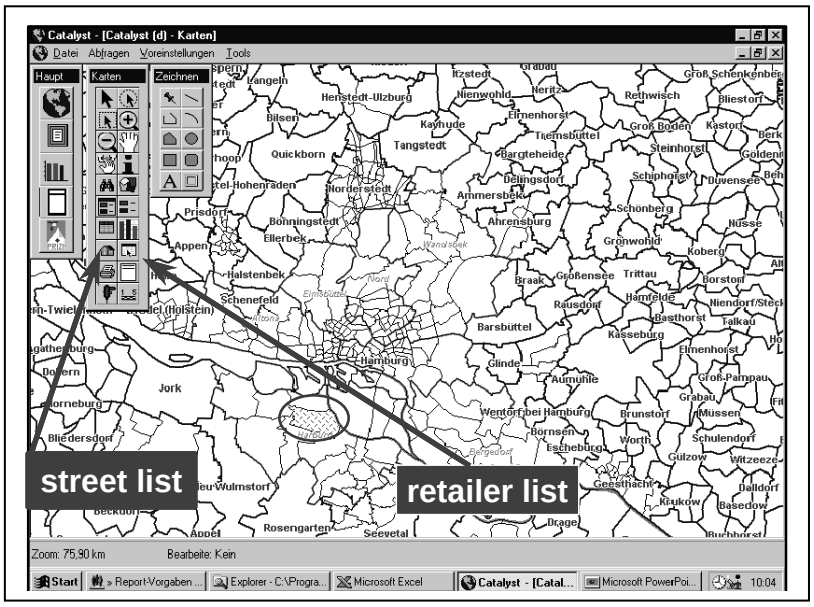

Figure 7: BASISregio – CLARITAS Mapping

In MAPINFO the borderlines of the smallest units are the micromarkets. Of course, it is also possible to create maps with bigger units. On the one side you can represent a characteristic as a coloured map. On the other side MAPINFO provides the user with a lot of helpful information. For each micromarket exists a list of outlets and streets (Fig. 7).

Time-Rich and Time-Poor: A New Way for Market Segmentation

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Abstract

Customer Relation Management, one-to-one marketing, e-commerce and e-anything as well as m-commerce and t-commerce analyze widely used classical parameters such as income, age, consumption patterns or education in order to make the market segmentation as accurate as possible.

For the new economy and IT-society one of the most important parameters for market segmentation, product, services and application development and marketing activities is time with a division on time-rich and time-poor users or consumers.

Both time-rich and time-poor people consume IT-based services, but their consumption patterns, choice of products and services and reasons to do so differ. The same goes for most of the products and services in general.

1. Background

Time is the topic. Time is one of the most popular themes in the press, TV, books, Internet chat groups and radio.

We passed the millennium shift with memories of the past and guessing the future. Hence, it was quite natural to have time as a subject. But there are more profound reasons for today's interest in time. We are at the turning point from the Industrial to the Information society. Functional divisions in space and time ruled the industrial society. Seasonal, weather and other changes in nature ruled the earlier agriculture society.

The Information society opens up new possibilities and new challenges. With information available to anybody, anytime, anywhere and anyway, it paves new ways to work, meet friends, shop, and keep in touch or to be entertained. It means a new way of living.

Day and night still have 24 hours and they are equally divided for young and old, rich and poor, in the south and the north, for directors, film stars, students and baby-sitters. However, the perception of time varies. Some people feel they have enough or too much time. They are time-rich. Some feel time is the biggest shortage. They are time-poor.

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The division in time-rich and time-poor has always existed but it is more important for the information society. This division is of interest for the development of new products and services, marketing activities and sales programs.

2. Time-Rich and Time-Poor

2.1. Who Are Time-Rich?

This group is large, larger than in any other period of human history. However, only a fraction of the time-rich is also money-rich. This group contains mainly of:

- Retired people;
- Children and youth;
- Unemployed.

The main reasons for having such a large group of time-rich are:

- Retirement with pension;
- Longer life;
- No child work;
- Increased prosperity.

To be retired with a pension is a new idea in a historical perspective. The number of retired people with pension is increasing rapidly. Life expectancy is also constantly increasing. Only a few generations ago we worked at home or outside home contributing to family survival until we dropped dead or due to illness could not contribute any longer. Elderly or children got just less pay. Thus, the work output depended mainly on physical strength, capacity of sight and hearing or skills in general.

In most countries, the law forbids child-work and the work debut is for every year becoming later. Many young people study and many are postponing their family and work responsibilities much longer than just a generation ago. This implies that there is an increasing amount of younger people who have more time at their disposition than at any other period in history.

A big group of the time-rich fluctuates depending on the state of the economy. This group consists of the unemployed. This type of time-richness is not at all desirable.

2.2. Who Are Time-Poor?

Most of the professionals and parents with small children are time-poor. "The busiest person on earth is the British working mother. If two parents work equal hours outside the home, the mother will work an average of nine hours more a week than the father in the home." (Kreitzman, 2001)

The main reasons for having a large group of time-poor are:

- No distinction between leisure and work;
- Increased supply and choices to fill up our time;
- Need to always be prepared for changes, to learn new things and acquire new knowledge;
- Consciousness that you are yourself responsible for your future.

No Distinction Between Leisure and Work

We have been used to go to job, work there, go home from work and be free for leisure activities, to relax, to be with family and friends, go fishing etc. Our time has been divided between work and non-work (leisure) activities. The information technology (IT) and telecommunications development gives us all the possibilities to work and be in touch with the office anywhere, anytime and soon even anyway. The intention with home or distance work was meant to be good, but it often resulted in both long hours at work and early or late hours at home. Few people can avoid the temptation to check the voice and e-mail messages when they are out of their office if they have the possibility to do that.

Increased Supply and Choices toFill up OurTtime

We have never before had so many choices of goods, services and activities and we must constantly take decisions at home, at work and other places. Independent job gives more degrees of freedom. Internet, TV, radio, books, games, children, parents, friends, movies, sports or shopping all of them compete for your time and each of these activities have almost unlimited amount of choices. It puts pressure on many people and you ask yourself. Was it OK to go to the cinema? Maybe it was a better film on TV, and how selfish when my parents wanted me to stay for dinner. "Promulgators of the 24-hour society begin by identifying (correctly) two themes of modern life; first a consumerist hunger designed to be unappeasable, and second a time-sickness at the heart of an over-hurried society; too much to do, too little time." (Griffiths, May 2000)

Possessions demand more time than we realize. If you buy a camera, or a pair of skis, or a food processor, or a hundred other similar items,

Need to Always be Prepared for Changes, to Learn New Things and Acquire New Knowledge

The technical development goes very fast and speed is likely to accelerate. Today's knowledge will be obsolete tomorrow. Life-long learning is not only a buzzword, it is becoming a reality for all professions.

Consciousness That You Are Yourself Responsible for Your Future

All your decisions can change your situation. It is important to meet the right people and to have the right education, be slim and tanned, wear the right cloth, read the right magazines and have the right new ideas in time that can be a key for success in professional or social life. Many are preaching the Carpe Diem approach, but it might be difficult to combine with the responsibility for one's own future.

3. Time and Money – A Historical Perspective

The antagonism between the haves and have-nots has to a large extent shaped our economic and political development. To be rich has in different epochs been expressed in different forms such as the possession of land, slaves, forest, mines, precious metals, machines or buildings, right position in the administrative apparatus or today by knowledge.

The division in time-rich and time-poor has always existed but its importance is underestimated today. Already in the 1960s, the Swedish economist Staffan Burenstam-Linder pointed out in "The Hurried Leisure Class" that consumption in an affluent society is limited by our scarcest resource: time. In his book Staffan Burenstam-Linder shows the mechanism behind time-poverty depending on increasing amount of products in the market. His predictions such as increasing prosperity is not giving us "… peace and harmony… in reality it is in this case in contrary. The pace increase and life becomes more hectic." (Burenstam-Linder, 1969) His predictions became true in the IT-society where such a big part of our consumption has become time-related due to the development of computers, Internet and telecommunications. The amount of products and services increases dramatically and continue to do so. His words "…not only production but also consumption demands time" are valid today and in the future.

More recently Paul Romer, a professor of economics at Stanford University explained: "The decline in the cost of IT hardware has been so rapid that it's tempting to assume it explains all the changes that take place in the economy and society. But in our lifetime, we've witnessed a second price change that's as jolting as the one in hardware: The cost of time has increased. To be sure, the rate of increase in the cost of time has been much less dramatic than the rate of price declines in IT. But human time is used in every productive process and every consumption activity, so changes in the cost of time have pervasive effects on the economy and society." (Romer, 2000)

3.1. Until Now

Historically two groups dominated – namely: time-rich/money-rich and time-poor/money-poor. The first group was few in numbers and had power. The second was many and powerless.

The group time-rich/money-rich represented power and money but also culture, fashion and trend setting. They also accounted for the largest part of consumption of entertainment, products and services. The position time-rich/money-rich was attractive. To achieve it, it was required to be born in the right class, to have the right means or at a later stage to have the right entrepreneurial skills.

The vast majority of the population was time-poor/money-poor. All members of the family had to contribute to family survival. The possibilities to change one's situation were limited. People used most of their time to produce for others and themselves. They had no time or money to consume more then the essentials.

Time-rich/money-poor were few. It was simply difficult to survive in this group. If somebody became sick or lost his job it could be a catastrophe for not only the person himself but also to his whole family. In the end it could lead to famine and death.

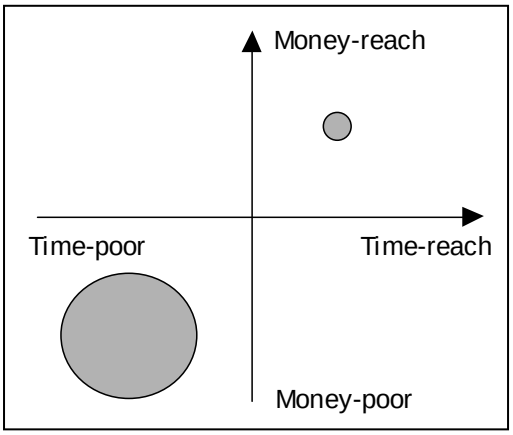

Figure 1: Time and money in a historical perspective.

Few became rich from their work. Time-poor/money-rich were made up by a small group of successful scientists and artists.

3.2. Today

Today the picture is completely turned upside down. The two most dominant groups are time-poor/money-rich and time-rich/money-poor. These two groups are more or less of the same size in the developed countries.

Today's elite is time-poor/money-rich. This group is the trendsetter. People on higher positions with big salaries work more. To get to the top means more working hours, less contact with the family and old friends. Ross Gittens points out: " … the people pulling in those big salaries are, as a general rule, working much longer hours than people in less-paid jobs. Consider the official figures for the hours worked in August by men with full-time jobs. Almost 60% managers and 40% professionals and associated professionals worked more than 48 hours a week. By contrast, only 25% of tradesmen and 18 % of laborers worked that long." (Gittens, 2000)

Time-poor/money-poor in our society are low-income single parents. This group is relatively small and of little economical and political interest.

The time-rich/money-poor of today in most developed countries would not have been considered poor in the past. In this group we find many retired people with limited pensions, unemployed and many young people. This group is often marginalized. "What worries people about persistently high rates of unemployment… is not just that unemployed may be poor but that they are likely to be "socially excluded". (Bittman, 1998)

The time-rich/money-rich group still exists but the members have lost their prominent positions.

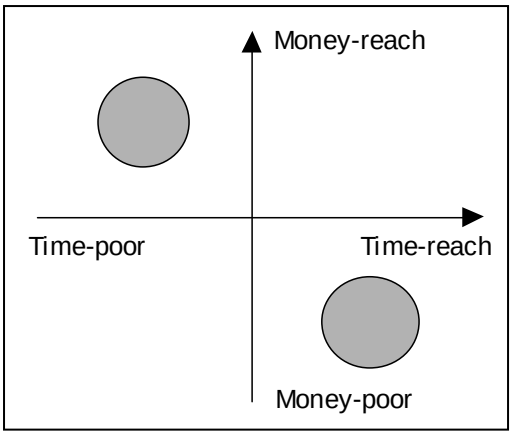

Figure 2: Time and money in the IT-society.

4. Market Segmentation

Most of the companies recognize the importance of market segmentation as a method to group potential customers and make conclusions about their needs and desires. This knowledge is used to create new products, marketing activities and maintain sustainable customer relations in order to increase and maintain the company's lasting profitability.

Methods to segment the market are continuously refined depending on the affluent supply of products, globalization and competition.

If the polarization between time-rich and time-poor characterizes the IT-society then this division has many important implications for the society. But its persistence and general existence means that the polarization on time-rich and time-poor can as well be used for market segmentation since any IT based service or usage of equipment is time-related, and IT also influences all other business and most of our daily life activities. It means that segmentation of the market based on time is as important as segmentation based on income, sex or education.

4.1. Example: The Furniture Industry

The furniture industry has been and still today is divided into two parts: those who produce, sell and distribute to households and those who do that for business or public environment. It is valid for the whole business chain from suppliers, partners or sales channels.

Analysis of time-rich and time-poor shows that one of the main reasons for time-poverty is the blurring distinction between work and leisure. We can do most of our work anywhere, anytime and anyway. We can work in the hotel room, waiting at the airport or sitting on a bench in the park. But it is home, that is becoming an important place for work. The Swedish government has for example subsidized the acquisition of personal computers in

order to stimulate home working. Offices are also changing their role. They are more and more becoming a place for formal and informal meetings.

This new situation and market demand will lead to major restructuring of the furniture industry. The demand for ergonomic, personal and office designed furniture will now be in homes. Office environment will change producing new demands such as some cozy sofas for informal meetings and flexible working posts where the furniture becomes a part of the data system and adapts automatically to the profile of the working person.

These changes are likely to have as big impact on the furniture industry as IKEA or the introduction of TV.

4.2. Example: E-commerce

To make a market segmentation based on time with time-rich and time-poor sounds intuitively relevant for commerce and e-commerce in particular.

For the rime-rich, each transaction should be felt as a bargain. To make a bargain can many times be more important then buying according to real needs. The buying situation should have a crowded ambiance of the Middle East or the medieval market with long haggling until reaching a bargain price.

The time-poor should receive proposals ready for decision. The lasting feeling should be a relief of burdens of choosing and that the offer was specially composed for me. Of course any relevant information in depth can be presented on request.

One-to-one marketing is a guiding-star for e-commerce and implies a meticulous market investigation at the individual level. Services and products are strongly time-related and most of the rich people are time-poor and thus difficult to reach. The important sources of information for time-poor are time-rich (young or old). It can even be more important to give good service to time-rich people then to time-poor. A gossipmonger, who in earlier age informed the whole village about any negative treatment, can now inform the whole world.

5. Conclusions

The historical relation between time and money has been turned upside down by the event of the information society. In earlier days, the majority was poor both in time and money while the minority was rich in both time and money. Today, there are two equally large groups. One is time-rich/money-poor. The other is time-poor/money-rich. This new relationship is a challenge for business. The increased significance of the time-dimension may herald large structural changes of any business sector. Therefore time is an important new market segmentation tool.

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Russian Internet Payment Systems' Market. Present Situation and Outlooks

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Abstract

This article evolves problems, which are standing on the way of Russian Internet Payment Systems' developing. Then, it shows how Russian sector of e-Commerce influences on On-line Payment Systems' Market. Also it contains some outlooks, which were maid as a conclusion.

1. Introduction

To the beginning of the 21st century Internet Commerce became an ordinary path of ruling business and making money. Now we have lots of on-line shops, firms sell their goods and services through World Wide Web, information market appeared. Emerged few years ago providing business became one of most profitable. Some commercial organizations prefer "virtual" businesses to "real".

Growth paces of sales through the Internet are impressive. Analysts (of "Binary Compass Enterprises") prognosticate in 2002, – $26 milliard output from the Internet retail system. The whole volume of Internet-payments only in Russia is about $4.5 milliard (in USA – about $150 milliard). About 40% of Internet users used to do on-line shopping. Such facts help many people in the whole world to face Electronic Commerce.

There are lots of obstacles on the way of making business through Web. One of them is integration of financial relations and payment means directly into the Internet. In Russia this problem is more actual, than in other countries going through "Net Blow" because of it's banking system's weak developing.

2. Russian Internet Payment Systems

In Russia, theoretical part of solving this problem overtakes practical. Just because it is moving another way. The way that is not connected with our general situation and mentality. In practice, most of developments are still only developments.

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Creation scenario of an Electronic Payment Systems' market in our country differs from the western one. The main cause of this is the absence of venture financing. That is why our banks became moving force in creation of payment-system types.

Situation with e-Commerce in Russia country operates on our Internet Payment Systems Market. 90% of transactions made through ASSIST's server (well-known Russian payment system) are from exterior clients. Lots of On-line Shops used to work with foreign buyers. They do it for a variety of reasons, such as (this points were named by owners of virtual shops and payment systems developers during our interview):

1. Our similar culture of on-line and catalogue shopping is not formed yet;
2. Different kinds of nonconcurrences with legislation;
3. Bank deposits misgive potential investors (because of August crisis of banking and financial system);
4. Disbelief to Secure Internet Technologies from people;
5. Weak paying capacity of Russian buyers;
6. Low Internet culture.

But the main reason, yet, is connected with the customers' non-acquaintance in Internet Payments' security aspects. As a result people bring on-line shopping into challenge and owners of Russian Internet shops prefer working with the foreign client.

Somehow or other, Russian e-Commerce's market is in evidence, it's just narrower than others are. Commercial resources, among participants of most popular rating system Rambler's Top 100, compose 42%, and theirs quantity forced up more than in 40% from 1998. Russian on-line Business To Business (B2B) sector rapidly outgrowths similar to Business To Customer (B2C). Lots of distributors use World Wide Web for creating their own dealers' net, forming and checking orders. In B2C sector supply of services is appreciably behind demand. This fact makes Russian on-line B2C sector very attractive. More than 50% of respondents (according to on-line magazine's "Mir Cartochek" interview) wish to pay theirs accounts through the Web.

It will be observed that "down payments" and money orders comprise 70% of e-Commerce's Market. So, payment systems take less percentage.

Nowadays we have two directions in the world's Payment System' market: credit payment systems and debit payment systems. Credit systems use simple plastic cards with magnetic stripe or code. Debit systems are based on two technologies: Digital Cash and Smart Cards (cards with integral scheme and microprocessor).

There is no need to describe all technical characteristics of each kind of system and standard schemes of payments through the Internet. One can easily find them in the Web. We just only want to say, that Smart Cards technology gradually becomes more and more popular and competitive with others. VISA International and Europay International declared their purpose of conversion into the sphere of Smart Cards.

In Russia, where infrastructure for simple credit cards is not well developed, advancement of debit payment systems (which use Smart Cards, for example) can be main and really serious step ahead. But it's the only from the first sight on this problem.

First, as it was said before, a huge number of Russian on-line Shops and other commercial organizations, which sell something through Internet, are working with foreign customers. Such kind of customer used to pay by his credit card through the Web. So, it is not in their interest to "vote" for developing Smart Cards' systems.

Furthermore, such kinds of debit system require big investments into technological developing and PR actions between businessmen and common people. Such systems considered, as a "half-pilot" by Russian Internet-elite, while these investments still are not done.

And, finally, aspiration to make "fast money" on well-known credit card technology will rule Russian banks.

The leaders of Russian Payment Systems' Market are presented on the Fig. 1.

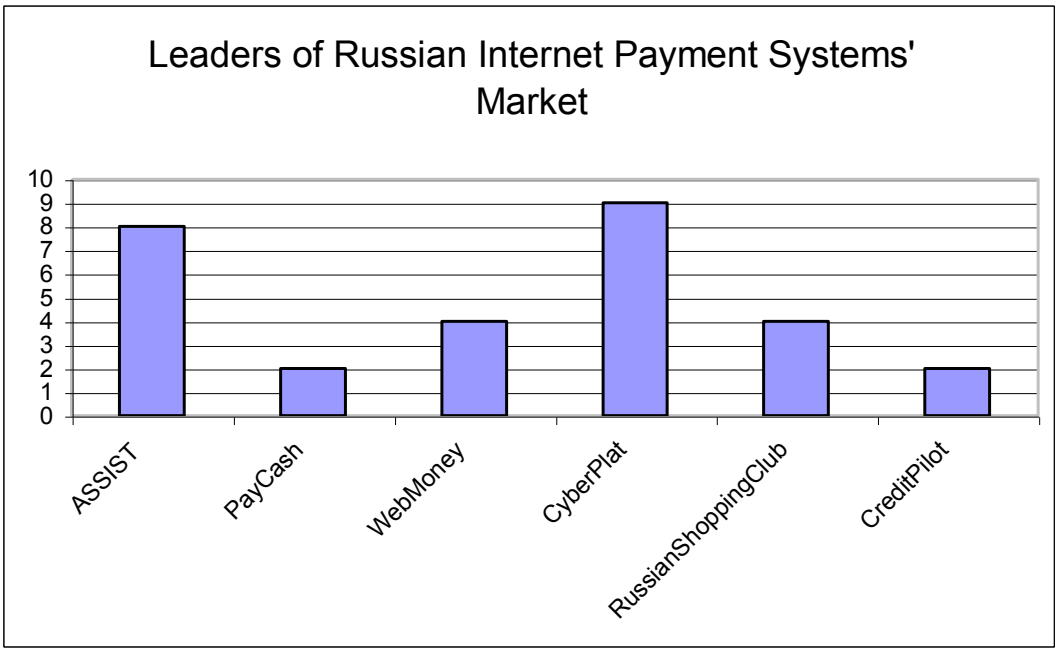

Figure 1: Leaders of Russian Internet payment systems' market.

This data was reached during ours interview of Internet shops owners and payment systems' developers. As we can see from the diagram 1, payment systems which are working with plastic cards overtakes others (WebMoney, PayCash). Also we can see that Smart-cards compatible systems are not exampled in this analysis. Just because there are no such systems in Russia.

3. Conclusions

So, we made some conclusions about the present and the future of Russian Internet Payment Systems' Market:

1. In Russia (now) Credit Payment Systems are more popular than Debit ones;
2. Mainly large and intermediate companies (which actively use informational technologies) inculcate Payment Systems;
3. Potential owners of credit cards' distrust to the banking system and Internet are the greatest obstacles in the way of developing Payment Systems' Market;
4. For Russian Internet business-elite conversion to the Smart cards technology is just a tale about beautiful future;
5. Development of the Credit Payment Systems' Market is the main direction in the nearest future;
6. On-line Clearing Payments will also take place.

Theory and Practice of e-Commerce

The Development of e-Commerce in Poland

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Abstract

The paper is dedicated to describe and analyse the development of Internet based trade in Poland, and its influence on changes in the way the business is conducted in Polish enterprises. The analysis of the usage of Internet in the small and medium Polish enterprises, the reasons for connection to WWW and the evaluation of the benefits gained from the Internet as a tool is presented. The analysis of the number of the Internet users in Poland and perspectives of its growth was done as well as identification of the main barriers preventing the growth in Internet users and factors that can stimulate that growth. The paper presents also short analysis of the Polish B2C and B2C sector and the influence the Internet has on the banking and financial services sector in Poland.

Keywords: Internet, e-commerce, B2B, B2C

1. Internet Users in Poland

The first wave of Internet users was mostly young people, for whom the technological abilities were fascinating, the second wave consists of people that are looking for the services Internet can bring. They use the Internet because it is a useful way of communication and can help in acquiring needed information.

According to the recent survey done in February 2001 by ARC Rynek i Opinia, 13,4% of Polish are the Internet users. For the purpose of that survey the Internet user has been defined as a person that have had used Internet at least once a month. The typical Internet user in Poland is aged 15 to 29 with a higher education degree, mostly males (around 66% of the Internet users). Most of the users connect to the Internet every day – 28,8%, around 30% of the users connects to the Net a few times a week, and 21,8% respondents connects once every two weeks or less frequently. Polish Internet users connect to the Net mostly at their homes – 43,3%, at work/office – 26,2%, at the school/university – 15,5% and Internet cafes – 8,0%. Home Internet users usually connects through TP S.A. (Polish telecom) telephone access numbers – 84%, and only 7% of Polish Internet users have the permanent Internet LAN connection. Polish Internet users mainly search for topics related to music and music files (34,3%), news (26,8%), information needed for the education and research (21,4%) and topics related to business and economy (20,1%). Activities mostly performed include visiting web pages (85%), e-mail (75%), ftp services and files downloading

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(31,2%), chat (18,8%). Most of the Polish users visit Polish portals (61%), and 35,5% of users visits Polish and foreign web pages at the same rate. The most frequently visited portals are: www.onet.pl – 78,5%, www.wp.pl – 73,7%, www.yahoo.com – 30,4%, www.arena.pl – 30,3%, www.interia.pl – 27,6%, www.altavista.com – 27,4%. The place of Yahoo.com and Altavista.com is rather surprising, the explanation could be that some Polish users are still loyal to the portals that they have been visiting in the early days of Internet, and the language is not the difficulty in that case. Another explanation can be that some people value the content of those particular portals or some part of the Polish Internet users, mainly those who were the "Internet champions" in Poland have their mailboxes with those portals and that is the only reason they visit them. The people who are outside the Net are mainly at the age of 36 and more, usually living in the rural areas and small cities. During the survey they have been asked why they do not use the Internet. The answers are presented on the Fig. 1. Those who named “no need” as the main reason of not using the Internet are mostly inhabitants of the rural areas. Lack of the computer and Internet connection is the main excuse for the people living in small cities (with a population less than 50 000) (Czyżewski, 2001).

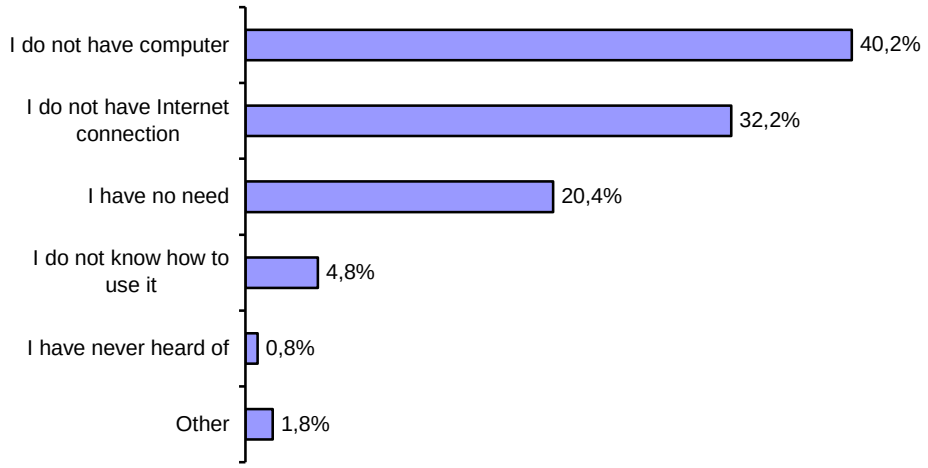

Figure 1 Why I do not use Internet
Source:ARC Rynek i Opinia Report [9]

2. e-Commerce

According to the survey done by Global eMarketing and Arthur Andersen at the end of 2000 in the B2C sector in Poland there was around 650 Internet stores of which more than a half offers only one product. The increase in 1999-2000 sale was accounted to 400%, but still the sector announced around 22,5 mln. USD of losses. According to the 2001 ARC Rynek i Opinia survey 11,2% of the Internet users in Poland have not bought anything using the Internet in the last year. The items that are usually bought are books (50,1%), CDs (22,5%), software (13,7%), computer hardware (10,2%) (Czyżewski, 2001). Nevertheless Internet traders are optimistic concerning the future and 70% of them states that they have loyal

customers. Polish virtual stores in the process of distribution use Polish Post (82,6%), and the dominant method of payment is postal order (88,9%) (E-handel w Polsce, 2001). According to the analysis of the International Data Corporation by the end of 2001 Polish B2C e-commerce segment can achieve value of 45 mln USD and in 2004 its value is estimated for 480 mln USD (Do 2004 r. Możliwy etc., 2001).

Typically the important segment of e-commerce are B2B transactions. Two electronic marketplaces are operational in Poland (MarketPlanet and Xtrade). Both platforms use technology of an American Commerce One. According to the most of the analysis only one have a chance to stay on the market and the reason is that Polish B2B services market is too small. MarketPlanet has a certain advantage, it already has one big customer, and also main shareholder, TP S.A. the biggest Polish telecom operator. TP S.A. wants to move to the Internet 20% of its acquisition of general goods. In four auctions that were organised until April 2001 TP.S.A. had made savings in acquiring goods that were estimated for around 3,4 mln USD. Xtrade as for the end of April 2001 still do not have clients. The company believes it will be able to achieve net profit after 26 months of existence on the market (Kretowicz and Zielke, 2001).

3. Barriers in Development of e-Commerce in Poland

In Poland there is still no need and motivation for modern forms of trade. Most of the big supermarkets use the European and USA patterns of trade from 80-ties, and there is no need for change. New mechanisms of trade start to emerge rapidly when there is need for more competitive ways of reaching the customer.

The lack of fast telecommunication structure seems to be another discouraging factor. Potential customers have to wait to long for graphics to appear on the screen, and if there are no satisfied customers there will be no satisfactory e-commerce turnover. The alternative could be m-commerce based on the mobile networks and WAP technology since the mobile phones networks are rather well developed in Poland and widely used. The mobile networks enabling fast data transmission and system of micropayments based on the prepaid systems can undoubtedly boost the B2C e-commerce segment in Poland.

Difficulties in paying for the Internet transactions were a real obstacle in the further development of e-commerce, mainly due to a lack of a single authorisation centre. Recently the biggest Polish credit cards operator PolCard has introduced the Virtual Card. The card that can be only used in transactions over the Internet, and the customer is notified by an e-mail or SMS about each transaction that took place on his account. PolCard's long awaited by traders initiative will hopefully convince people that Internet transactions can be safe and easy to execute. Because, as for now, Internet users see postal order (46,4%) and bank transfer (20,9%) as preferable way of paying for goods bought over the Internet (Czyżewski, 2001; PolCard Web Site, 2001).

The important barrier, sometimes underestimated is low cultural acceptance of electronic forms of trade. After years of economic crisis, and empty shelves in the shops customers appreciate the contact with professional shop assistant and ability to "touch and see" the

product. Polish Internet users have no confidence in "electronic" form of shopping (39,5%) (Odrowąż-Sypniewski, 2000).

4. Financial e-Commerce in Poland

According to the "Banker" magazine, service of customers in the physical bank cost 1,07USD, while Internet banking service cost 0,01USD (Wojtach, 2000). At the beginning of 2001 most of the Polish banks could offer their customers full account operations using Internet. Purely Internet banks with no physical branches also emerged, and become popular in Poland. The two with the biggest market share are WBK24 and mBank with number of customers that can be accounted for 150 000. Clients of Internet banks use mostly Internet and mobile phone SMS service to perform account operations.

Internet can also be used for transactions on the Warsaw Stock Exchange. The first was Stockbrokers House of Bank Ochrony Środowiska who offered their clients stock transactions over Internet in 1998. At the end of 2000 there was 17 Stockbrokers Houses that were able to offer their clients Internet transactions services and at the beginning of the 2001 around 10 000 investors have Internet accounts. Stockbrokers at the BMT stated that 62% of the stock transactions and 76% of the futures transactions are done over the Internet. Other stockbrokers usually have the Internet utilisation result at the range of a few percentages. The specific of the BMT is that their main clients are the most active traders usually day-trades for whom the speed of transaction is the most important issue. The above level of turnover in BMT was achieved within a year, that is how long the BMT stockbrokers have offered the Internet service to the investors (Internet dominuje w DM BMT, 2001; Mielczarek, 2001).

Autumn of 2000 has brought a start of a new financial service portal that is dedicated to insurance services – Elfin.pl. The portal owners are aware that selling insurance products over the Internet is difficult due to complexity of the insurance product itself and the security reasons – the nature and amount of data needed to perform the insurance selling transaction is rather specific. The problem arises also with the validity of an electronic sign but Elfin.pl believes that at the beginning they can offer their visitors professional expertise. The company owners are sure that standard insurance sale over the Internet can grow rapidly in a few years time. Most of the Internet users are mainly young people – they are potential customers and will be interested in insurance of all kinds in some time. Elfin.pl also sees the use of the Internet in the insurance sector for updating the personal information such as change in the address or changes in the fees structure and timing and possibility to claim insurance payments. Some types of insurance policies can not be sold over the Internet (e.g. life and medical insurance) in that case Internet can provide customers with application forms needed and help to choose among the offers (Stevenson, 2000).

5. What Will Influence Growth of e-Commerce in Poland?

The increase in the number of Internet users undoubtedly will cause an increase in the e-commerce turnover. Therefore every action that can facilitate the Internet access will result in the creating the bigger e-market. According to the ranking assessing readiness to e-

commerce prepared by Information Society Index, Poland is on 30-th place among 55 countries.

Recently Polish Parliament has introduced a bill lowering the VAT on the computer equipment for schools and at the same time the VAT on Internet connections was also lowered to 7% from 22% to everyone (0% VAT for schools). That was a part of the Ministry of Education initiative to promote Internet education and enable access to the Internet in all Polish primary and secondary schools. Cheaper connections as well as Internet education on all levels in schools will undoubtedly have positive influence on the e-commerce development.

Another interesting government initiative that also will boost Internet usage in Poland comes from the National Social Security system. In the process of the reform of the system itself and to improve the effectiveness of collecting payments by ZUS – Social Security, Polish Parliament have brought the bill introducing the system of electronic distribution of social security documents to the local ZUS offices. Employers that employ more than 20 people have to deliver documentation through Internet, email, or in a form of files on CD-ROM. The files are generated by *Płatnik* software that was elaborated and distributed free of charge by ZUS. That system required an Electronic Signature Bill that was introduced by Parliament at the beginning of 2001. The specific system of certification centres, which issue the electronic signature, is already in operation. The biggest companies (employing more than 1000 employees) their first electronic documentation deliver to ZUS at the end of July 2001, and companies employing between 20 to 99 employees – at the end of September. Undoubtedly, that can be stimulant for the growth of the Internet presence among Polish companies.

According to the recent surveys, the reaction of firms is rather positive, 54% of companies using computers but not having the Internet connection is not against the requirement of electronic documents distribution and only 8% are against it. Moreover 51% of "non Internet" managers would like to distribute documents to tax authorities in the same, electronic way. Among the companies that are already connected to the Net, 80% of managers see the electronic documents distribution as very useful, and 70% would like to see the same way of documents distribution to tax and statistics authorities (Raport: wykorzystanie Internetu etc., 2001).

6. Polish Enterprises in the Internet

Results of the survey conducted in late 2000 by ARC RYNEK i Opinia and by Demoskop show that most Polish small and medium companies are satisfied with the way the Internet is improving efficiency of their operations.

The survey was done on the group of companies employing more than 5 employees. Among the surveyed firms 38% has the connection to the Internet, and within the range of big companies (employing more than 250 employees) 40,5% can use the Internet. In the group of small and medium companies the ratio of Internet connection equals to 39%. It is also worth noticing that in the segment of small companies (employing not more than 49

employees) only 42% of them use the computer. More than 25% of firms that have computer hardware but are not connected to Internet are planning to do so in the next half a year.

The main reason that companies decided to be connected to the Internet is the ability to use electronic mail (as stated by more than 40% of respondents), improved communication with suppliers and customers (more than 22%), and general interest in the Internet phenomenon (21,4%). Detailed results are presented on the Fig. 2.

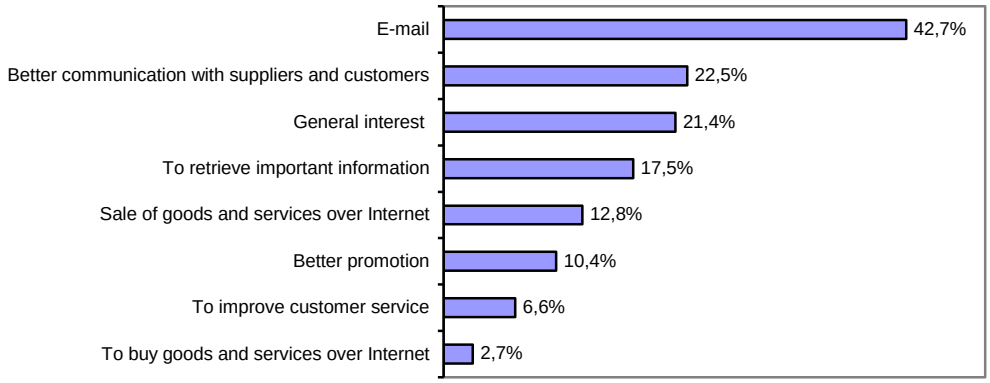

Figure 2. The main reasons of connecting to the Intern
Source: ARC Rynek i Opinia Report [1]

Generally, Internet is neither used in buying or selling process nor to perform Internet based banking transactions. The main reason of this is the lack of confidence in the financial operations carried out in the Net.

The above results show that among Polish companies Internet is perceived as a place of acquiring the information, not offering it.

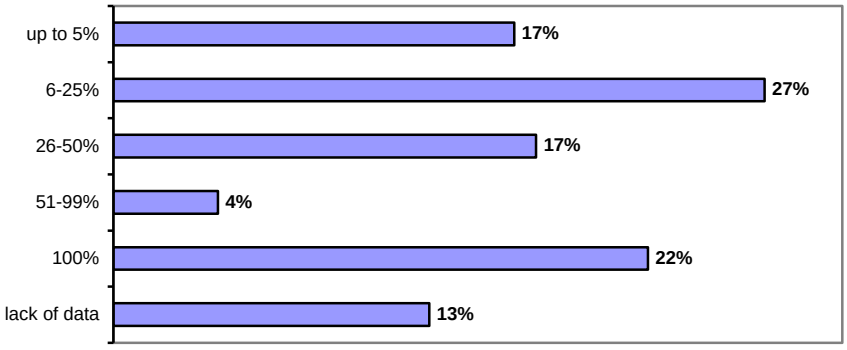

Figure 3 Acces to the Internet among employe
Source: ARC Rynek i Opinia Report [1]

The dominant way of connecting to the Internet is the use of modem and Internet services provided by national telephone operator TP S.A. (53,6% surveyed companies).

In the 22% of surveyed companies all the staff has the access to the Internet, but in more than 40% of companies less than 25% of staff can use the Internet. The detailed results are presented on Fig. 3.

Surveyed companies very highly evaluate effects of the connection to the Internet, more than 95% of companies assess it as a valuable tool and around 50% state that Internet has a positive influence on efficiency. Those results are presented in Table 1.

	Evaluation of the Internet as a tool of work		**Evaluation of the impact of the Internet on efficiency**
Highly useful	57,2%	High influence	51,6%
Rather useful	38,5%	Have no impact on efficiency	41,9%
Not useful	2,4%	Had negative impact on efficiency	0,4%
I do not know	1,9%	I do not know	6,1%

Table 1. Evaluation of usefulness of the Internet and its impact on company's efficiency. Source: ARC Rynek i Opinia Report, 2000

Although more than 70% of the managers perceive the Internet usage as a time consuming and 40% of managers evaluates the Internet usage as expensive.

Although almost 75% of the surveyed companies do not use Internet banking, more than a 50% of firms perceive Internet banking as better than traditional. The main reasons is the: easy access to accounts balance (60,8%), fast transactions (59,3%) and usefulness for accounting purposes (56,5%). The main obstacle in using the electronic banking are the security concerns – 32% of the surveyed companies state that these are the reasons traditional banking is better than electronic. Still 49,7% respondents see that it is highly probable they will use electronic banking in the future (Polska firma w sieci, 2000; Trojanski, 2000; Bartczak, 2000; Raport: wykorzystanie Internetu etc., 2001).

7. Barriers in Introducing Internet to Polish Companies

The main barrier in the connecting to the Internet is not sufficient knowledge about possible business use of it, more than 60% of managers in the companies that do not have Internet connection do not see the need of Internet in their business operations. Another barrier is the perceived cost of using the Internet, more than 64% of managers perceive the Internet as expensive. Managers of not connected companies also do not think that Internet have direct

influence on companies operations (52%) and the 57% of managers say that Internet is not well developed in Poland therefore they should wait. But what is also interesting, is that nearly 70% of "not connected" managers thinks it will be difficult to manage their companies without Internet in the near future, although their plans of using Internet concentrate mainly in the e-mail activities (69%) and retrieving information from the web sites (86%). Active use of the Internet, such as publishing information about company, goods and services and e-trade sees only around 10% of managers (Polska firma w sieci, 2000; Trojanski, 2000; Bartczak, 2000; Raport: wykorzystanie Internetu etc., 2001).

8. Conclusions

Dynamic development of the Internet has changed the way the business is done nowadays. The Internet is changing both models of business and internal organisational schemes within companies. Market leading companies are using Internet abilities of creating global market, offering their goods and services all over the world. At the same time Internet has also increased client's expectations and requirements. Companies operating in the E-economy have to fulfill not only technical requirements and guarantee the security of the transactions but also undertake the process of education of their clients, business partners and very often to learn themselves about that new economic phenomenon.

Analysts predict that in 2020 more than 50% of our shopping will be done from home. In that case the role of supermarkets will change radically. They will become distributors of the goods bought in the biggest ever-imaginable shop – small computer screen. Therefore companies now should keep in mind that every day of delay in entering the E-economy could only bring losses. In the future it will be more and more difficult to acquire clients. Apparently, in times to come there will be two types of companies: those that operate in E-economy or those that will have to file for bankruptcy (Walcerz, 2000; Mierżyńska, 2000).

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Enterprise Portals:
Linking Strategy with e-Business Technology

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Abstract

An Enterprise Information Portal (EIP) provides a unified interface whereby information from any source – legacy systems, Lotus Notes databases, intranets, the Web, others – can be presented to users based on what each user should, needs to, and wants to see. This paper explores the dimensions of portal functionality, and uses the Value Center concept of Venkatraman (1997) as a framework for understanding the strategic nature of EIP features. It presents a case study of an EIP at a large U.S. utility firm, where recent deregulation has greatly increased the need for new business initiatives, efficiency, and e-business solutions. It is found that the EIP rollout to date focuses more on the "cost center" and "service center" aspects of IT than on aspects that will directly affect future strategic advantages.

Keywords: Portal, EIP, Energy Industry, Strategic alignment

1. Introduction

As the dust has begun to settle from the "cyber frenzy" of the past five years, firms are beginning to reassess what they have built and are looking for ways to get it under control (Such a pattern is typical for new IT developments and has been observed since the 1970s. See Nolan (1979).) Most larger firms built intranets, and by 2000, more than 50% of all workers in the US, Germany, Sweden, and Canada had intranet access. However, the process was somewhat haphazard, with numerous departments adding their own websites and functionality. Many firms deployed more than one intranet (White, 2000). These firms are trying to realize projected and expected gains from these new systems, while seeking ways to leverage their investments for new strategic advantages. The enterprise information portal (EIP) has arrived at the nexus of these trends, offering the promise of a unified means of unlocking all the heretofore unrealized potential of existing information repositories and systems.

There is no doubt that the EIP market has grown rapidly. Plumtree (2001a, 11), one of the leading EIP vendors, reports an IDC estimate that "half of all organizations and nearly 60 percent of large organizations will deploy a corporate portal in 2001." Delphi's survey found that more than 70% of firms in its sample would deploy EIPs by the end of 2001

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(Delphi Group, 2000a). Merrill Lynch estimated in 1998 that the enterprise portal market would grow to U.S. $14B by 2002 (Shilakes and Tylman, 1998), and this estimate has been widely cited to justify the importance of the field. This level will certainly not be reached. Delphi's latest forecast is for sales of portal applications to reach $730M in 2001, but this is still five times more than in 1999 (Tweney, 2001). There is no doubt that the portal market is following a well-worn progression from promising invention to diluted buzzword, in which more and more firms are labeling their products as portals regardless of the set of functions they offer. The U.S. market now has over 100 vendors who offer portal products (Tweney, 2001).

2. Dimensions of Portal Functionality

An enterprise information portal (EIP) has been defined as "the new Internet-based business desktop, integrating the most important electronic resources available to an organization in an experience that is simple enough for everyone to use" (Plumtree, 2001a, 3). Therefore it should comprise a single gateway to all of the information and applications that the user needs (Fig. 1).

Finkelstein (1999) notes that EIPs have been evolving in four stages: connecting people with information, providing collaboration tools, connecting people to other people with specific expertise and interests, and "knowledge portals" that "combine [these] to deliver personalized content based on what each user is actually doing." By this definition, most portal products have at least passed through the first two stages, although some are hindered by the legacy systems on which they were initially based. Web interfaces to stand-alone systems do not qualify as EIPs (Plumtree, 2001a).

The strategic advantage which derives from portals, therefore, is seen as more than just a more convenient way of retrieving information. Delphi states: "In the simplest sense, portals provide a vehicle by which to maximize innovation through leveraging opportunities represented in the transactions and knowledge crisscrossing an enterprise value chain. From this perspective, the corporate portal provides a mechanism for building unique core competence in executing knowledge chain activities" (Delphi Group, 2000b, 4). Mears provides an example of the level of integration that is envisioned to provide such "crisscrossing." In the InfoImage Freedom Portal Version 4, metadata will be collected in such a manner that the user can execute a search spanning all relevant sources. The portal is then updated to display this information (Mears, 2001). But even this functionality does not solve the problem of how to integrate the information once it is found. "Next generation" portals will need to go further than integrated searching. The new standard will be the extent to which the portal provides tools for (or delivers content to tools for) integrating the disparate information that is retrieved, not just displaying it side by side.

Portals are therefore being envisioned as nothing less than the universal interface to all existing useful information systems. As such, we must beware the false promise that this utopian vision offers. First, if the goal of an EIP is to provide a relatively simple, universal interface to a wide variety of applications, then it cannot be appropriate for all circumstances. At a certain point it does make sense for a user to switch to the native

interface of an application, considering that that interface was designed to provide access to all of that package's functionality. Otherwise using a portal may engender a "dumbing down" of the functions the knowledge workers use, serving as a bandage that obscures the absence of training and learning.

ACCESS TO NATIVE APPLICATIONS, EXTERNAL INFORMATION
Retrieval & manipulation of existing structured & unstructured content, often as static pages
New content captured by native applications (e.g. data entry)
Connection to the data warehouse
Search engines and access to knowledge metadata

FUNCTIONALITY AT PORTAL LEVEL
Ability to personalize
New content captured by portal (e.g. message boards)
Ability of portal to perform aggregation & processing, i.e. create content derived from existing content
Ability of user to direct (ad hoc) manipulation & aggregation of retrieved content, e.g. to create higher-order data structures linking various forms of content for later retrieval as a unit
Use of "intelligent tools" within the portal
Important messages (for quick distribution of knowledge)
Collaboration tools

DESKTOP TOOLS AND AIDS FOR EASE OF USE:
Connection to all existing applications (word processing, spreadsheets, …)
Customizable bookmarks and folders
Dynamic and customizable links and icons
Connection to all user defined short-cuts
Access to training tools, help, FAQs, etc.

CULTURE, ADMINISTRATION, TECHNICAL CAPABILITY
Recognition (for those who contribute to the knowledge)
Administration (for those that manage the metadata, submit artifacts)
Scalability & extensibility

Figure 1: Dimensions of EIP Functionality (based partially on Seiner, 2001)

Second, ease of use does not necessarily mean better results. Internet users are familiar with commercial portals such as Yahoo!, AOL, and MSN: as many as 98% of Internet users have visited them. They are increasingly being viewed as places to go and get work (or play) done rather than as places from which to go elsewhere (Pastore, 2001). So companies may be right to think that the portal model will be easy for users to learn. But firms may be surprised to find that access to information on the portal does not in itself guarantee changes in the way that people perform actual business processes.

Finally, it is not inconceivable that a portal will become a way of lengthening the life of legacy systems that may embed obsolete business rules and should be retired. Thus, firms should not become too enamored by the promise of a universal interface and ease of use, but should start by examining more concrete ways in which an EIP adds value.

3. Strategic Advantages of Portals

Venkatraman (1997) has created a framework for understanding the strategic impact of IT that is useful for categorizing potential EIP benefits (Fig. 2).

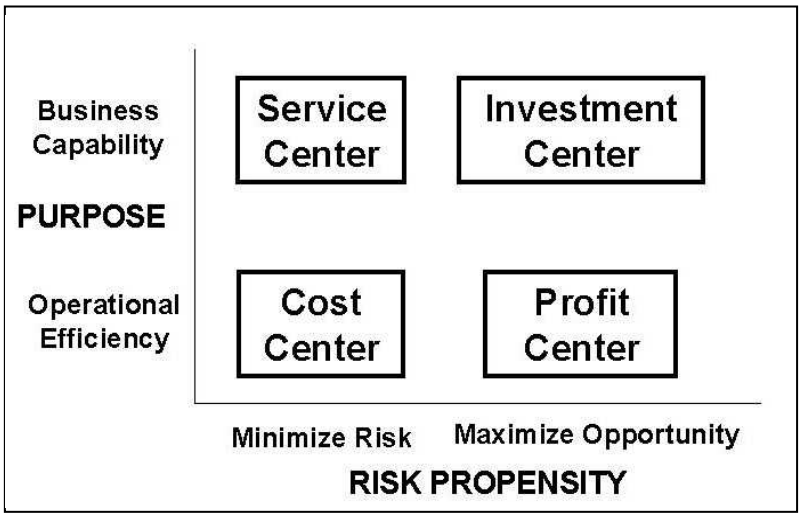

Figure 2: IT as a Value Center (Venkatraman, 1997).

A cost center orientation focuses on delivering IT products and services at the lowest cost (like a utility), "managing scale and scope for operational efficiency." It uses metrics such as cost or computer throughput, and parts of this IT infrastructure may be outsourced. A service center orientation "delivers IT-enabled business capabilities to support current business strategy," focusing on how technology and this strategy are aligned. Metrics include client satisfaction and internal service guarantee levels. Both emphasize minimizing risk, because they support current strategies, and distinguishing where operational efficiency leaves off and business capability begins can be difficult. An investment center focus tries to "proactively create IT-enabled business capabilities that shape new business strategies, identifying and nurturing a portfolio of technology-enabled new business capabilities." Metrics try to capture the benefits of new capability creation. Finally, a profit center orientation tires to "deliver IT products and services in the external market to realize marketplace knowledge, credibility, and additional profits." Products and services that survive this external test are likely to be best for the firm itself (Venkatraman, 1997, 58).

Plumtree (2001b) has provided a set of nine case studies of leading users that outlines how they are using the portal and what strategic advantages they purport to receive from it. Although not a representative sample, it is revealing that even in a group selected to

showcase the portal, of 41 applications and uses, 54% were for retrieving static text, 11% for retrieving aggregated information, and 19% for interactive data management. Only 14% involved collaboration. Less than half of the firms made use of personalization. Furthermore, 22% of the applications were unambiguously of the cost center type, 43% were in the service center category, and another 8% were either cost or service. Thus three-quarters of the applications in this select group of examples had to do with the "minimizing risk" side of IT use, i.e. supporting existing strategic goals better.

Plumtree company representatives might not agree with these categorizations. For example, they list one advantage as "speeds products to market, reducing time spent searching for information." Here the objective occurrence is reducing time spent for searching. Whether or not that speeds products to market remains to be seen, and one could argue that even this is just better execution of existing strategy. "Connecting manufacturers, vendors and end-users" may or may not speed products to market. In my opinion, using the Venkatraman framework to characterize the actual applications of the portal is a better way to understand their potential strategic impact than making claims such as those in the Plumtree literature.

4. The EIP Project at EnerCO

EnerCO is a large U.S utility that serves over four million customers and has revenues of over $12 billion. Having recently been through more than one large merger, EnerCO may continue to acquire other utilities and other, related businesses in the relatively near future.

The E-Business group (EBG) at EnerCO was started in late 1999. In the ensuing 17 months, the team grew to five, with some other personnel in the traditional IT group also allocated to e-business. The EBG found sponsorship under the Vice President of Business Ventures and Planning, one level below the CEO, and outside the mainstream IT organization. Meanwhile, IT costs were skyrocketing and the most recent merger exacerbated the problem. One organization had 500 IT personnel, and was quite decentralized; all of the business units had almost complete discretion about what they spent on IT. The other organization had a more centralized IT function with just 200 IT personnel. IT spending was "way out of whack," as the EBG director so aptly put it. A strong culture of "build" rather than "buy" prevented one IT group from even considering some outside solutions, and when the EIP project was initiated, it had already begun creating in-house intranet interfaces. One organization used Oracle ERP modules, while another used SAP. Hardware and software of various vintages were mismatched, with diffuse layers of IT architecture. Both organizations used Lotus Notes (one having 22,000 separate databases), but many other applications were different.

The EBG director had concluded that an EIP was needed to deliver access to all of these disparate applications, especially until deeper application integration took place in the post-merger period. Unlike some firms that had done extensive development of overall interfaces to company intranets, EnerCO's intranet was configured in such a way that it was very hard to find any particular applications. Interfaces to information on employee benefits, for example, were there, but the only way to find them was if you knew in advance which URLs to use. Overall search tools did not exist. Employee HR functions became an early

focus of the EIP project (Fig. 3). And finding the right person to help with a problem could be a major chore. In one case, it took an EnerCO employee a half-day using his laptop from a remote site to find the needed information, something that could have been done in seconds using a portal and a high-speed wireless connection. The company telephone book was added to the EIP.

COST CENTER
Employee Data: Employee updating own demographic data; eliminates handoffs between HR and employee
Document Webification: HR hourly timekeeping and management procedures distributed via the Web

SERVICE CENTER
Compensation Planning: Compensation planning by managers via the web; reduces process cycle time and increases security
Recruiting: Web-based application, workflow assessment, and candidate scheduling; reduces time to fill positions and administrative work, increases candidate satisfaction, and improves data quality

Figure 3: EnerCO Pluses for HR Employee Self-Service.

The EIP project did not start off with a strategy meeting among the highest level EnerCO executives. Rather, a Business Intelligence unit had purchased a number of licenses to use the Plumtree portal to crawl the web, gathering information about competitors. Just as their project was about to be terminated, the EBG director took over the existing licenses, re-envisioned its use an EIP, and purchased more licenses. He found a high-level corporate executive who wanted to use it to send out his traditional "message of the day". Not an avid computer user, this sponsor was delighted with its ease of use, and greatly facilitated its initial acceptance.

The EBG director also found an environmental group that would serve as an initial pilot project. It had taken 600 person-hours and $60,000 to build a database to support due-diligence searches and compliance with regulations, but users found that accessing it was a significant barrier to using it. Within a period of about three weeks the bridge software was created to link the Plumtree to the database, and a test got underway within the group. The initial reaction was quite positive.

Another compelling example was that out of hundreds of potential users for Seibel's customer relationship management software, less than 10% had yet been fully trained. It was hoped that the Plumtree portal's ability to deliver just the needed functionality could eliminate most of the training costs for the others, converting them to productive users.

Armed with these initial "wins," the EBG director next had to win approval of Plumtree as the corporate standard. The EBG used a combination phased and pilot rollout in which they started with whatever select set of internal customers would buy into it, rolling out to them increasing numbers of features, so any pro-portal constituency within top management was at best fragmented. After the merger SAP was chosen as the central enterprise system, so a

rationale had to be found to keep Plumtree rather than using SAP's own portal. Essentially speaking, four months after the EBG director decided to aggressively push the EIP, senior executives were only beginning to consider the strategic role that the EIP might play in the firm.

When it came time to justify the portal, it was necessary to provide some kind of quantitative benefits. Fig. 4 represents the initial cut taken by EnerCO, in which 11 areas of potential quantifiable savings were found. For (1), for example, EnerCO estimated that if just five minutes per system could be saved, and that a typical user accessed six systems per day, then a "most likely" estimate of how much could be saved in terms of the cost of those employee minutes would be on the order of $10M per year. A counter argument can be made, of course, that if use is easier and more profitable, use may increase. The same or a greater amount of time will be spent accessing information, but the information accessed will be more timely and better focused on the task at hand. Presumably this would lead to better decisions, but whether it is $10M dollars worth of better decisions is debatable.

COST CENTER (User)

1. Reduced Costs of Extracting/Disseminating Information
2. Estimated Average Time Savings to Sign-on with Single Sign-on
3. Reduced costs for user interface training
4. Reduced costs for Help Desk support

COST CENTER (IT)

5. Reduced costs for personalization of Web portals
6. Elimination of in-house development costs
7. Elimination of maintenance of in-house developed sites
8. Reduced estimated annual costs for PC upgrades and maintenance
9. Reduced costs by standardizing the User Interfaces to one system
10. Abandonment of legacy systems & write-offs to expense
11. Eliminating costs to modify/retrofit existing systems to communicate with other systems

Figure 4: EnerCO Quantifiable Benefits from Using EIP.

5. Conclusions

Ultimately the portal was approved as the EnerCO standard. Part of the rationale was that it could better access the full range of systems within EnerCO than MySAP. But this victory of the e-business group leaves many questions unanswered. While the EBG director himself bought into the idea that the EIP could have a transformative effect on business strategy, the initial applications selected for it all seemed to fit into the cost center and service center

quadrants (Fig. 3 and 4). They were much more oriented towards supporting current operations and minimizing risk, than towards maximizing opportunities. The EIP's ability to reduce IT costs in the face of the merger was particularly attractive. EnerCO was only making use of a fraction of the dimensions of EIP functionality listed in Figure 1, and the emphasis was on the benefits of ease of use and the universal interface, rather than on its use a knowledge management system. Plans to allow external customers access through the EIP to selected teams for information sharing and collaboration (which could be an investment center type application) seemed far off, especially considering security objections from the mainline IT group. And without having the direct ear of the most senior executives, it seemed unlikely, at least in the short term, that the EIP would be folded into key strategic plans for new business ventures.

The EIP rollout at EnerCO is not at all unique. Once again the software industry has promised a system that will finally unlock all the riches that are buried in information systems, providing numerous strategic advantages. Firms pay lip service to these goals, but as a practical matter, saving money is at the top of the agenda. Users continually run up against the all-too-typical barrier that true transformation requires widespread revision of business processes, which comes from organizational learning and appropriate software tools. Strategic transformation does not start from the bottom up through the implementation of a software package, but comes about when senior management works in conjunction with IT to develop a clear vision of how IT can support and transform strategy (Luftman & Brier, 1999). EIPs will provide concrete benefits to firms who wish to reduce costs and support existing strategies, but will not be a means for obtaining lasting strategic advantages unless explicitly incorporated into such visions.

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e-Commerce Intelligent Support with GIFT Technology

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Abstract

The paper presents the GIFT (Graph Inference Functions and Tools) technology of creation and support of special GIFT-objects, which use expert knowledge involved into the domain data processing. Practical application of GIFT technology is illustrated by implementation of solutions connected with sellers' intellectual support within the marketplace of e-Commerce portal.

Keywords: e-Commerce Portal, Intellectual support, GIFT-object, GIFT technology, Graph Inference

1. Introduction

One of the main problems, which face developers of e-Commerce portals today, is the problem of design, implementation and support of users business-processes. At that, solutions of the tasks arising require not only knowledge of IT-specialists but of highly qualified domain experts, who are often in shortage. It appears to be even more difficult with the brain "drain", which happens when those experts leave the company taking their expertise away from it. That is why the explicit representation of these knowledge and expertise in computer databases is the key to successful solving of business-processes intellectual support problems.

Unfortunately, nowadays all the methods and means of knowledge extraction, representation and processing in data bases are considered within the framework of AI problems, and e-Commerce systems normally apply "traditional" technologies, as a rule, where expert knowledge is put into programs and is not available for analysis, correction and reuse without reprogramming. The GIFT technology proposed in the paper is based on the micro-expert approach (Baron et al., 1999) and allows solving these problems by concentration of explicitly represented expert knowledge in easily built-in GIFT-objects. It is extremely important that, practically, a programmer is excluded from the chain of business processes specification by means of special instrumental tools, oriented at domain expert.

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2. Specification of Business Processes with GIFT Technology

2.1. GIFT Technology: Preliminary Remarks

The main idea of the GIFT technology is based on the concept, which draws an analogy with the modes of thought applicable by a human – first, the task is solved within the frame of insular, but combined terms, whereupon more detailed data and conclusions are attached. They decode, but do not cancel the logic of the higher levels of thought.

The technology is based on GIFT-objects hierarchy. Hierarchical levels reflect the levels of thought. Each level is represented by a set of GIFT-objects, which model the logic of experts. At that, the core of the whole technology is represented by the GIFT-object, which contains expert knowledge.

Structurally, the GIFT-object consists of information and situation spaces. Information space represents a set of variables and methods of giving values to these variables. Values are given to variables in the process of initialization or in the course of object functioning. In contrast to the information space, the situation space has more complicated structure and is represented by a graph.

The nodes of the graph contain rules with the right side always representing the name of a node (the shift to the specified node is semantically meant in case the left side is true). In addition, within the node it is possible to identify variables and specify the value, which is to be given to variables while shifting focus to this node of the graph. Finally, the third component of the node may be represented by some attached procedure, which is performed while shifting to the node. Links in the flow graph determine any possible shifts from the node. The architecture of GIFT-objects is shown on Fig. 1.

2.2. GIFT-Objects Hierarchy and Types of Initialization

Thus, each GIFT-object specifies a semantic network of a special type. At that, simple behavior is determined by dynamic trace in such network. The more complicated behavior may be modeled by means of hierarchical set of GIFT-objects. Such hierarchy is formed in the nodes of the rules situation space, using indefinite variables.

In case a variable from the left side of the rule is not given a value and does not belong to the current information space, the procedure of value determination for that variable is started. It contains two stages. The first stage includes creation of the list of GIFT information spaces, which may contain this variable. At the second stage each information space is examined to define whether that variable is the target one. If the requirement is met that GIFT-object starts functioning. While making logical inference it may be required to start the procedure of an indefinite variable computation again, etc. Hence, to create hierarchy it is enough to use the name of variable in the right part of the rule, which is not determined in the information space of the GIFT-object, and then to design the GIFT-object with such target variable. Fig. 2 illustrates the process of hierarchical start of the coherent GIFT-objects set.

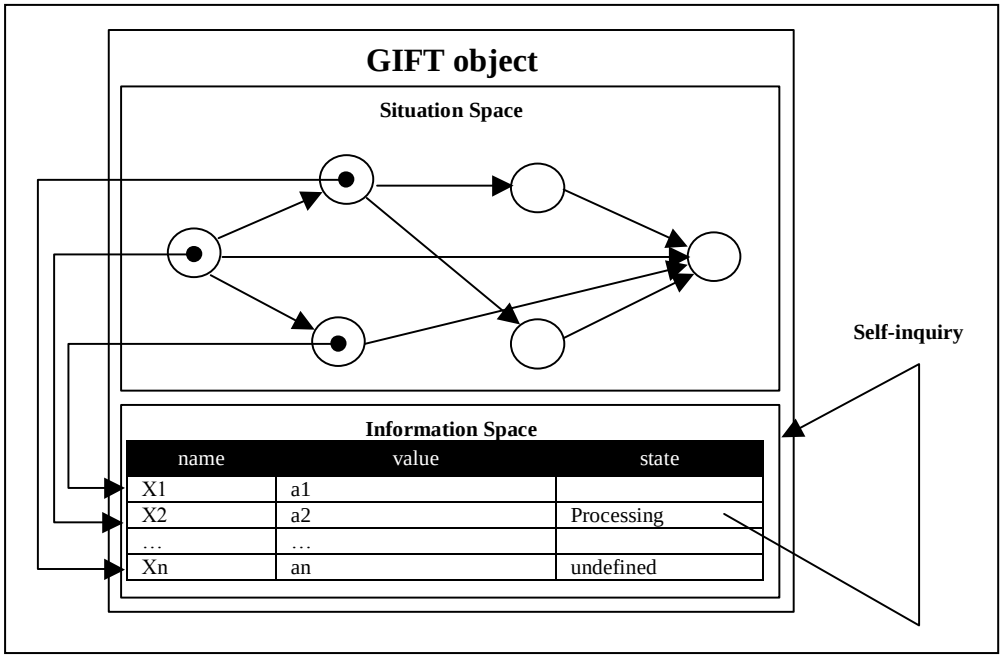

Figure 1: GIFT-object architecture.

Considering the aforesaid, one of the most essential phases of GIFT-objects functioning is the initialization stage. At that, GIFT-object initialization implies initialization of its information space, i.e. identification of variables set included into the information space. Values of the initialized variables may be obtained from various sources of information and through diverse methods.

By the time of preparing this article, two types of GIFT-object initialization have been implemented. While performing the first type of initialization the source of information is represented by information space of another GIFT-object. In case the initialized information space contains a variable with the name, which is identical to the name of a variable from the data source, it gets the same value.

The second type of initialization is less specialized, but more complicated. It implies preliminary creation of the initializing file and implementation of initialization methods. The structure of the initializing file is quite simple. Section DataSource contains a variety of key-value pairs. The key is represented by the name of the data source, and the name of the library, which contains initialization method and its name, represents the value of the key.

Example:

```
[DataSource]
Variables space=inivar.dll,init
Map=inisin.dll,init
User=iniuser.dll,init
```

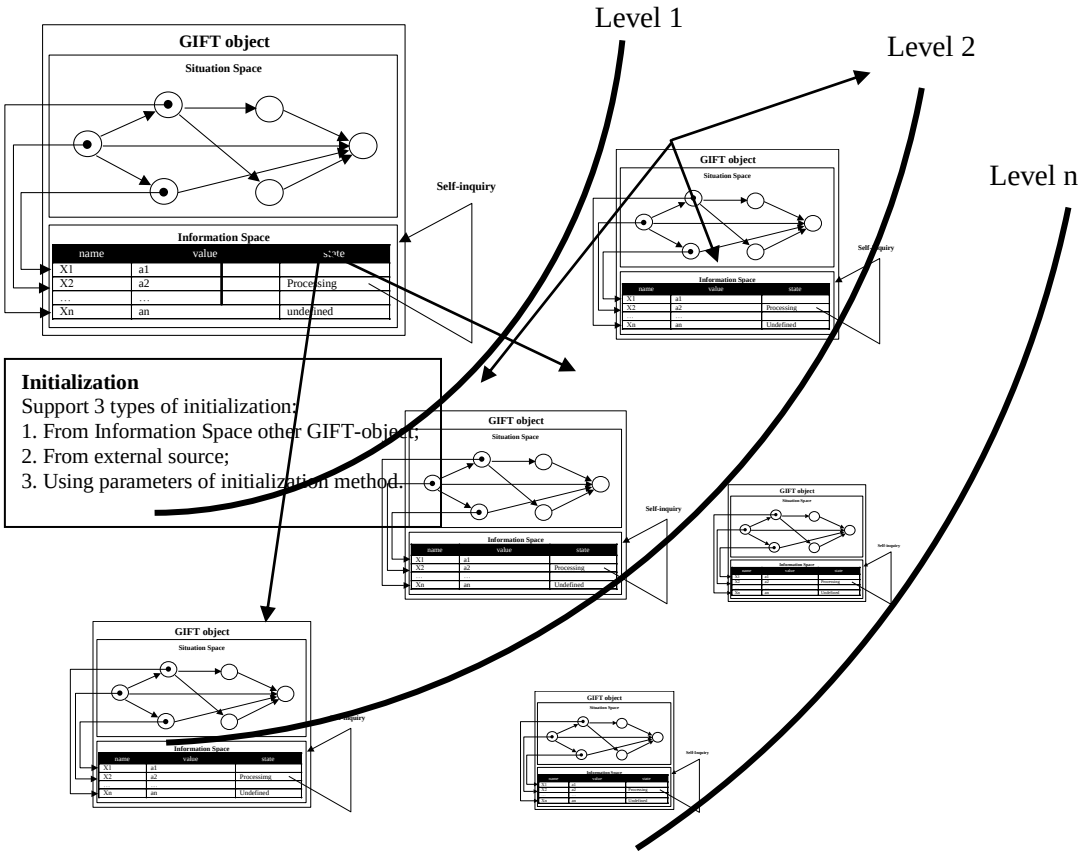

Figure 2. The process of hierarchical start of the set of coherent GIFT-objects.

In the example given a user is offered three possible data sources to initialize: information space of variables, map and user. Each method corresponds to its library `inivar`, `inisin`, `iniuser`. The name of the method "init" is always the same. After choosing certain initialization type, the corresponding dynamically loading library is launched and the specified initialization method is generated.

The task of initialization may be solved by means of the specialized GIFT-object, which is oriented at the task. The situation space of such GIFT-object contains explicitly represented knowledge of initialization types and procedures attached enabling specified initialization methods.

To describe initialization methods, supported by this GIFT-object, the standardized object "tree" containing wide range of navigation and modification methods is utilized.

The GIFT-object, created and integrated into any environment, represents a module, which enables logical situation analysis corresponding to its internal structure.

3. Instrumental Component of GIFT Technology.

In order to create and adjust GIFT-object, special instrumental shell has been developed and implemented. By means of the shell user is able to configure both information and situation space of the GIFT-object. The main procedures in the context of situation space are creation, deletion and modification of nodes and links, while in the context of information space – creation, deletion and change of variables.

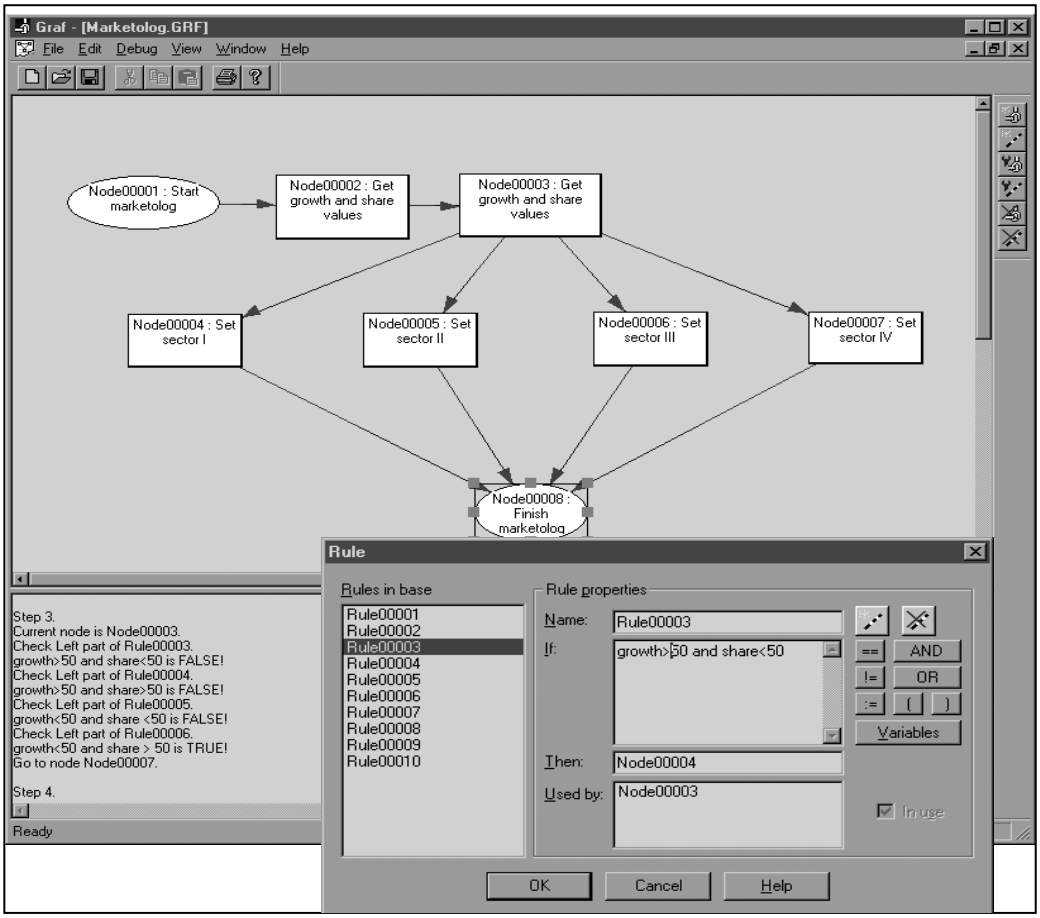

Figure 3. GIFT "SWOT-analysis" situation space.

The shell allows one to adjust created GIFT-object in the step-by-step mode. Results of the rules application at this stage are represented in a special window, located at the bottom part of the shell's main window. Fig. 3 illustrates the shell's main window with the GIFT-object loaded, implementing logical selection of the recommendation type while conducting SWOT analysis.

4. Example of the GIFT Technology Application.

Implementation of Intelligent Support Seller-Buyer Marketing (IS/SBM) system within the framework of Axwell portal, delivering services in the field of e-Commerce, is based on the GIFT technology application.

The GIFT-object created with GIFT technology is built in those parts of the IS/SBM system where logical inference, modeling the process of expert mode of thought, is required.

Release 1.0 introduces marketing analysis enabling current business situation assessment and forecast as well as estimation of entrepreneur's product portfolio efficiency on the basis of SWOT analysis (analysis of Strengths, Weaknesses, Opportunities and Threats). First of all, this method allows determining weak and strong points of one's business or certain products, and second, it allows estimating all possible opportunities and difficulties that may be faced during developing. While conducting traditional SWOT analysis user has to choose which factors to estimate, and the way it should be done. We propose a unique approach: all the factors that are the most important for entrepreneurs are identified beforehand.

Besides, all weak and strong points of business or product as well as opportunities and threats are given certain quantitative value. For this purpose two different tables are introduced: the indices of product attractiveness and product competitiveness. A user is asked to give a certain value to each factor depending on the degree of its success. The quantitative assessment allows one to fasten conducting analysis, as well as apply the results of SWOT analysis in solving other tasks. The data obtained from a user are processed by GIFT-object and are used to model "product attractiveness – product competitiveness" matrix. This matrix specifies four semantically significant fields of values. Depending on which field the product examined belongs to, the GIFT-object defines the place occupied by this product in users portfolio, providing expert recommendations and forecasts.

Fig. 3 illustrates the situation space of the GIFT-object. This GIFT-object calculates "growth" and "share" integral indices, and using the primitive rules like those in Fig. 4.

5. Conclusion

This paper introduces GIFT technology, developed by Scientific Technological Center "Progress-Informatics", Ltd within the framework of Intelligent Shell creation for e-Commerce portals. Experience gained from application of GIFT technology and aimed at the provision of intellectual support to sellers operating within the framework of e-Commerce portal, has proved efficiency of the proposed approach and opportunities to apply this approach for the explicit representation and processing of domain experts knowledge in the field of e-Commerce.

```
If growth>=50 and share>=50 then Node00004:Set sector I;
If growth>=50 and share<50 then Node00005:Set sector II;
If growth<50 and share<=50 then Node00006:Set sector III;
If growth<50 and share>50 then Node00007:Set sector IV;
represents recommendations and forecasts in XML.

<recommendation>
      <sector>1</sector>
      <text>
            <tip>
                  <header>Hot advice</header>
                  <text>
                  Invest in these products to increase or
maintain market share
                  </text>
            </tip>
            <position>
                  <header>Product rank in the portfolio</header>
                  <text>Products of the category analyzed are
placed in sector I of the matrix. These products, on the whole,
gain high competitiveness and market attractiveness. If products
within this category have a stable rising tendency in sales and
one may expect future demand growth as well, then these products
are very promising.
                  </text>
            </position>
            <todo>
                  <header>What should be undertaken (short-
run)</header>
……
      </text>
```

Figure 4: An example of Primitive rules.

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Intelligent Shell of Portal: The Lessons of Development and Implementation

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Abstract

Overall trends in e-Business today are connected with creation of e-commerce portals. The aim of the paper is to share the authors' experience gained during the development and implementation of advanced portal, where intellectual support to individual business-processes is represented. The concept, technology and ways of implementation of e-commerce portals are proposed within the framework of a new approach – Intelligent Shell of Portal.

Keywords: e-Commerce Portal, Intelligent Shell, Enterprise Knowledge Warehousing, Data Mining, Text Mining, OLAP.

1. Introduction

Overall trends in e-Business today are connected with creation of e-commerce portals. To date many e-commerce portals have already been developed and in operation. The main task of such portals is to deliver all the business processes support. At the moment this task solution is gained by development and implementation of balanced mix of business functionalities over appropriate Data Warehousing, using modern XML-standards of the information representation, modern Web-oriented interfaces along with Web-integration of all the components mentioned above. It seems to be the right point on the one hand, but on the other, innovations in this area imply involvement into e-commerce a set of methods and tools for knowledge representation and processing developed in AI community. Thus, the goal of this paper is to represent this kind of approach to e-commerce portals development and implementation.

The presentation is organized as follows: A brief overview of e-commerce domains' state of art is represented in the "E-Commerce Intelligent Systems – State of Art" section. Then the

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concept of e-business portal and its intelligent shell is introduced with their further consideration. The next section represents the intelligent shell architecture and components already implemented within the e-business portal. And the last section sums up the lessons of portal intelligent shell development and implementation.

2. E-Commerce Intelligent Systems – State of Art

Plenty of information on e-Commerce technologies and products is represented in publications (EC-00, 2000) and in the Internet (http://www.webopedia.com/) nowadays. The most famous within the community are such companies as Forrester (leading independent research firm that delivers analysis of the future of technology change and its impact on businesses, consumers and society (http://www.forrester.com/)), Morgan Stanley (the leader in financial services industry (http://www.morganstanley.com/)), Commerce One (company that revolutionized trade by building global e-marketplaces – Internet destinations that bring diverse companies together to conduct electronic commerce on a secure business platform (http://www.commerceone.com/)), etc.

In comparison to the companies mentioned above there are not so many firms and organizations that are positioned in the field of intelligent technologies and systems for e-Commerce. There are many companies operating in "traditional" e-Business sphere, and some of them "migrate" to the field of business-processes intellectual support. One of such enterprises is Ozro, Inc. (http://www.tradeaccess.com/). According to its mission, Ozro, Inc. develops technology and software products to facilitate negotiation between people and organizations, prompting, capturing and synchronizing communications and data, and producing supporting documentation. Another example is Brio Technology (http://www.brio.com/), business intelligence software provider which offers a complete, integrated intelligence infrastructure that addresses decision-making needs of contemporary e-enabled B2B world by delivering dynamic, reliable, easy access to real-time business information. Impressive results are received by I2 Technologies (http://www.i2.com/) which provides suite of value chain solutions, designed to optimize each phase of the supply chain to transform the way companies do business by means of Supplier Relationship Management (SRM), Supply Chain Management (SCM), and Customer Relationship Management (CRM), supported by the i2 TradeMatrix Platform™. The new generation of value chain management solutions is also introduced by Ariba (http://www.ariba.com/). Its Value Chain Management (VCM) solutions are the key to collaborative commerce and private marketplaces. Ariba VCM solutions optimize, automate, and integrate most strategic value chain processes including product development, sourcing, direct and indirect procurement, manufacturing operations, and sales and fulfillment.

Several developers in the field of Intelligent Information Gathering and Processing can be outlined. For instance, RuleSpace, Inc. (http://www.rulespace.com/) – the company that provides instant web content recognition services for Internet applications. These features are supported by Contexion™ (the key RuleSpace's product). Some other representatives operating in the field are the following: Cognos, Inc. (http://www.cognos.com/), which creates a unified information infrastructure enabling insightful analysis, reporting, and high-

level visualization available to key decision-makers, both inside and outside organization; Intelliseek, Inc. (http://www.intelliseek.com/), which is a provider of Intelligent Applications for knowledge discovery and consumer and corporate intelligence, offering timely market research, competitive intelligence and distributed searching and tracking to enterprises and individual researchers.

It may sound strange but the application of full-scale intelligent systems from the field of Artificial Intelligence (AI) into e-Commerce is at its initial point (IAWTIC, 2001). To date the main results have been obtained in data mining and knowledge discovery (KDD, 2000), in applications of ontologies with information retrieval systems (WS ECAI, 2000) and in some other hot topics (WECWIS, 2000). On the other hand, attempts of W3C (World Wide Web Consortium) in developing and applying modern XML-based technologies (Lassila, et al., 1999) fix the explicit trend to transform Internet into semantic Web. The same goals are set within AI community as well (Benjamins et al., 1998; Khoroshevsky, 1998).

The brief overview of information resources in e-commerce domain represented above shows that nowadays all required basic technologies and solutions for the implementation of full-scale "traditional" e-commerce systems do exist. There are many e-commerce software products from all over the world, and B2C and B2B models have already been widely applied. The main problems, which arise in this area, are the following: shifting from probably powerful but split solutions to the integrate e-commerce systems supporting full business life cycle; standardization of information representation circulating within the Internet and Intranet and transformation of existing Web into semantic space for support of knowledge-based problem solving.

E-Commerce pace and way of development in Russia has its own peculiarities. There are several Russian companies in the sphere of e-commerce nowadays (http://www.it.ru/; http://www.tops.ru/; http://www.actis.ru/; http://www.gorod.ru/). But it seems that e-commerce itself is not the only business for these companies. Most of them start as Web-design companies and/or system integrators, pass through B2C "stage" and operate now in B2B domain. It also seems that the gap between Russian companies specialized in corporate management systems and e-commerce systems development does exist now. Another feature of Russian IT-companies is the use of (mainly) western e-commerce solutions and products and further distribution among Russian consumers. Russian IT-companies follow traditional models and solutions in e-commerce and do not apply knowledge-based approach. The only exception is an intelligent adviser “GURU” working within the Yandex portal (http://www.guru.yandex.ru/), which is good in design, but at the same time has poor knowledge base and weak inference engine based on decision trees techniques. Meanwhile, technical personnel of Russian IT-companies are highly qualified, well educated and able to develop their own innovative systems in e-commerce domain.

3. The Concept of Portal Intelligent Shell

The overall trend in E-business today is creation of e-commerce portals, where intellectual support to individual business-processes is represented. As a matter of fact the following requirements currently set by E-business to intellectual systems are fulfilled: conversion

data into knowledge even if the source data are insufficient, incorrect, distorted or controversial; dynamics of vision of current situation; scenarios of situation progress depending on decisions taken; providing optimal recommendations on the best options; estimations of risks and opportunities of certain decisions; prompt and adequate reaction of the system; favorable and functionally sufficient business environment.

Scientific Technological Center "Progress-Informatics" (http://www.progressinfo.ru) strategy of e-business portal development is based on "3Cs+3Is" model which enables user to employ portal capacities to the full extent, providing opportunity to apply the latest innovations in the field of Artificial Intelligence theory to his/her business.

In this way the key formula of success is following:

$$\text{E-business} = 3\text{Cs} + 3\text{Is},$$

where 3Cs = Commerce + Content + Connection; 3Is = Intelligent Information Gathering + Intelligent Information Processing + Intelligent Communication.

The notion of Commerce implies provision of e-business platforms that enable user to realize and manage all e-commerce activities thus effectively creating and meeting market demand. Commerce concept bolsters users' business development by facilitating interaction both within portal and outer business community. Content concept enables users to have opportunity to design and manage content with up-to-date information concerning market, products, prices, contract details, and other parameters that impact e-commerce interaction. Portal considers Content solutions scheme as an important function that widens the spectrum of its capabilities. Connection solutions provide clients with user-friendly tools which enable them to become a member of portal community and thus participate in online business interaction.

Intelligent Information Gathering is based on the use of models, methods and instruments worked out in the field of Artificial Intelligence for retrieval of information relevant for a specific business in the Internet and Intranet; knowledge accumulation aimed at development of adequate integrated business models and provision of obtained knowledge within the framework of balanced system of interrelated knowledge bases. Intelligent Information Processing implies business processes support based on knowledge and expertise, realized in terms of balanced universal mix of specialized Expert Systems (ES) and specialized Online Analytical Processing program packages (OLAP). Intelligent Communication implies user-friendly interaction with all software components as a result of virtual space infrastructure development; personally customized interface; natural language software application and cognitive graphics application.

3Is are unique Intelligent solutions for e-business of the next generation since particularly this balanced combination of Intelligent Information Gathering, Intelligent Information Processing and Intelligent Communication forms Portal Intelligent Shell, which in turn serves as a natural basis for development of customized virtual offices of the third millennium, where the strategy of overwhelming intellectual support of all the business processes of the enterprise is perfectly realized.

Project and technical solutions serving as platform for Intelligent Shell are based on the following concepts:

- Knowledge-based applied hybrid systems that provide
  - Real business processes intellectual support,
  - Employment of the whole spectrum of successfully applied analytical algorithms;
- Open systems, which gives opportunities of
  - Scaling,
  - Use of existing solutions;
- Agent-oriented implementation, ensuring:
  - Intellectual delegation of responsibilities,
  - Vertical and horizontal specialization,
  - Cyberspace collaboration.

Why Intellectual Applied Systems? Because knowledge, often not formalized as a number of algorithms but existing in the minds of experts, makes it possible to select relevant solutions for emerging tasks, use right analytical procedures in the right place and in the right moment. Hybrid Expert System concept developed in the field of Artificial Intelligence and approved as a result of longstanding field research in business and production suits the requirements to the full extend.

Why open systems? Because this very concept provides natural scaling of solutions as far as user's business grows. Because this very concept supports implementations independent of processing platforms used in user's virtual office. Because this very concept allows to organize unique customized virtual office in the international cyber space.

Why agent-oriented implementation? Because this very new era paradigm of complicated distributed systems implementation enables formation and application of the community of intellectual program agents, that are capable of developing tasks solutions concerning users' business processes. Because these very specialized autonomous agents are able to react adequately to the changes in current situation and are able to work out correct solutions within the limits of the authority granted to them. Because these very agent technologies enable users to actualise cyberspace for their business.

The key point of the concept is the Enterprise Knowledge Warehousing, which is a new technology providing intelligent support to all business-processes within the portal. Enterprise Knowledge Warehousing is based on the following modern technologies that may serve as the platform for development and implementation of Intelligent Shell:

- Enterprise Data Warehousing;
- Data mining and text mining based on natural language processing;
- Direct and Indirect Knowledge Acquisition;

- Knowledge structuring guided by interrelated ontologies of objectives and tasks, methods and tools;
- Hybrid expert systems for business processes support;
- Online Analytical Processing (OLAP) of multi-dimensional data realized through Enterprise Data Warehousing and controlled by continuously replenished knowledge;
- Other perspective information technologies along with Artificial Intelligence technologies, which have already brought significant benefits.

4. Intelligent Shell Architecture

As it was mentioned above, portal Intelligence is determined by the system of coherent knowledge bases and their means of processing. This approach requires explicit presence of a special tool kernel within the framework of the portal. Its functionality should be aimed not at applied tasks solutions but at formation of knowledge bases, which are necessary for business processes support, as well as at implementation of the knowledge processing methods. This kernel forms Intelligent Shell.

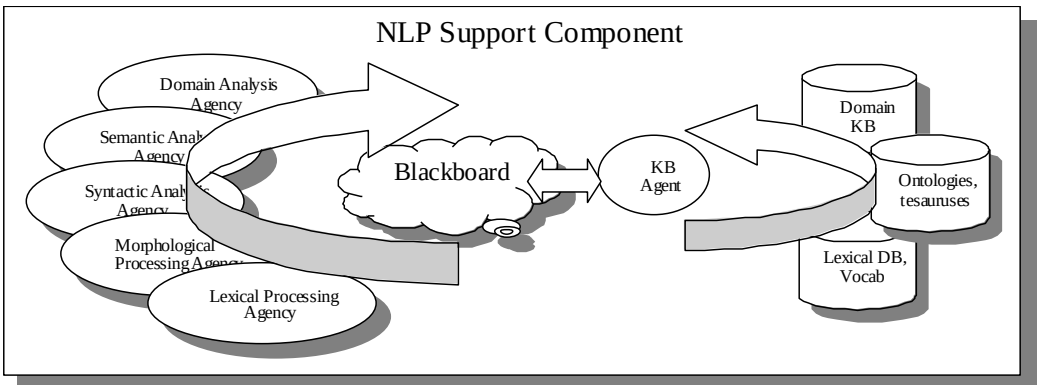

Figure 1: NLP Support component.

There are several layers of Intelligent Shell: System layer, Components-oriented layer, Task-oriented layer. The System layer is represented by:

- Basic means of distributed intellectual applications development and implementation, based on multi-agent paradigm;
- The tool means of knowledge bases formation and support, as well as the toolkit for development and implementation of data and knowledge management means;
- Declarative (data and knowledge bases), and procedural (data and knowledge access tools as well as knowledge-based decision inference) components of intelligent systems.

The Component-oriented layer implies individual program components:

- Natural language processing (Fig. 1);

- Expert systems and intelligent decision support systems (Fig. 2);
- Intelligent software packages (Fig. 3).

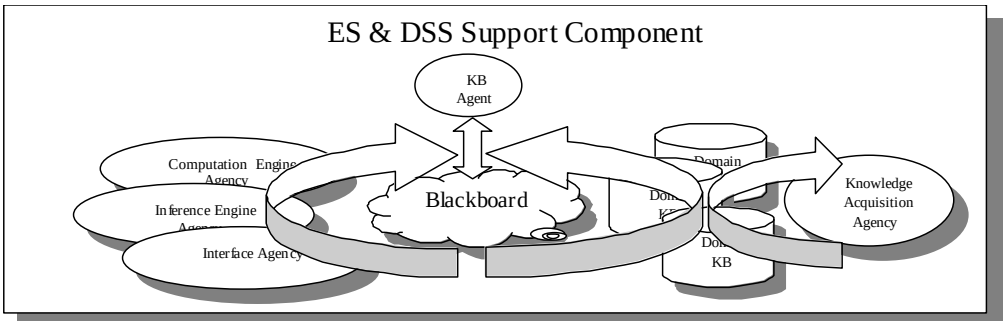

Figure 2: ES & DSS Support Component.

Task-oriented layer which is oriented at the Intelligent Shell functionality implementation. Intelligent Shell concept basing on Enterprise Knowledge Warehousing paradigm is a novelty. Its implementation is based on the Artificial Intelligence theory and cutting-edge information technologies, methods and tools of design and implementation of the intelligent software, which can be used within the Internet environment.

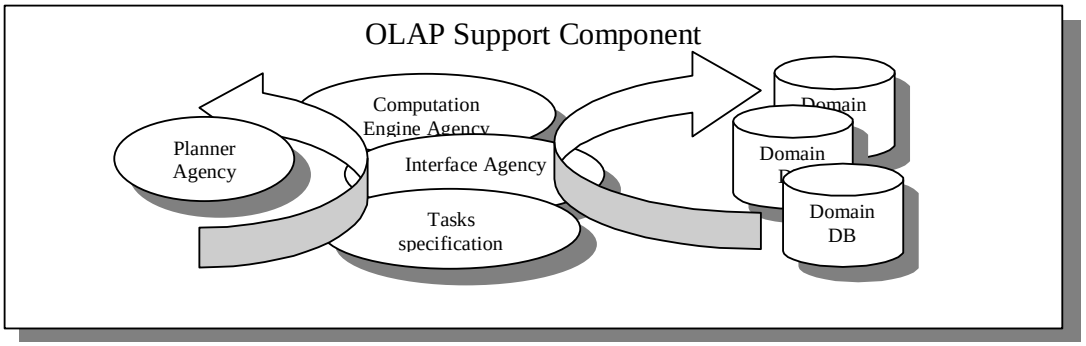

Figure 3: OLAP Support Component.

By the time of preparing this paper, intelligent solutions have been partially implemented in Axwell e-Commerce Portal (http://www.axwell.com). Axwell offers wide spectrum of decision support solutions including data access, data mining, data visualization and expert qualitative analysis (see, Fig. 4). The results achieved can be integrated into sellers decision-making process, which makes all the functionality applicable and customer-oriented.

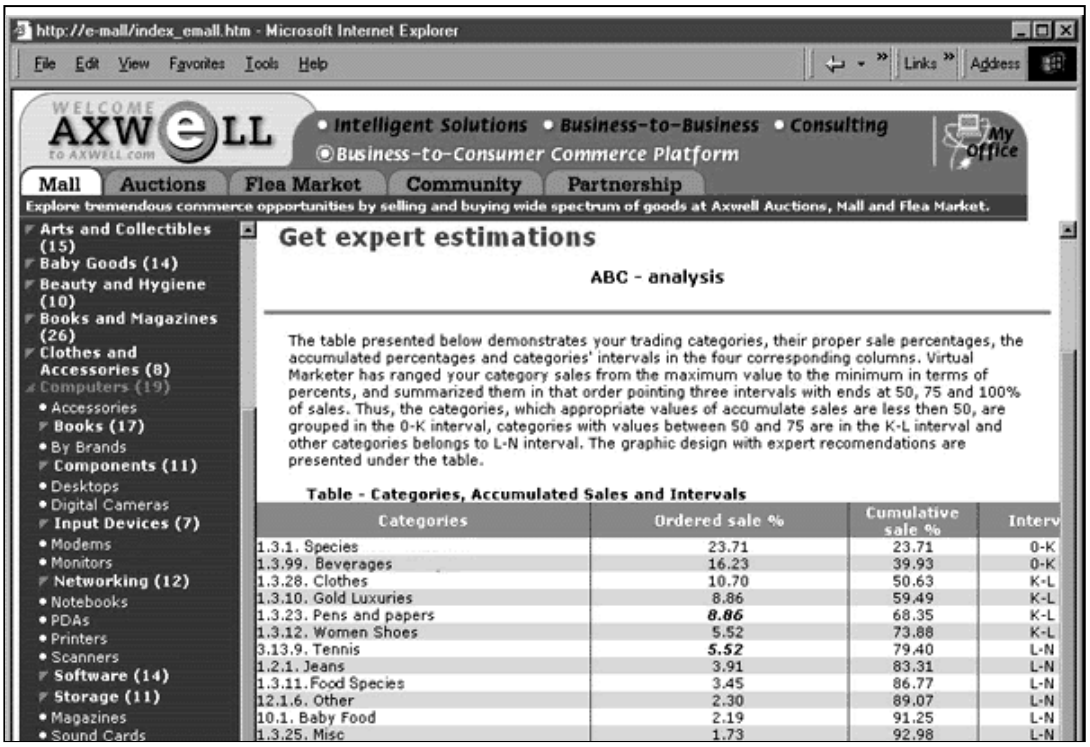

Figure 4. Axwell portal screenshot.

The following list represents description of the Intelligent Support Application components:

- **General Knowledge** (Natural Language Applications, Graphical Inference Features & Tools);
- **Thorough Knowledge** (Descriptive statistics, Correlation analysis, Factor analysis, Regression analysis, Discriminant analysis);
- **Expert Estimations** SWOT Analysis–>PAPC matrix (Product Attractiveness – Product Competitiveness), ABC Analysis (analysis of product portfolio structure), Comparative Analysis, CRM (Customer Relationship Management).

5. Conclusion

The key to success and competitiveness for companies operating in e-Business lies in ability to convert data into knowledge, which enables to take effective decisions. Basing on the lessons taken and experience acquired through analytical research and development of Intelligent Shell for e-Commerce it is important to outline the following five core factors of the successful e-Business technologies development:

1. The new generation of intelligent solutions for e-Business offers integrated environment of intellectual tools, which allows to quickly and effectively retrieve information in the

Internet, extract knowledge on customers, suppliers, marketing events and improve decision-taking process.

2. Implementation of Enterprise Knowledge Warehousing concept creates the platform for intensive development of the following e-Business technologies:
   - CRM (Customer Relationship Management);
   - Enterprise Knowledge Management;
   - Content Management.
3. The platform of applied Intelligent Solutions is the basis for the provision of services in ASP (Application Service Providers) category.
4. Integrated expert-analytical platform serves as the means of Business Intelligence, which combines knowledge both from on-line and off-line business sectors, increasing customer loyalty, i.e. influencing personalized relations with customers and quick response to market changes.
5. Integrated mechanisms of knowledge extraction and operation are the core factors of Internet development in conditions of enormous growth of information resources.

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Business Process Reengineering

Software Process Improvement in Russian Company: A Case Study

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Abstract

Our company has a long and successful history of creating different kinds of software solutions. As the company grew larger the need for software process improvement program became evident. In this paper we present an intermediate report on these activities and lessons learned. We also compare several software standards and propose a scheme for their effective usage in process improvement.

1. Introduction

LANIT-TERCOM and its team have a long history, which dates back to 1971 when a new chair of computer science was established at St. Petersburg State University. The core team that gathered then at Laboratory of System Programming has worked together for the next 20 years. In 1991, it became clear that new organizational forms were needed in order to prosper in the rapidly changing post-Soviet era, and a new state enterprise named TERCOM was founded. In 1998 it was supplemented with a privately held company LANIT-TERCOM, which was co-founded with a Moscow-based holding LANIT. Both companies are working in the same environment and are headed by the same General Director Prof. A.N. Terekhov, so further in the paper we will consider them as a single entity.

Despite all organizational changes, the core team remained intact since 1970s, and the academic spirit that was characteristic for this team never disappeared. But when the company started to work on industrial projects it turned out that in some cases we simply could not meet the expectations of our customers. There were clear problems in subordination and project execution. Responsibilities of the employees were unclear and rarely were written down in any form. Finally, the dominating mindset in the company was still more of academic than industrial.

Below we will enumerate several facts about our enterprise at that moment. It is interesting to note that one could interpret these facts as both positive and negative, because the reality is always more complicated than any simple scheme.

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Most of our projects were more complicated than usual software construction. In fact, we were balancing on the edge of research and development, so we could not abandon our academic roots altogether – and we did not want to anyway, because we always positioned ourselves as more than a simple software house.

It was a common practice for our employees to work in several projects simultaneously, so in most cases it would be next to impossible to formalize all relationships that existed in the company; also, these relationships were constantly changing from project to project without any visible system. On the other hand, this constant flux of employees was helping us to share best practices and to unite the team.

The company was heavily relying on personal character and will of its employees in overcoming all management problems; up to some point it really worked!

Nevertheless, the company was growing fast, and by the end of the year 2000, the number of programmers exceeded 200. Considering the current level of the software market and management practices in Russia, the company of this size should be regarded as quite large.

We realized that our processes were inefficient and it was becoming increasingly difficult to support old practices. The quality of the products delivered by our company to the customers was inadequate to the customer demands, and thus we needed to improve it. To achieve this, we started our process improvement activities in the year 2000. Even though these works are not completed yet, we are already starting to reap the fruits of our labor.

The paper is organized as follows. Section 1 is dedicated to discussion of some fundamental differences between software industry and other industries. In Section 2 we formulate our requirements for the ideal software process. Then in Section 3 we compare several software standards and define our approach to software process improvement. Section 4 describes some problems that were encountered during the course of our process improvement activities. Finally, the conclusion briefly summarizes our experience.

2. Software: Art or Engineering?

The very first challenge in standardizing the software process is the intellectual nature of software engineering. Even though the programming itself is more or less formalized, it is still more of an art than a science or engineering (McConnell, 2001). For this reason one of the best works on software is named “The Art of Computer Programming” (Knuth, 1998). The software is built out of abstract ideas and constructions, not from solid physical objects as in other industries, and it is impossible to create a quality software product without solving several typical problems:

Development team consists of creative personalities, and it is difficult to unify and standardize their activities.

Virtually every software program contains errors; this is unavoidable, but makes it much more difficult to promote typical quality goals.

Any given software product is unique and requires special development – at the moment, software engineering is not anywhere near mass production of programs.

One might say that every successful software project is a result of individual craftsmanship, and it is very difficult to extract the basic process of software development from the mosaic of past experience. Even software project plans are more like paintings than clichés.

Another problem of programming is that it does not scale up. Programming productivity grows very slow, if at all – it is estimated (Jones, 1986) that the average programmer creates 10–50 statements per day, and this estimate should be even lowered for bigger systems, i.e. bigger task require bigger expenses in relative terms. This fact separates programming from other industries where the mass production radically lowers the cost of one item. In fact, the whole modern economy is based on this assumption! So we are forced to conclude that creating software is more of an art than usual engineering at the moment. Definitely, it makes any quality improvement programs in this industry more difficult than in other areas.

3. Defining the Ideal Process

In the beginning, we decided to comprehend and formulate our requirements for the ideal software development process that we wanted to establish in our company. CMM standard (Paulk et al., 1994) presents the following framework for process improvement activities (see Fig. 1).

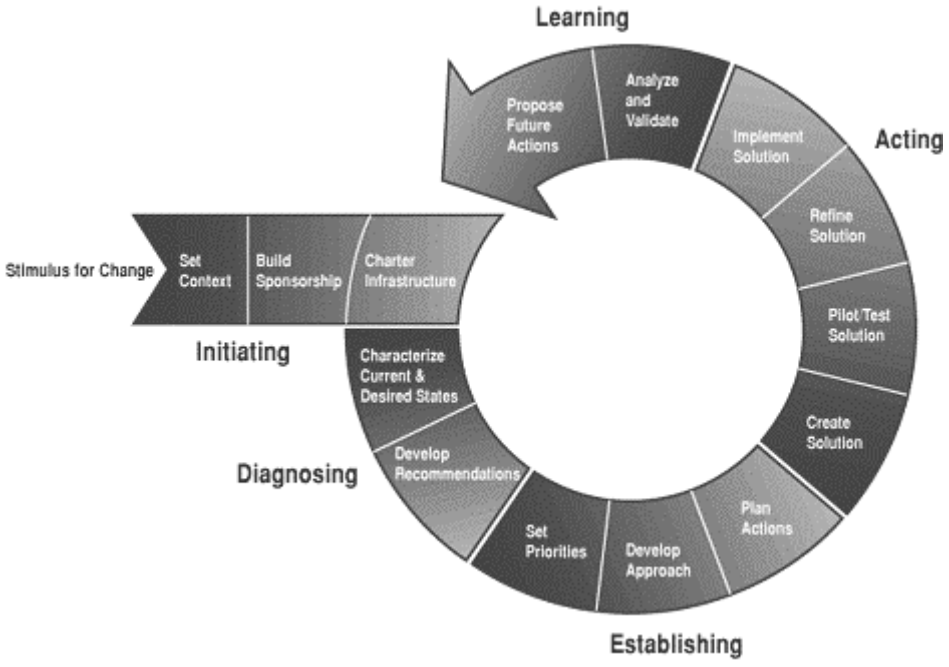

Figure 1: The CMM approach to software process improvement.

This figure is definitely nothing more than a general representation of the processes, and requires customization for any given company. We decided to base our process improvement activity on a "best process" that was established in one department of our organization working on contract with American company. This process was also more or less documented – a description of this process could be found in the academic paper (Onosovsky and Terekhov, 2000).

We also formulated the minimal requirements for the process environment that is needed to create a software product. We believe that for stable delivery of software products, the software development process should contain at least the following stages (see Fig. 2).

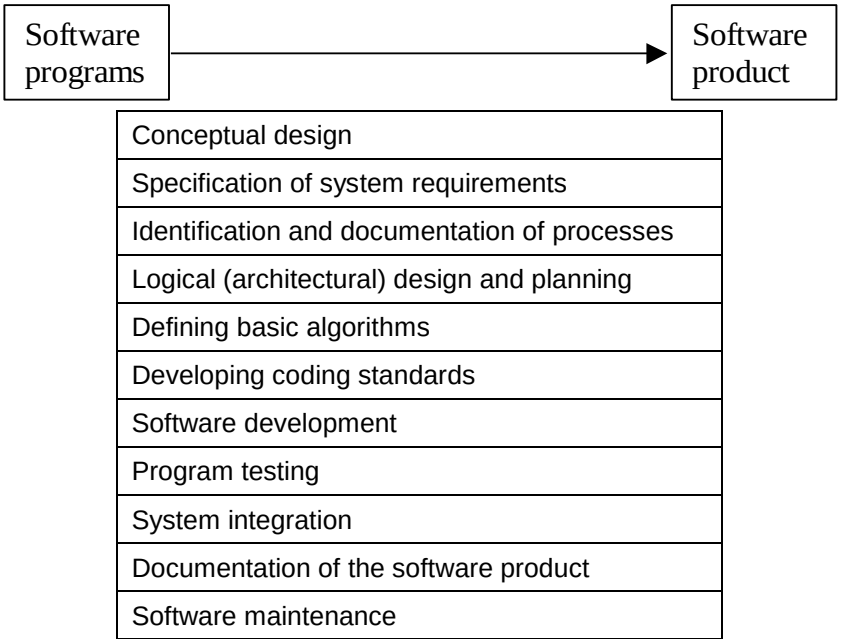

Figure 2: Structure of the process environment.

It is clear that the main process of software development should be also accompanied with the processes of administrative control, creation of infrastructure, configuration management, enhancement of audit, personnel training etc.

4. Finding a Proper Standard

As a next step we evaluated several existing software quality standards in order to find a useful and cost-effective approach that would satisfy our requirements. We have concentrated on the following families of standards:

- ISO 9000 and related standards (ISO 9001, ISO 12207);
- MSF (Microsoft Solutions Framework);

- CMM (Capability Maturity Model) and SPICE (Software Process Improvement Capabilities and dEtermination).

We started with investigation of the possibilities to formalize our processes using model ISO 9001. This standard is popular and well recognized in Europe, so the importance of achieving ISO 9001 certification for marketing is quite clear.

On the other hand, application of ISO 9001 rarely leads to the satisfying results, because it is over-formalized and requires nothing more than to create a document flow for the manufacturing process. This standard fixes the "status quo" of existing process and after that essentially prevents any substantial process improvement. Also, ISO 9001 does not contain any explicit requirements for the software development process, because it was originally designed for application in a broad number of topics, including development of products, systems or services. This "flexibility" makes ISO 9001 quite difficult to implement.

We also understood that we could not use ISO 12207 for identification and description of our software processes, even though the standard was designed exactly for this purpose. We found out that that this standard is too primitive and formal for our frequently changing software processes. In fact, it is not clear how this standard could be applied for any living production process.

Then we considered Microsoft Solutions Framework. It turned out that MSF is quite useful for organization of the development process in separate groups, because it contains a well-defined set of effective procedures for planning, development, testing and deployment of software products.

We have successfully adopted MSF in several outsourcing projects and the results of its application were quite positive. We did not implement all features of MSF, but it was not necessary anyway, because MSF is not a rigid standard, but rather a collection of best practices and thus it is impossible to judge the "purity" of MSF implementation.

Unfortunately, it is not possible to describe all company processes using only MSF concepts, because MSF does not provide any means for coordination between independent departments in a large company, so we believe that MSF should be viewed only as an intermediate step on a way towards more complete standards. Adopting MSF for enhancing the processes in a small company or in a department of large company is a sound idea, but later on these processes should be integrated into a more general company-wide quality standard.

Most of the drawbacks are resolved in CMM and similar standards, such as CMMI and SPICE. These standards were designed specifically for software companies and propose different methods for description of the software development process in any given organization (CMM requires compliance to some fixed process, while CMMI and SPICE provide a generalized templates, which could be used to describe virtually any kind of software process). These standards are not only good for identification and maintenance of current processes – they are also useful for process improvement and provide means for assessment of the company's maturity.

Summarizing everything that was stated above, we devised the following scheme of software process improvement:

1. MSF software processes and best practices are promoted in all departments of organization to enhance the processes used in individual software projects.
2. All processes are documented using ISO 9001 standard. At the end of this stage the company should receive a certificate of compliance to the standard.
3. Consequent process improvement efforts are carried out on the basis of CMM standard. This should be taken into account as early as possible to reduce the amount of documents that would require rewriting and other unnecessary paperwork. Fortunately, in most cases it is possible because the key areas of these standards are more or less corresponding to each other (Paulk, 1995).

An idea of using more than one standard for software process improvement is not new, for example similar, though simpler approach is described in (Andrés et al., 1997). We believe that this way minimizes the risks of software process improvement activities and represents the best practical way to achieve both long-term and short-term benefits for most software companies.

5. Implementation Problems

Introduction of new paradigms is always painful, and our quality program was no exception. We believe that some of the problems that we encountered are quite typical and thus should be considered by any company starting its own quality improvement process.

It turned out that even our "best processes" were in some parts inadequate. For instance, our quality assurance was initially limited to the simple functional testing. Later on this process was supplemented with other features, such as daily builds and regression tests. Still a lot of practices typical for more mature companies, such as code inspections, architectural reviews or prototyping, were out of scope of our process, even though we knew that different testing techniques complement each other – see Table 3 taken from (Jones, 1986).

It is clear from this list that our quality assurance was not very effective, so the biggest quality improvement could be achieved simply by introducing new methods to our testing practice – this is often quoted as a viable way to improve quality (Boehm et al., 2001). But it turned out that it is not so difficult to identify the ideas that could be potentially useful as it is difficult to promote them into practice. The customers (and the team!) usually resist to most changes in the existing process, so in our case the only changes that made their way into practice prior to our quality improvement program were those that were formulated as a strict requirement by the customer himself!

Actually, customer's influence on the company's maturity level is rather typical for current situation in Russia, because Russian business is still in its infancy and thus the average level of efficiency is quite low. In the absence of traditions or role models, the biggest source of useful information for improvement is the outer world, i.e. the customers. In a way Russian companies are evolving in parallel with their customers, and thus their maturity level are

usually more or less corresponding. So the best scenario for the growing software company is to get a long-term contract with competent customer, because this usually leads to great quality improvements on contractor's side.

Removal Step	Lowest Rate	Modal Rate	Highest Rate
Personal checking of design documents	15%	35%	70%
Informal group design reviews	30%	40%	60%
Formal design inspections	35%	55%	75%
Formal code inspections	30%	60%	70%
Modeling or prototyping	35%	65%	80%
Personal desk-checking of code	20%	40%	60%
Unit testing (single routines)	10%	25%	50%
Function testing (related routines)	20%	35%	55%
Integration testing (complete system)	25%	45%	60%
Field testing (live data)	35%	50%	65%
Cumulative effect of complete series	93%	99%	99%

Table 3: Defect detection rates.

This idea could be demonstrated on examples from the history of our company. In 1993 TERCOM started to work on contracts from two large foreign companies – SEER Technologies (USA) and Italtel (Italy). These customers wanted to solve some complicated problems that they could not solve themselves because they lacked the required knowledge or simply because they considered alternatives to be financially infeasible. TERCOM successfully carried out its initial assignments, so these contracts became long-term ones.

Getting these contracts was very fortunate for TERCOM, because the customers brought in not only money and work, but also their knowledge of established business practices. Today this might sound funny, but in 1993 TERCOM did not have even simplest attributes of any self-respecting Western company, such as fax machines and e-mails. As time went by, we adopted more and more practices from our customers – hierarchy of project managers, independent quality assurance groups, weekly reports etc. We believe that without these customers it would have been much harder for our company to achieve even the current maturity level.

Of course, we have also seen the reverse of the medal: working with ignorant customers. This is a painful process, because this type of customers rarely has a clear understanding of what he really needs. These customers usually try to keep control of the process, frequently change their requirements and do not want to spend extra effort on activities that they

believe to be unnecessary. One of the problems of the growing company is that in most cases it cannot reject the offers from any kind of customers, even if this means working in counterproductive environment. Fortunately, our company has passed this point long ago.

Another thing that is really important for the success of quality improvement is setting up the proper measurement program. Without exact historical data about the previous projects it is virtually impossible to argue about usefulness of any parts of the software process. Prior to start of quality improvement process we had to rely only on personal judgement of our employees. But in a lot of cases the personal feelings of the employees contradict to the business interests of the company. For instance, people usually resist to introduction of any additional process overhead, such as weekly reports or daily builds yet these practices really help to improve the process. Nevertheless we started our movement from "ad hoc" processes to historical measurements and statistical criteria.

Similar problems also appear in other aspects of quality improvement program. We were constantly encountering hostile reaction to any quality-related activities, especially in the beginning, because people tended to think about the time spent on quality as completely wasted. For example, it was really difficult to organize high attendance at the internal courses about software quality. Then we had a hard time persuading leading project managers that they should work on identification of the existing processes. We also had problems in organizing the document flow and even in defining the organizational chart.

This rejection is a sign that our corporate culture is still not ready to accept quality goals wholeheartedly. Partially this could be attributed to the academic history of our team or maybe even to Russian mentality in general, but to achieve any kind of quality improvement we will have to improve the corporate culture first. This process will require a lot of time, effort and dedication to the quality goals on the management level. Nevertheless, we believe that currently our company is on the right track.

6. Conclusions

In this paper we shared our experience in setting up the quality improvement in Russian software company. In our opinion, the optimal scheme of software process improvement should adopt best practices from the various software standards, such as MSF for management of individual projects, ISO 9000 for document flow and CMM for creation of complete process environment.

During our quality activities we encountered a lot of problems related to the rejection of quality activities. We believe that these difficulties could not be overcame without improvement of corporate culture, so the quality group should view this as its primary goal. Quality group should also work on identifying the ways to improve the existing process, though in the early stages of company's history the competent customer could carry out this function. In any case, the overall direction of movement should be "from process improvement to the improvement of the company".

We hope that our experience could be useful for other Russian and international software companies.

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Re-engineering the Supply Chain – A Systems Approach for the Electronic Commerce Age

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Abstract

Recent advances in electronic commerce have provided businesses of all types and sizes with the potential to improve competitive advantage. The potential benefits associated with the embracing of these new technologies include potential access to new markets on a global basis, more effective integration of upstream and downstream supply chain partners and better streamlining of internal and external business processes. In short, the technological potential exists to simultaneously improve customer service levels and to reduce supply chain costs.

However, if this potential is to be realised in practice there is a need to re-evaluate current supply chain configurations. A mismatch currently exists between the technological capability and the supply chain or logistical reality. This mismatch has sharpened the focus on the need for robust approaches to supply chain re-engineering. Traditional approaches to business re-engineering have been based on manufacturing systems engineering and business process management. A recognition that all companies exist as part of bigger supply chains has fundamentally changed the focus of re-engineering. Inefficiencies anywhere in a supply chain result in the chain as a whole being unable to reach its true competitive potential. This reality, combined with the potentially radical impact on business and supply chain architectures of the technologies associated with e-commerce, requires organisations to adopt innovative approaches to supply chain analysis and re-design.

This paper introduces a systems approach to supply chain re-engineering which is aimed at addressing the challenges which the new electronic business environment brings with it. The approach, which is based on work with a variety of both conventional and electronic supply chains, comprises underpinning principles, a methodology and guidelines on good working practice, as well as a suite of tools and techniques.

The adoption of approaches such as that outlined in this paper helps to ensure that robust electronic supply chains are designed and implemented in practice. This facilitates the removal of the major obstacles which many organisations have encountered in attempting to capitalise on the potential benefits of emerging electronic commerce solutions.

Keywords: e-commerce, systems, re-engineering, business processes, methodology.

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1. Introduction

Companies have long realised the need for company-wide approaches to organisation design and redesign. The development of systems engineering approaches to manufacturing system redesign in the 1970s and 1980s (Hitomi, 1996) was followed by the focus on organisational re-engineering, often based on business processes, in the 1980s and 1990s (Macdonald, 1995). A common feature of all of these approaches is a recognition that "the whole is greater than the sum of the parts". In other words, optimising subsystems (whether those subsystems are functional departments, production sites or individual processes in the manufacturing cycle) can result in a sub-optimised total system. Lack of efficiency and/or effectiveness is often a result of the poorly designed interfaces between subsystems rather than any inherent subsystem weaknesses. There are numerous examples of companies who have generated significant improvements in competitive advantage as a result of the application of this "total systems" thinking.

It must be recognised that a product is delivered to the ultimate customer through a complex interaction of several companies on the way. The manufacturer's ability to give the customer what they want, when they want it, at the price and quality that they want, is not just determined by the efficiency and effectiveness of the manufacturer's own operation. Inefficiencies anywhere in the supply chain will reduce the chances of the manufacturer successfully competing against other suppliers. Without a proper focus on total supply chain management, therefore, a company will never achieve true competitive advantage (Christopher, 1999). The increasingly international nature of markets and companies has resulted in many companies becoming part of large and complex global supply chains. In addition, the potential benefits associated with emerging electronic commerce technologies provide the potential to simultaneously improve customer service levels and to reduce supply chain costs. These factors have sharpened the focus on the need for improvements in all aspects of supply chain performance.

2. Elements of The Systems Approach

The systems approach to analysing supply chains and improving their performance recognises that the process of re-engineering supply chains needs to be carried out in a logical and systematic manner. The approach has been developed based on the experiences of a range of companies in a range of different business sectors. This paper describes the four distinct constituent elements of the systems approach. The principles summarise the underlying thinking and concepts. The methodology is the series of steps to be followed in analysing and improving a typical supply chain. The guidelines on good practice summarise the main relevant elements of world class operating practice. Finally, the tools and techniques support the implementation of the methodology.

2.1. Principles

The Oxford English dictionary describes a system as, 'a set of connected things or parts; an organised group of things; orderliness'. The italics are those of the author because they highlight those aspects of the definition which provide some pointers to problems which

exist in supply chains and, hence, to the type of change which might be required. Any finite system will have a boundary and anything outside that boundary can be regarded as the environment. An important aspect of the study of systems involves examining the interaction between systems and their environments. Indeed, the way in which a system interacts with its environment will largely determine the usefulness or degree of success of the system. If the supply chain under consideration is regarded as the system then the environment is the business environment in which that supply chain operates. The business strategy of firms is concerned with the interaction between supply chain companies and their business environment (Porter, 1980). Essentially, the strategy formulation process defines the nature of this interaction.

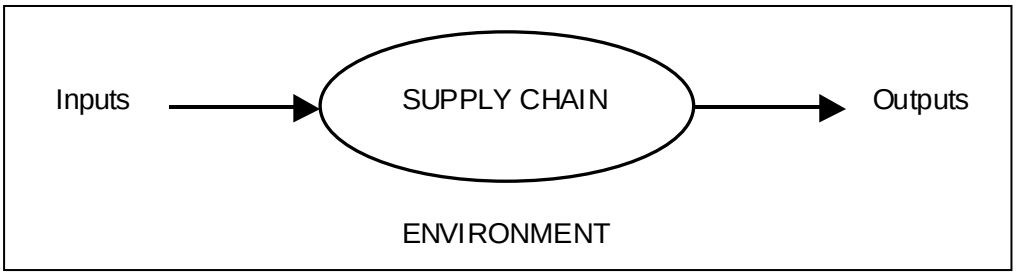

Figure 1: The supply chain as a system.

The supply chain system could be regarded as shown in Fig. 1. The interaction of the system with its environment is represented by the system inputs and outputs. In practice, supply chain systems can be broken down into subsystems. This aids understanding of the operation of the system and facilitates systems analysis. Each of the subsystems should display the characteristics of a system; each subsystem will have inputs, outputs and a boundary. When considering a company's internal supply chain the subsystems can be regarded as the company's business processes (e.g. designing, buying, making, moving, selling). These business processes are multidisciplinary activities that cross traditional functional department boundaries. When considering a supply chain which comprises several companies the subsystems can be regarded as the individual companies or the business processes which cross company boundaries. Traditionally, efforts at improving supply chain or organisational effectiveness have focussed on making changes within the subsystems. This often resulted in optimal subsystems but sub-optimal total systems.

The systems approach to analysing supply chains and improving their performance is based on the need to consider the whole system rather than confining improvement efforts to particular subsystems. Developing the best solution requires the analysis, planning and implementation work to be carried out systematically (i.e. methodically, thoroughly and with proper attention to detail). This involves a far reaching investigation and radical reappraisal of the whole supply chain and often results in a complete redesign of supply chain organisation and operations.

2.2. Methodology

The systems approach to analysing supply chains and improving their performance involves the application of logical, structured methods rather than relying on making limited improvements in particular areas of the system. The methodology provides guidance on how to address this process in an organised manner, proceeding in logical stages to develop a solution. Fig. 2 shows an outline of the methodology.

STAGE	STEP
INITIATION	• Set project scope, objectives and time plan • Create project team or task force
DATA COLLECTION	• Determine structure of supply chain and objectives of each element • Supply chain audit: detailed data collection concerning the companies and their competitors, markets, currently available resources and future resource requirements
ANALYSIS	• Preliminary analysis of supply chain • Identification of key supply chain business processes
PLANNING/DESIGN	• Realignment of organisation and operations in line with key business processes • Detailed design of organisational structures • Detailed design of operational procedures • Develop business plans
IMPLEMENTATION	• Development implementation plans • Implementation of change • Performance measurement • Continuous improvement

Figure 2: Methodology for supply chain re-engineering.

There are a number of features of this methodology which are worth highlighting. The data collection, analysis and planning stages are carried out by a project team or task force. Such a team is multi-company (multidisciplinary in the case of internal company supply chains) and possesses the knowledge and skills necessary to carry out the tasks required. It should have the commitment of management and be dedicated to its task for the duration of the project. Once the overall structure of the supply chain has been determined and the strategic objectives of each element identified, the task force carries out a supply chain audit. This audit involves collection of detailed data concerning all aspects of the supply chain. The

general classifications of data to be collected are: general company and competitor data; market and customer data; data concerning currently available supply chain resources; and, data concerning future resource requirements. The supply chain audit is one of the most important parts of the methodology and it results in a considerable volume of data. The next stage of the methodology involves analysing this data with a view to identifying the key supply chain business processes. The planning/ design stage involves (top-down) realignment, and (bottom-up) detailed design of supply chain organisational structures and operational procedures. Business plans for each element in the realigned organisational structures are also required. Detailed implementation plans define how the required change will be put into place. An effective performance measurement system forms the basis of the continuous improvement process.

2.3. Guidelines On Good Practice

Every supply chain is unique. It has unique products, processes, people and a lot more besides. Hence, there is no universal solution which can be applied which will automatically result in a supply chain achieving its optimum competitive potential. The methodology helps to identify the most suitable solution for a particular supply chain but there are approaches which appear to exist in the majority of world-class companies (Schonberger, 1996).

These approaches include employee involvement, total quality management, JIT, (total) preventive maintenance and a philosophy of continuous improvement. The key is not to blindly copy the approaches used by successful companies but to learn from their experiences. Education and training of project team members plays an important role in this.

2.4. Tools and Techniques

A potential problem when analysing supply chain organisation and operations is that there are few (if any) established analytical tools which can be employed. The lack of such tools can result in practitioners failing to apply a methodical, scientific approach and instead relying purely on experience, intuition and iteration. However, there are many techniques in use in other fields which are relevant to supply chain analysis. Such approaches include financial analysis, strategic planning techniques (e.g. SWOT analysis, the Porter model), Pareto analysis, systems analysis techniques (e.g. input/output analysis, flowcharting), IDEF0 and process mapping. These techniques can be used to support various stages of the methodology with many being particularly useful at the analysis stage.

In addition, computer-based tools, which assist in the application of the techniques, are also available. Many of these tools are useful in managing the data collected during the supply chain audit. Useful tools include spreadsheets, databases, visual interactive simulation and project planning software.

3. Conclusions

The systems approach (to analysing supply chains and improving their performance) provides a basis for achieving world class standards for supply chains operating in all types

of industry. The approach involves considering the whole supply chain and avoiding a situation where subsystems are optimised but the whole supply chain is sub-optimal. To apply the approach requires a methodology, a recognition of what constitutes good working practice and the use of tools and techniques to perform the required analysis. The process of supply chain analysis and improvement is complex – it requires total management commitment and dedicated resources. With this commitment and the necessary resources, the use of the systems approach can result in significant improvements in supply chain performance. It is only in this way that the mismatch between the electronic commerce technological potential and the logistical supply chain reality can be addressed in any meaningful way.

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The Experience of Implementation and Application of GERAM International Standard for IT Reengineering in Russia

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Abstract

The notion of workflow is practically unknown in Russia, while in the world the Workflow Management Coalition exists since 1993. Nevertheless, usual approaches for creating accounting, economical and automation solutions are usually suffering from the great number of problems. This is especially true for large information system such as those based on SAP R/3, BAAN IV, because they are resistant for changes, and thus in a lot of cases business processes turn out to be "locked" in the code.

Our team was the first in Russia to use ISO 15704 standard, which is also known as GERAM, for IT reengineering in an industrial setting. We found out that this approach could be used effectively, even though it requires solid knowledge in the areas of workflow and business processes. We believe that application of GERAM methodology could be especially beneficial for Russian companies, because most of them are in dire need of information reengineering.

1. Introduction

1. The enterprises interaction on the real time scale is typical for the modern economy, when market needs are continuously changing, new technologies and products are appearing but competition amongst producers is global. New market trends, economy globalization and forming of great economic blocks such as European Alliance, NAFTA, MERCOSUL require from the companies the accomplishment of the business administration international rules, new forms of organizations and standard quality observance of the product. Under these circumstances the enterprise strategies must adapt quickly to the new conditions of business administration and to be supported by technological facilities for realization of their business-processes reengineering. The following generation of production systems will be more oriented to the reduction of the product production (development) cycle, expenses and quality increasing. Such enterprises must satisfy the following main requirements:

- Integration of enterprises. The separate and complex production enterprises must integrate with suppliers, partners and clients in dynamically built networks of

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information transfer for the realization of global concentration and flexible market reaction;
Distributed organization. The efficient integration of enterprise is possible on the base of distributed organization, ensuring the interaction at a rate of technological systems of efficient management;

- Heterogeneous environment. The production systems must be provided with facilities for joint functioning co-ordination of heterogeneous program and technical ensuring both in the internal environment and at the interaction with the external world;
- Open dynamic structure. The enterprises must have a possibility to dynamically integrate the new subsystems to the acting systems without stop and regeneration of working surround;
- Co-ordination and cooperative work. The production enterprises must have a possibility to efficiently co-ordinate their own production programs in accordance with market requirements, suppliers and business-partners possibilities;
- People and information systems integration. The consumers (people) through the information systems get the information about the condition of all types of activity at the enterprise and they have an influence on the different parameters of running business processes. The flexibility of access and the modification possibility of information systems components are the necessary conditions for realization of efficient integration;
- Flexibility. The enterprises must continuously develop their own production strategies for the expansion of their sales markets and, thereby, to reconstruct flexible the technological, resort and information environment under new economic conditions;
- Knowledge concentration. It is necessary for the successful operation in dynamically changing market environment of enterprise to hold a repository of knowledge on their organizing building, structure and composition of business-processes and resources, information environment. The enterprises will be able to produce dynamic reengineering of their own production strategies using given information and corresponding tools;
- Product, interfaces, protocols and processes standardization. The efficient integration, co-operation and dynamic reorganization can be accomplished materially when using only the international standards and united conceptual foundation.

2. The enterprises will use information systems with the adaptive architecture, based on modules reusing, which ensure business-processes flexible support for successful functioning in dynamically changing market conditions. The future enterprises must be network, flexible and they must take advantages of the following technologies:

- The international communication systems, ensuring connection to the clients, suppliers and partners enterprises;

- The standards for enterprise models description, ways of their integration, business-rules, agents, specifications and information protocols;
- The workflow controlling systems, supporting co-ordination of all enterprise activities;
- The designed imitating surrounding, supporting evolution of the product and production equipment and optimization of production processes;
- The general infrastructure based on open architecture, for enterprise integration, general service realization through network and business-supporting applications.

3. The main problems of reengineering are enterprise models building and its interaction with all other business participants, performance of these models in the simulation environment in order to work out the necessary technical decisions. The application problems of existing tools for distributed systems modeling of business conduct are concluded in following:

- Modeling paradigms and user languages. The tools must model events, processes and individual works, facilities and information objects;
- Monolithic models, i.e. majority of tools deal with the single model and simple set of business-rules. It makes them poorly available for the enterprise modeling, where the behavior of business-essences depends on external and internal events, resources, conduct of the agents and coordinating mechanisms;
- The tools do not support simultaneous modeling of information and controlling flows;
- Modeling environment and imitating one have a different set of constructors, specific syntax and semantics;
- Enterprise models sizes and difficulties. The enterprise models can have a great amount of the modeling components and relationships between them. The simulation modeling of such enterprises is not supported by existing facilities;
- Multilevel models structure. Some models components have hierarchical structure. For example, the domain-processes consist of the business-processes, which in turn consist of separate works;
- Existing facilities transform such hierarchy to the flat single model;
- Network models structure reflecting the interaction of suppliers, producers and clients. Classical simulation facilities reduce a network organization of business with separate thread to the one linear process.

Analyzing given existing tools limitations, we see, it is necessary to develop a new set (family) of facilities, having multilevel distributed architecture and ability to reconstruct their own configuration and modeling rules quickly to provide processes of designing and reengineering of networks. In this report we have tried to formulate the main principles of modern information systems building.

2. International Standards Applications for All Stages of Enterprise Life Cycle

In our opinion, it is necessary to follow at least the following standards for modeling and specifications:

- ISO 14258 – Concepts and Rules for Enterprise Models;
- ISO 15704 – requirements for Enterprise reference architectures and methodologies;
- ISO 10314 – Shop floor -production model;
- CEN ENU 4003 – CIM – systems – architecture framework for modeling;
- CEN ENU 12204 – Constructs for enterprise modeling;
- ISO/IEC 15288 -System life-cycle Processes;
- IEEI – Standard Upper Ontology.

Planned standards:

- Universal Enterprise Modeling Language (UEML);
- Process Specification Language (PSL);
- Extensible Business Reporting Language (XBRL).

Standards for designing and integrations:

- ISO 10303 – Standard for Exchange of Product Model Data;
- ISO DIS 14750 – specification language IDL;
- ISO/IEC 10746 – Open Distributed Processing;
- ISO 8879 – Standard Generalized Markup Language;
- IGES – ANSIY14.26M – Initial Graphics Exchange Specification;
- ISO 9735 (EDIFACT) -Electronic Data Interchange for Administration, Commerce and Transport;
- ISO 18876 – Integration of Industrial Data for Exchange, Access, Sharing;
- GENCR 1831 – Systems Architecture Enterprise Model Execution and Integration Services.

3. GERAM Methodologies Transformation for Integrating Technology Building

At present there are six main methodologies for developing models of an enterprise, reflecting different aspects of its activity (functions, facilities, organization, information objects). They are: GERAM, ARIS, CIMOSA, GRAI/GIM, IEM and PERA.

GERAM methodology synthesizes main components such as CIMOSA, GRAI/GIM, PERA and consists of the following main components:

- Review Architecture;
- Methodologies;
- Languages;
- General and private models;
- Tools;
- General program modules;
- Detailed models.

The association of these components to the technological chain for the enterprise information system development is a necessary condition for the successful solving of enterprises reengineering problems.

The integrated technology review architecture consists of main CASE facilities required for enterprise information system development or reengineering which reflects general, private and detailed data domain models. The cardinal principle of CASE facilities building is based on the generation of program components on the base of meta-models of goals, scenarios, business-rules, roles and business-processes. The CASE facilities association to the technological system depends on realized project goals and provided with corresponding workflow facilities.

4. The Instrumental and Applied Facilities Component Building

4.1. Architecture

The component built business-system architecture consists of four levels: data, business-rules, business-processes, and client applications. The developed component models (COM, CORBA, EJB) can be used on each level. The processes and data components must have different interfaces for heterogeneous surrounding realization to be dynamically reused and (to be) retargeted.

4.2. Technologies

The component technology must ensure the performing of the following functions:

- Transaction processing;

- Object request brokers;
- Message brokers;
- Configurable security.

The given functions realization ensures components independence from programming languages and used platforms, dynamic connection of components in a real-time, virtual execution of the program module, business-exhibits adaptation to the new rules of the business administration and independent designing, implementation and testing.

4.3. Tools

It is possible to divide tools for the components development and implementation into five groups: (1) modeling facilities (support components and interfaces modeling), (2) construct facilities (intended for separate components designing and testing), (3) repository (ensures components keeping), (4) interconnecting facilities (support components visual specification and interconnection in some executing environment), and (5) integration facilities (ensure heterogeneous platforms integration).

Modeling facilities – ensure an enterprise model development in the manner of component-built scenarios, business-rules, roles, business processes with the interface specification and interaction protocols.

Construct facilities – ensure components program generation on the specified models base:

- Interfaces generation for component models;
- Tests generation on model specifications base;
- Automatic certification of applied processes;
- The interfaces with the available program environment creation.

Interconnecting facilities – produce separate components assembling on two levels:

- Business-semantic – components assembling is accomplished in accordance with specified concrete proposition business-logic;
- Technological – components assembling is accomplished in accordance with the product development or provided service technological cycle.

Integrations facilities – ensure different technologies integration through used platforms and component applications integration with ERP systems.

5. Multiagent Realization of Instrumental and Applied Facilities Interaction Mechanisms

The dominant feature of the information system reengineering is a new business-processes multichoice construction and efficient network organizations modeling. One of the ways to solve these problems is a multiagent infrastructure building, ensuring the instrumental

environment adaptation and information enterprise system to the changing conditions of business administration. Agents are characterized by the following characteristics:

- Adaptability – an ability to be educated and to be self-improved in the process of using;
- Autonomy – direct and self-organize behavior;
- Behavior in the community – an ability to work with other agents for general purposes realization;
- Ability to make a conclusion – a possibility to work on abstract problem specifications;
- Communications at knowledge level – an ability to interact with other agents on the natural language communication;
- Mobility – a possibility to move from one platform to another;
- Reactivity – the system quick reaction due to an ability to recognize a sense and semantics.

Multiagent systems are used for solving both as technological problems (such as modeling, imitation and specification) and as problems of applied nature (planning, management, checking and integration). General components of such systems are:

- Agent architecture – reflects a agents content as essence capable to the perception, action and discourse;
- Agent system architecture – expresses agents ability to iterations and interaction;
- Tools – ensure agent construction (for instance, systems Voyager, Eaglets, Odyssey);
- Infrastructure – adjusts communications between agents.

The following aspects characterize agents' infrastructure:

- Ontologies – define concepts schemes and their relationships (KIF) description;
- Communication protocols – describe communications languages;
- Communication infrastructure – specifies channels for agent communications;
- Iterative protocols – describe agreements for agents' iterations.

Multiagent system under the domain presentation of data domain includes several types of agents, ensuring interaction inwardly domain and between them.

Multiagent infrastructure practically is a semantic information system shell, reflecting the business administration rules and its participants interaction.

Integration of Business and Technology

Managing the Merge of Biotechnology into Business: New Challenges for Business and Management Practice

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Abstract

Managing the integration of biotechnology from R&D into business occurs through a complex and strategic process of stakeholder interactions. These interactions are manifestations of the routines and practices, expectations and norms of intra- and inter-organisational relationships. The R&D phase of biotechnology is the anchor for its subsequent development, commercialisation and application as value-added products, processes and applications. As such, elucidating the interactive process by which biotechnology is recognised and integrated into stakeholder value chains, to become part of established industry systems, presents a strategic challenge to established business and managerial practice.

Successful technological integration can be seen by the degree that effective value chains are established. Stakeholder interactions provide the interactive platform for technology integration through their '*relationship architecture*' (Kay, 1995). Only through these interactions is the emerging technology accepted (seen as legitimate) as a viable (valuable or significant) contribution to existing systems, often in part reconfiguring these systems in the process.

This paper offers a new methodological approach to examining stakeholder interactions in the integration of biotechnology into business and industry. Based on a synthesis of theoretical perspectives, it has been developed to provide a strategic approach to inform business and management practice. This interpretative research strategy aims to unravel the processual dynamics of stakeholder interactions in inter-organisational relationship architecture of biotechnology organisations during the process of technology integration.

1. Introduction

The transfer of biotechnology from its scientific origins into the business arena is the foundation for its subsequent development, commercialisation and application as value-added products, processes and applications. This transfer process is accompanied by multiple and complex inter-organisational relationships. Often reaching across professional

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groups and industry sectors, managing these relationships provides new challenge to managers and scientific practitioners. The advent of a methodological tool for analysis of the fundamental considerations made in the process of these relationships offers participants a strategic advantage in this disparate industry where agendas are blurred and flexibility is a premium.

Stakeholder interactions are considered using 'relational architecture' to examine the structures, agents, processual dynamics and contextual influences in the R&D phase of biotechnology that contribute to the technology's integration into the industry network. This approach develops an important intellectual perspective of organisational interactions because it enables processual analysis of inter-organisational relationships as well as analysis of business and industry network formation and behaviour.

The foundations for this approach have been derived from a new synthesis of theoretical perspectives. Each of these has contributed to understanding the dynamics of stakeholder interactions in the relationship architecture (Kay, 1995) of inter-organisational networks to inform a new interpretative research strategy. This provides a methodological approach to give academics and practitioners an insight into the processual dynamics of participant interactions in organisational networks. It does this by balancing traditional theoretical approaches with an appreciation of the sanctioning and integration activities that occur in inter-organisational relationships.

1.1. Purpose

Stakeholder relationships and the process by which they affect the integration of biotechnology from science based R&D environment and along the commercial value chain, are frequently overlooked in business research and by practitioners and R&D managers. The merge of cross-disciplinary professionals required to facilitate the transfer process can be a delicate balancing act when expected outcomes are unclear and organisational objectives are divergent. We suggest that understanding and anticipation of these concepts in inter-organisational interactions can provide strategic advantage and inform practice in business and management activities.

A methodology to fulfil these research objectives needs to be grounded in the experience and practice of the interacting organisations and industry network. The methodology should recognise that organisations collectively and individually *define their own* network of interactions in a process of sanctioning and integration in the value chain. This develops the view of the industry as a social system, following Easton, Burrell et al. (1993; 17-18) and Garud and Van de Ven (1989; 492). The social systems view stresses the inter-relatedness of firms, the range of interactions both competitive and cooperative, and the emergent industry group level activities and institutions. This approach deviates from traditional assessments of industry and inter-organisational networking that impose predetermined network parameters, rather than allowing the interacting organisations to identify their own contextual environment and relational architecture.

1.2. Scope

This paper examines the process by which stakeholder interactions inform value-seeking activities of participants in inter-organisational relationships. The integration of biotechnology and most enabling technologies occurs through a complex and strategic process of stakeholder interactions that can be understood simply as a process of sanction and integration.

A number of important methodological issues have been identified that must be addressed to inform this theory's development. The multiple participant nature of inter-organisational and industry level relationships requires that contextual influences be recognised as contributing to the defining scope of participant relationships, and thus the relationship architecture of the participants in network. This analysis of relational architecture aims to address the theoretical imbalance by providing a socially relevant interpretation of inter-organisational dynamics and network processes.

1.3. Structure

We offer here an innovative research strategy for developing theory and practice that examines intra and inter-organisational relationships in industry and business networks. Following this introduction, the various theoretical areas are discussed briefly to identify their relevance and contribution to the development of this research perspective. Constructed to provide an insight into the process of biotechnology's integration into industry systems, we present an overview of the theoretical foundations and intellectual approach that informs this interpretative research strategy. Methodological issues are then outlined, and the conceptual tools discussed as they are derived from theory and relate to empirical analysis. Analytical challenges are presented and implications considered in the penultimate section of the paper. Finally we offer a conclusion that summarises the strengths and weaknesses of this research approach. The fundamental issue of examining the inter-organisational relationships that support the integration of biotechnology from the R&D phase into commercial viability is considered and the potential of this research approach in providing a cross-disciplinary analysis of technology integration is offered.

2. Theoretical Issues

Theoretical roots of this approach are derived from a sociological perspective of inter-organisational interactions in conjunction with a synthesis of stakeholder and networking theories. Using stakeholder (Coase, 1937; Williamson and Ouchi, 1981; Wikström and Normann, 1994; Athaide, Meyers et al., 1996; Uzzi, 1997) and networking theories (Granovetter, 1985; Powell, 1990; Kogut, Shan et al., 1992; Möller and Wilson, 1995; Liebeskind, Oliver et al., 1996; Lee and Hassard, 1999) together with structuration theory (Giddens, 1984) we develop a new interpretative research strategy for understanding stakeholder interactions and the inter-organisational relationship architecture in the R&D phase as it contributes to the process of biotechnology's integration.

In this paper the relational network is viewed as arising from the dynamic interactions of organisational agents and industry participants, *and* the routines and practices that form the

structural parameters of their organisations operations. Structuration theory (Giddens, 1984) provides a theoretical foundation that embraces the duality of structure and agent, and contends that each informs the other. This approach is used here to identify the industry and its participants in a relational architecture (which form a dynamic network) and the actions of those agents as a product of organisational structures (norms, routines etc.) in a process defined by sanctioning and integration activities.

The approach enables recognition of the technology integration process as greater than but inclusive of the stakeholders and their networks of interaction. Structuration theory provides a theoretical position that recognises the 'relationship architecture' as a dynamic product of the interaction process. The activities that support these relationships are grounded in their cumulative expectations and practical activities in the developing industry network. Thus Easton and others (1993;17) consider an industry to be a "composite socio-economic" concept, describing "firms, people and institutions held together by norms of behaviour, customs, mores, and a sense of belonging". Further, the participants themselves define the boundaries of the industry, rather than trying to impose somewhat arbitrary external boundaries (Easton and others 1993, p.3). Van de Ven and Garud (1989;204) similarly describe a new industry, in their case based around a new technology, as "a new "community" of symbiotically-related firms and actors, who through individual and collective action, invest resources in and transform a technological invention into a commercially viable business".

Technological integration, the degree that effective value chains are established, is linked to stakeholder interactions through their relationship architecture. An important research insight offered in this paper is the recognition of *value* in relationship architecture (Kay, 1995). Value and value seeking is seen here as a key stage in the process of sanctioning and integration in industry and inter-organisational interactions. Some authors identify value creation as the fundamental motivation for interaction (Coase, 1937; Granovetter, 1985; Easton, Burrell et al., 1993).

3. Methodological Implications

We believe that the perspective offered here provides an opportunity for the holistic analysis of inter-organisational networks, where the relevant areas of influence for organisations and actors can be self-defined by the participants in the process. The advantage is that rather than imposing a narrow analytical perspective onto the inter-organisational relationships and the interactive industry network, participants can define their own networking environment. Such flexibility enables recognition of the unique social construction of collective forms of organisations as networks, architectures and industries (Coase, 1937; Granovetter, 1985; Easton, Burrell et al., 1993) and reinforces the notion that "the firm is a set of relationships among its stakeholders" (Kay, 1995). In this way relationship architecture can be examined as the dynamic and interactive process of stakeholder relationships' across the industry, rather than just imposing the theoretical parameters of existing industrial and inter-organisational theory. Thus appropriate industrial and organisational management strategies

can be developed to address the unique contextual environment and participant relationships of the participating organisations.

This approach views structure and action as a recursive interplay of agents and their environment and is fundamentally informed by Anthony Giddens' (1984) theory of structuration. Giddens theory has been marginally reworked to allow a more comprehensive explanation of the processual dynamics of inter-organisational interactions. The concepts of legitimisation (acceptance), significance (value), motivation (direction) and domination (power) are developed as the foundations of the relational process of industry interactions. These analytical concepts enable analysis of the industry, inter and intra-organisational and business networks to be seen as manifestations of participants' recursive interplay. Participant interactions are enacted as they assess and engage in their environment as '*knowledgeable*' actors (Giddens, 1984). This is both a serendipitous and constructive process of self-determination that is affected by the participant interpretation of existing organisational structures, relational environment and contextual history. This view of the industry network contributes understanding to both theory and practice as it interprets both the *dynamic and processual events* that inform participant activities and interactions.

R&D organisations are at the epigenesis of industry change, and hold a unique position in the developing value system and inter-organisational networking activities. Conversely, these organisations are informed by the established practices and norms of traditional partners and alliances. These may often require strategic relational redevelopment to enable new value-adding relationships to innovate management and business practices and facilitate the integration of technology into new systems. This paper holds the relational architecture of the R&D organisations in emerging industries can best be considered from a network perspective that embraces the inter-organisational relationships of participants.

4. Analytical Challenges

A processual approach is important for future studies of inter-organisational relationships as it enables holistic and integrated industry research to be conducted as a contextual multi-level analysis (organisation, network, industry as levels). This can best be pursued in the following way. First, relational research needs to work at a minimum of two levels, industry and organisation, as well as the interactive space between them. These two levels and the space between them then effectively embrace the contextual environment that forms and informs the relationship architecture in a recursive process of participant interaction. The two levels and the space between them then effectively embrace the context of relational architecture in which they reside. The second issue is the need for a flexible and interpretive methodology that can examine the process of multiple stakeholder interactions and the dynamic relationship architecture that facilitates or impedes activities, such as technological integration, in the industry network.

The interpretive methodology presented here recognises the network value chain as the fundamental driver of inter-organisational interactions and participants in the inter-organisational value creation process. Biotechnology industries across the globe have been the source of much research into radical industrial change, technological revolution,

collaborative ventures and organisational alliances. However, elucidating the process and dynamics by which technology is recognised and integrated into stakeholders' value chains to become part of the industry system still remains a challenge for managers, researchers and academics. In an emerging industry, R&D organisations are in a unique position to establish new relationships where opportunities exist to add value and develop their work. Similarly these organisations build relationships along traditional lines of interaction and innovate the relationship where opportunities to cultivate value become apparent. Thus the need for a contextual multi-level analysis in operationalising (theory testing) and in interpretation (theory building) in assessing the relational architecture of inter-organisational interactions is established. This approach recognises the autopoietic origins of networking relationships within the contextual framework of each participating organisation and as such offers a strategic opportunity for future industrial and inter-organisational theory.

The lack of emphasis on traditional business and management fields may be seen as a limitation to this perspective. The multiple participant epistemology required for this perspective does relegate dominant disciplines in management studies (such as economics, commerce, marketing, finance, culture etc) to second level influences. Its broad focus enables these contributing influences to be appreciated in combination with each other and with the extant organisational locus. This interpretative philosophy does however provide a more soundly based contextual understanding of the foundations on which business networks and inter-organisational relationships are organised and maintained.

5. Conclusions

R&D organisations are the starting point of technology's emergence into industry networks; they are the locus of value chain initiation. The R&D phase establishes a forum for the interactions of participating organisations, wherein they seek to establish a network of interested stakeholders to foster acceptance and uptake of their technology. As Adam Smith (1776) conceived that the 'invisible hand' of the market guides economic transactions through the interaction of dynamic market forces, so too the self-direction or 'autopoiesis' of the network of technological integration evolves through the dynamic relationships of industry participants.

Resource and information asymmetries provide the incentive for the complex and multiple interactions between stakeholders (Hamilton and Singh, 1991:213) and are the impetus for integrating value added technologies through inter-organisational interactions. These multiple interactions develop the networking perspective, "typified by reciprocal patterns of communication and exchange" (Powell, 1990). The strategic management of participant interactions in the networked relational architecture can contribute to the development of inter-organisational governance regimes, structural paradigms, organisational design efficiencies and competencies.

A processual approach is important for future studies as it enables holistic and integrated research to be conducted with evidence from diverse participants. Inter-organisational relationships emerge through a process of recursive consideration of value-chain activities and the organisational benefits that can be derived from them. The inter-organisational value

system is a matrix of relationships; these establish the relational infrastructure in which interactions, and the structures and actions that inform them, are grounded. Interactions between multiple participants can be examined with the processual constructs of acceptance, value, motivation and power to understand the relational architecture of inter-organisational participants. These constructs are identified as components of a sanctioning and integration process that directs autopoietic networking as the process of value creation is pursued in inter-organisational activities. By moving away from traditional theoretical frameworks this approach may be used to examine these relationships and their contribution to value-adding interactions in the development of industry networks and technological integration.

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Application Integration of Information Technology: Classification of Benefits and Barriers

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Abstract

During the last decade, enterprises have focused on implementing Information Technology (IT) to automate their business processes. These applications were not developed in a co-ordinated way but have evolved as a result of the latest technological innovation. Application Integration (AI) technology is new generation of software tools that incorporates functionality from disparate applications and results in integrated IT infrastructures. The adoption of integrated solutions provides significant benefits to organisations such as increased return on investment, customer satisfaction, processes automation etc. However, a number of barriers to application integration (e.g. lack of employees with AI skills) exist with companies needing solutions to overcome these barriers. This paper attempts to explore this area and classifying AI benefits and barriers. Both benefits and barriers have been classified according to Chang and Seddon model. In doing so, the paper allows researchers, managers, developers and consultants to better understand the strength and weakness points of application integration.

Keywords: Application Integration, Benefits, Barriers and Information Technology

1. Introduction

The need for integration is not a new one but, it has existed since applications moved from central processors to enterprise solutions. In the last decade, many companies have implemented disparate applications such as custom systems (legacy), best of breed, packaged applications, Electronic Commerce (EC) solutions etc, to support their business activities. These individual applications were not developed in a co-ordinated way but, have evolved as a result of the latest technological innovation (Themistocleous and Irani, 2000). Therefore in simple systems terms, many companies consist of a set of complex incompatible information systems with diverse information formats, heterogeneous computing platforms, and various programming models (Klasell and Dudgeon, 1998). Many critical enterprise processes still run on legacy systems but, there is often no time and justification processes in place to support the replacement of these systems (Hasselbring,

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2000). The tremendous expansion of EC applications and Enterprise Resource Planning (ERP) systems during the last decade amplifies the need for integration (Eck and Marchetti 2000; Al-Mashari and Zairi 2000). Edwards and Newing, (2000) explain that the real value from the use of IT comes when companies integrate all disparate applications in a way that supports efficient business processes across the whole value chain, which in doing so, provides a robust and responsive Information Systems (IS).

The incorporation of enterprise applications as well as interorganisational systems can be facilitated by a new class of integration software called Enterprise Application Integration (EAI) or simply Application Integration (AI) (Themistocleous et al., 2000). Despite the apparent importance of AI for organisations, the topic remains somewhat under-researched in the normative literature. The limited literature is attributed to the infancy of AI technology. However, several organisations have turned to AI technology as a mean of establishing a more functional infrastructure by incorporating functionality from disparate applications. Sufficient knowledge of AI is important for many reasons, with organisations needing to justify their investments in IS before committing time and money to implementation (Irani and Love, 2001). Managers also need to have a better understanding of the impact of AI on organizational performance and infrastructure management (Weill and Broadbent, 1998). Such understanding can help an organisation better utilise resources and improve its position vis-à-vis its competitors.

In this paper the authors will focus on a classification of the benefits and barriers for application integration. In doing so, Section 2 describes a model for classifying the benefits and barriers while Section 3 discusses and classifies AI barriers. Then, the benefits of AI are analysed and classified.

2. Chang and Seddon Model for the Classification of Benefits

A number of different models (McFarlan, 1984; Porter and Miller, 1985; Rackoff et al., 1985) exist in the literature to classify the benefits or the drawbacks of information technology. Chang and Seddon (2000) suggest that Enterprise Resource Planning systems support the integration of IT infrastructures and processes and developed a model for the classification of the benefits of ERP systems. The authors of this paper suggest that the model proposed by Chang and Seddon (2000) can be adopted for the classification of AI benefits as AI technology provides integration and automation of both IT infrastructures and business processes. The model proposed by Chang and Seddon (2000) for classification of the benefits of Enterprise Resource Planning systems is illustrated in Table 1.

3. Barriers to Application Integration

Literature findings indicate that those organisations that have adopted application integration solutions have to overcome technology barriers. As mentioned above, diverse disparate and in many cases heterogeneous systems co-exist alongside each other in organisations. In addition, organisations rarely have a single approach for implementing information systems (Duke et al., 1999). Thus, applications were developed without a common enterprise architectural planning (Brown, 2000; Markus and Tanis, 1999). Hence,

in many cases information systems were not developed to incorporate with other solutions but, focused on point problems and usually form autonomous islands of technology (Swenson and Cassidy, 1993). Apart from the lack of enterprise architecture there is also a lack of common definitions, structures, business concepts and standards (Duke et al., 1999). As a result, application integration is much more difficult and complex than software development as integration requirements should be considered with the constrains and the requirements of existing systems. There is also a complexity of existing information systems which, in many cases have fixed and rigid structures for messages, interfaces and databases (Duke et al., 1999). Moreover, there is a lack of documentation, especially in legacy systems, and usually important technical information is missing (Duke et al., 1999).

Dimension	Sub-Dimension
Operational	• Cost reduction • Cycle time reduction • Productivity improvement • Quality improvement • Customer services improvement
Managerial	• Better resource management • Improved decision making and planning • Performance improvement
Strategic	• Support business growth • Support business alliance • Build business innovations • Build cost leadership • Generate product differentiation (including customisation) • Build external linkages (customers and suppliers)
IT Infrastructure	• Build business flexibility for current and future changes • IT costs reduction • Increased IT infrastructure capability
Organisational	• Support organisational changes • Facilitate Business learning • Empowerment • Built common visions

Table 1: A Model for Classifying ERP Benefits (adopted from Chang and Seddon, 2000).

Despite AI vendors promoting their products as ‘plug and play’, there are no ‘off-the-self’ application integration solutions that offer ‘out-of-the-box’ (automated) integration. Application integration solutions are based on a combination of technologies as no AI product addresses all integration problems and cases (Ring and Ward-Dutton, 1999). Another barrier to application integration is the product choice and the maturity of integration technologies (Edwards and Newing, 2000). Integrators have to combine a variety of technologies and products to achieve integration. However, there is a lack of knowledge about the real capabilities of each technology. This therefore makes the product selection more difficult (Ruh et al., 2000). In addition, some integration technologies are still immature which also becomes a barrier to application integration. Moreover, some integration technologies cannot interoperate with existing systems (Markus, 2000).

The role of information systems into companies is changing day by day (Brown, 2000) and the need for flexible, open infrastructures that support e-business transactions is emerging (Kalakota and Robinson, 1999). The e-business era requires integrated information systems that facilitate real-time transactions. However, enterprises are reluctant to share their business data over open networks such as Internet, as security issues form a barrier to both application integration and e-business (Ruh et al., 2000). In addition, the integration of cross-enterprises applications requires integrators to understand and analyse the existing applications, together with their requirements and dependencies (Duke et al., 1999).

According to Markus (2000) application integration requires a vast amount of technical expertise and a complex set of skills. Similarly to other advanced technologies, such as ERP systems (Davenport, 1998) and Electronic Commerce (Kalakota and Robinson, 1999), there is a lack of skilled staff who is familiar with application integration. Ruh et al., 2000 report that application integration requires different skills than those that have traditionally been available in IT groups. Apart from knowledge of integration techniques and tools, IT staff should also have knowledge of middleware technologies such as database oriented, message oriented, transaction oriented and distributed objects oriented middleware (Ring and Ward-Dutton, 1999; Ruh et al., 2000). Moreover, the shortage of skilled staff and the high-skills required have led to high salaries for integrators, which translates in higher project cost. In addition, cost of integration could be a factor to application integration as many companies have considered integration as a major investment. Another barrier to application integration could be the organisational culture, as previous data integration failures have created negative perceptions to be overcome (Brown, 2000).

Application integration barriers are classified based on Chang and Seddon (2000) model and summarised in Table 2 below.

4. Benefits of Application Integration

Case studies on application integration e.g. Tesco stores UK, Deutsche Bank, General Motors, Bosch Group (Edwards and Newing, 2000; Puschmann and Alt, 2001) suggest that it achieves various types of integration. These types include data, components, interfaces, processes, real-time, custom applications, packaged applications and e-business integration. In addition, application integration supports reusable business processes, enables information sharing and allows easier migration to new technologies. Other benefits include adherence to common standards, provision of an integrated enterprise infrastructure that can be used for several years and support for the changing requirements of IT departments. Moreover, application integration reduces the time of integration and leads to more flexible, powerful, manageable and maintainable solutions.

Ring and Ward-Dutton (1999) among others report that a significant business benefit of application integration is the reduction of overall integration cost. The reason for this is due to the decrement of both integration time and maintenance costs. Application integration leads to return on investment (ROI) as it provides a flexible, manageable and maintainable enterprise infrastructure that supports the changing business and technical requirements.

Dimension	Sub-Dimension	Reference
Operational	• Extra cost for redesign and change business structure, processes • AI has a high cost	• Edwards and Newing (2000) • Duke et al. (1999)
Managerial	• Lack of employees with AI skills • Earlier AI approaches had proved problematic	• Markus (2000) • Brown (2000)
Strategic	• Resistance to change • Organisations are reluctant to share their data and processes with business partners	• Edwards and Newing (2000) • Kalakota and Robinson (1999)
IT Infrastructure	• No plug and play AI solutions • No single AI product solves all integration problems • No single integration technology solves all integration problems • Integration technologies are confusing • Integration solutions are based on a combination of AI products and integration technologies • Lack of knowledge • High complexity in understanding the processes and systems in order to redesign and integrate them • Lack of enterprise architecture • Lack of common definitions and standards • Existing systems have restrictions regarding their integration capabilities • Lack of documentation especially in the case of custom systems • Many existing systems are complex and incompatible • Some AI products and technologies are immature	• Linthicum (1999a) • Duke et al. (1999) • Ring and Ward-Dutton (1999) • Ruh et al. (2000) • Linthicum (1999b) • Markus (2000) • Edwards and Newing (2000) • Brown (2000) • Duke et al. (1999) • Zahavi (1999) • Zahavi (1999) • Kalakota and Robinson (1999) • Duke et al. (1999)
Organisational	• Politics and political impact (e.g., who controls the processes) • Complexity of business processes • Cultural issues • No time for training employees on integration technologies	• Edwards and Newing (2000) • Brown (2000) • Edwards and Newing (2000) • Markus (2000)

Table 2: Classification of Application Integration Barriers.

Based on an integrated enterprise architecture, companies can increase their productivity and provide better services for their customers and improve their relationships with their clients (Ruh et al., 2000). Moreover organisations can improve their performance (Urlocker, 2000). Likewise, application integration supports strengthened supply chains and improved relationships and collaboration between organisations and suppliers. Other benefits include the provision of a centralised point of control, the reduction of skills level required to integrate applications, faster time to marketing and increased market share.

The benefits of application integration can be classified according to (Chang and Seddon, 2000) model as explained in the previous section. This classification is summarised on Table 3.

Dimension	Sub-Dimension	Reference
Operational	• Reduces lost sales	• Edwards and Newing (2000)
	• Increases productivity	• Duke et al. (1999)
	• Achieves customer satisfaction	• Kalakota and Robinson (1999)
	• Reduces cost	• Linthicum (1999a)
	• Improves data quality	• Ring and Ward-Dutton (1999)
Managerial	• Provides more understanding and control of processes	• Duke et al. (1999)
	• Improves management and supports decision making	• Edwards and Newing (2000)
	• Improves planning in supply chain management	• Kalakota (2000)
	• Increases performance	• Linthicum (1999b)
	• Achieves return on investment	• Edwards and Newing (2000)
	• Results in reliable data	• Zahavi (1999)
	• Increases data analysis	• Klasell and Dudgeon (1998)
	• Provides a centralised point of control	• Brown (2000)
Strategic	• Improves planning in supply chain management	• Linthicum (2000)
	• Allow organisations to do business more effectively	• Brown (2000)
	• Increases collaboration among partners	• Edwards and Newing (2000)
	• Increased market share	• Urlocker (2000)
	• Improves relationships with suppliers	• Ruh et al. (2000)
IT Infrastructure	• Results in reusable systems, components and data	• Zahavi (1999)
	• Reduces redundancy of applications, data and tasks	• Klasell and Dudgeon (1998)
	• Faster and cheaper implementation than bespoke solutions	• Edwards and Newing (2000)
	• Offers interfaces-standardisation	• Morgenthal and La Forge (2000)
	• Provides flexible, maintainable and manageable solutions	• Linthicum (2000) • Zahavi (1999)
	• Results in reliable data	• Ruh et al. (2000)
	• Provides process and systems scalability	• Ring and Ward-Dutton (1999)
	• Provides portability	• Ring and Ward-Dutton (1999)
	• Reduces development risks	• Linthicum (1999a)
	• Achieves non-invasive solutions	• Zahavi (1999)
	• Achieves process integration	• Zahavi (1999)
	• Improves data quality	• Linthicum (2000)
	• Supports efficient data sharing	• Edwards and Newing (2000)
	• Provides data integration	• Klasell and Dudgeon (1998)
	• Provides objects/components integration	• Ring and Ward-Dutton (1999)
	• Provides real-time integration	• Themistocleous et al. (2000)
	• Integrates custom systems	• Morgenthal and La Forge (2000)
	• Integrates packaged systems	• Linthicum (2000)
	• Integrates e-business solutions	• Kalakota and Robinson (1999)
Organisational	• Results in more organized business processes	• Brown (2000)
	• Allow organizations to do business more effectively	• Linthicum (2000)
	• Increases flexibility	• Ring and Ward-Dutton (1999)
	• Achieves quicker response to change	• Kalakota and Robinson (1999)
	• Achieves process integration	• Linthicum (1999a)

Table 3: Classification of Application Integration Benefits.

5. Conclusions

Organisations are increasingly turning to application integration (AI) technology to establish an integrated infrastructure by incorporating functionality from disparate applications. Application integration helps organisations gain control on their inter and intra organisational processes. In doing so, addressing various integration problems such as custom, packaged and e-business applications integration.

This paper critically reviews the literature on application integration. In doing so, focusing on the benefits and barriers of AI. Both benefits and barriers are classified based on a model that introduced for the classification of the benefits of ERP systems. As a result, the authors of this paper demonstrate that the adopted model proposed by Chang and Seddon (2000) can be used for the classification of AI benefits and barriers. The reason for is that both ERP systems and application integration technology focus on the automation of both IT infrastructures and business processes. In addition, application integration addresses more effectively integration problems and supports fully automated processes and integrated infrastructures. Hence, based on Chang and Seddon (2000) model the benefits and barriers of AI technology can be divided into operational, managerial, strategic, IT infrastructure, and organisational.

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Information Security Auditing

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Abstract

Information Security auditing is one of the most dynamically developing trends of strategic/operational management and an urgent question regarding corporate network (Internet/Intranet) protection. Its aim is to evaluate and assess the state of information security of the enterprise, provide support for security enhancement and as a result to increase business effectiveness. This report considers all issues of information security audit: ideas, principles, different schemes, methodology and gives the analysis of information security inspections accomplished in governmental and commercial organizations.

Keywords: safeguard, risk management, risk analysis, risk assessment, threat, uncertainty, vulnerability

1. Business Impact Analysis vs. Risk Assessments

There is still confusion as to the difference between a Business Impact Analysis (BIA) and risk assessment. It is not unusual to hear the terms used interchangeably. But that is not correct. A BIA, at the minimum, is the equivalent of one task of a risk assessment – Asset Valuation, a determination of the value of the target body of information and its supporting information technology resources to the organization. At the most, the BIA will develop the equivalent of a Single Loss Exposure, with supporting details, of course, usually based on a worst-case scenario. The results are most often used to convince management that they should fund development and maintenance of a contingency plan. Information security is much more than contingency planning. A BIA often requires 75 to 100% or more of the work effort of a risk assessment, while providing only a small fraction of the useful information provided by the same effort spent on a risk assessment. A BIA includes little if any vulnerability assessment, and no sound basis for cost/benefit analysis.

1.1. Target Audience Concerns

Risk assessment continues to be viewed with skepticism by many in the ranks of management. Yet those for whom a well-executed risk assessment has been done have found the results to be among the most useful analyses ever executed for them.

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To cite a few examples: in one case, an organization with multiple large IT facilities – one of which was particularly vulnerable, a well-executed risk assessment promptly secured the attention of the Executive Committee, which had successfully resisted all previous initiatives to address the issue. With the risk assessment in hand, IT management got the green light to consolidate IT activities from the highly vulnerable site to another facility with much better security. This was accomplished despite strong staff resistance.

In another case, a financial services organization found, as a result of a quantitative risk assessment, that they were carrying four to five times the amount of insurance warranted by their level of exposure. They reduced coverage by half – still retaining a significant cushion – and have since saved hundreds of thousands of dollars in premiums.

In yet another case, management of a rapidly growing organization had maintained a rather "entrepreneurial" attitude toward IT in general – until presented with the results of a risk assessment that gave them a realistic sense of the risks inherent to that posture. Substantial policy changes were made on the spot, and information security began receiving real consideration, not just lip service. Some specific areas of concern are addressed below.

1.2. Diversion of Resources

That organizational staff will have to spend some time providing information for the risk assessment is often a major concern. Regardless of the nature of the assessment, there are two key areas of information gathering that will require staff time and participation beyond that of the person(s) responsible for executing the risk assessment: (1) valuing the intangible information asset's confidentiality, integrity, and availability, and (2) conducting the vulnerability analysis. These tasks will require input from two entirely different sets of people in most cases.

1.3. Valuing the Intangible Information Asset

There are a number of approaches to this task, and the amount of time it takes to execute will depend on the approach as well as whether it is qualitative or quantitative. As a general rule of thumb, however, one could expect all but the most cursory qualitative approach to require one to four hours of continuous time from two to five key-knowledgeable staff for each intangible information asset valued.

Experience has shown that the Modified Delphi approach is the most efficient, useful, and credible. This approach will require (typically) the participation of three to five staff knowledgeable on various aspects of the target information asset. A Modified Delphi meeting routinely lasts 4 hours, so, for each target information asset, key staff time of 12 to 16 hours will be expended in addition to about 12 to 20 hours total for a meeting facilitator (4 hours) and a scribe (8 to 16 hours).

Providing this information has proven to be a valuable exercise for the source participants and the organization by giving them significant insight into the real value of the target body of information and the consequences of losing confidentiality, availability, or integrity. Still, this information alone should not be used to support risk mitigation cost/benefit analysis.

While this “Diversion of Resources” may be viewed initially by management with some trepidation, the results have invariably been judged more than adequately valuable to justify the effort.

1.4. Conducting the Vulnerability Analysis

This task, which consists of identifying vulnerabilities, can and should take no more than 5 work days – about 40 hours – of one-on-one meetings with staff responsible for managing or administering the controls and associated policy, e.g., logical access controls, contingency planning, change control, etc. The individual meetings – actually, guided interviews, ideally held in the interviewees’ workspace, should take no more than a couple of hours. This one-on-one approach minimizes disruption while maximizing the integrity of the vulnerability analysis by assuming a consistent level-setting with each interviewee.

1.5. Credibility of the Numbers

Since the *Guideline for Information Valuation* was published, and significant progress has been made by some automated tools’ handling of the numbers for information asset valuation, threat frequency and impact distributions, and other related risk factors and their associated knowledge bases. The knowledge bases that were developed on the basis of significant research do establish credible numbers. And, credible results are provided, if proven algorithms with which to calculate illustrative risk models are used.

However, manual approaches or automated tools that require the users to develop the necessary quantitative data are susceptible to a much greater degree of subjectivity and poorly informed assumptions.

As recognition of the need for strong information security and associated risk assessment continues to increase, the pressure to launch the function of establishing *a standard Information security threat population, Associated threat frequency, threat scenario and impact data* and maintaining that information that protect the providers of impact and scenario information from disclosure will eventually be successful.

1.6. Subjectivity

The ideal in any analysis or assessment is complete objectivity. As more of the elements of risk are expressed in independently objective terms, the degree of subjectivity is reduced accordingly, and the results will have demonstrable credibility.

Conversely, to the extent a methodology depends on opinion, point of view, bias, or subjectivity, the results will be of increasingly questionable utility. Management is loathe to make budgetary decisions based on risk metrics that express value and risk in terms such as low, medium, and high.

There will always be some degree of subjectivity in assessing risks. However, to the extent that subjectivity is minimized by the use of independently objective metrics, and the biases of tool developers, analysts, and knowledgeable participants are screened, reasonably objective, credible risk modeling is achievable.

1.7. Utility of Results

Ultimately, each of the above factors (Diversion of Resources, Credibility of the Numbers, Subjectivity, and, in addition, Timeliness) plays a role in establishing the utility of the results. Utility is often a matter of perception. If management feels that the execution of a risk assessment is diverting resources from their primary mission inappropriately, the numbers are not credible, the level of subjectivity exceeds a threshold for the organization, or if the project simply takes so long that the results are no longer timely, then the attention and trust of management will be lost or reduced along with the utility of the results.

A risk assessment executed with the support of contemporary automated tools can be completed in a matter of weeks, not months. Developers of the best automated tools have done significant research into the qualitative elements of good control.

The bottom line is that it makes very little sense to execute a risk assessment manually or build one's own automated tool except in the most extraordinary circumstances. A risk assessment project that requires many work-months to complete manually can, with sound automated tools, be done in a matter of days, or weeks at worst, with credible, useful results.

2. Tasks of Risk Assessment

In this section, we will explore the classic tasks of risk assessment and key issues associated with each task, regardless of the specific approach to be employed. The focus will, in general, be primarily on quantitative methodologies.

2.1. Project Sizing

All project methodologies there are a number of elements to be addressed to ensure that all participants understand and are in agreement about the project. These elements include: Background, Purpose, Scope, Constraints, Objective, Responsibilities, Approach.

2.2. Threat Analysis

In manual approaches and some automated tools, the analyst must determine what threats to consider in a particular risk assessment. Since there is not, at present, a standard threat population and readily available threat statistics, this task can require a considerable research effort.

The best automated tools currently available include a well-researched threat population and associated statistics. Using one of these tools assures that no relevant threat is overlooked, and associated risks are accepted as a consequence. If, however, a determination has been made not to use one of these leading automated tools and instead to do the threat analysis independently, there are good sources for a number of threats (for all natural disasters, fire, and crime). For those determined to proceed independently it will be necessary to rely on automated risk assessment tools, or vendors, or your own research for a good threat population and associated statistics.

2.3. Asset Identification and Valuation

The discussion of asset identification and valuation will assume a need for the application of monetary valuation. There are two general categories of assets relevant to the assessment of risk in the IT environment: tangible assets, and intangible assets.

2.4. Tangible Assets

The tangible assets include the IT facilities, hardware, media, supplies, documentation, and IT staff budgets that support the storage, processing, and delivery of information to the user community. The value of these assets is readily determined, typically, in terms of the cost of replacing them.

2.5. Intangible Assets

The intangible assets, Information Assets, are comprised of two basic categories: replacement costs for data and software, and the value of the confidentiality, integrity, and availability of information.

Replacement Costs. Replacement costs for data is not usually a complicated task unless source documents don't exist or are not backed up reliably at a secure off-site location. Conceivably, source documents can now be electronically "scanned" to recover lost electronically stored data. Clearly, scanning is a more efficient process, but it is still time-consuming. However, if neither source documents nor off-site backups exist, actual replacement may become virtually impossible, and the organization faces the question of whether such a condition can be tolerated. If, in the course of the assessment, this condition is found and a determination must be made as to whether such a condition can be overcome.

Value of Confidentiality, Integrity, and Availability. These values often represent the most significant "at risk" asset in IT environments. When an organization is deprived of one or more of these with regard to its business or mission information, depending on the nature of that business or mission, there is a very real chance that unacceptable loss will be incurred within a relatively short time. A brief explanation of each of these three critical values for information is presented below:

- *Confidentiality* is lost or compromised when information is disclosed to parties other than those authorized to have access to the information. In the complex world of IT today, there are many ways for a person to access information without proper authorization if appropriate controls are not in place.
- *Integrity* is the condition that information in or produced by the IT environment accurately reflects the source or process it represents. Integrity may be compromised in many ways, from data entry errors to software errors to intentional modification. Integrity may be thoroughly compromised, for example, by simply contaminating the account numbers of a bank's demand deposit records. Since the account numbers are a primary reference for all associated data, the information is effectively no longer available. There has been a great deal of discussion about the nature of integrity. Technically, if a single character is wrong in a file with millions of records, the file's

integrity has been compromised. In other words, the loss of integrity can have consequences that range from trivial to catastrophic.

- *Availability*, the condition that electronically stored information is where it needs to be, when it needs to be there, and in the form necessary, is closely related to the availability of the information processing technology. The value of the information's availability is reflected in the costs incurred over time by the organization, because the information was not available, regardless of cause.

2.6. Vulnerability Analysis

This task consists of the identification of vulnerabilities that would allow threats to occur with greater frequency, greater impact, or both. For maximum utility, this task is best conducted as a series of one-on-one interviews with individual staff members responsible for implementing organizational policy through the management and administration of controls. The vulnerability analysis should be conducted by an interviewer who guides each interviewee through a well-researched series of questions designed to ferret out all potentially significant vulnerabilities.

2.7. Threat/Vulnerability/Asset Mapping

Without connecting – mapping – threats to vulnerabilities and vulnerabilities to assets and establishing a consistent way of measuring the consequences of their interrelationships, it becomes nearly impossible to establish the ramifications of vulnerabilities. Of course, intuition and common sense are useful, but how does one measure the risk and support good budgetary management and cost/benefit analysis when the rationale is so abstract?

Let us carry the illustration further with two basic vulnerabilities.

No Logical Access Control – means that anyone can sign on the system, get to any information they wish, and do anything they wish with the information. Most tangible assets are not at risk. However, if IT staff productivity is regarded as an asset, as reflected by their annual budget, that asset could suffer a loss while the staff strives to reconstruct or replace damaged software or data. Also, if confidentiality is compromised by the disclosure of sensitive information, substantial competitive advantage and associated revenues could be lost, or liability suits for disclosure of private information could be very costly.

Since the only indicated vulnerability is not having logical access, it is reasonable to assume monetary loss resulting from damage to the integrity of the information or the temporary loss of availability of the information is limited to the time and resources needed to recover with well-secured, off-site backups.

Therefore, it is reasonable to conclude, all other safeguards being effectively in place, that the greatest exposure resulting from not having logical access control is the damage that may result from a loss of confidentiality for a single event. But, without logical access control, there could be many such events!

No Contingency Plan – Not having an effective contingency plan means that the response to any natural or man-made disaster will be without prior planning or arrangements. The

consequences of the loss of information availability would almost certainly be made much worse, and recovery, if possible, would be much more costly. Studies have found that organizations hit by a disaster and not having a good contingency plan are likely (4 out of 5) to be out of business within 2 years.

By mapping vulnerabilities to threats, and threats to assets, we can see the interplay among them and understand a fundamental concept of risk assessment: *Vulnerabilities allow threats to occur with greater frequency or greater impact.* Intuitively, it can be seen that the more vulnerabilities there are, the greater is the risk of loss.

2.8. Risk Metrics/Modeling

The objective of risk modeling is to convey to decision makers a credible, useable portrayal of the risks associated with the IT environment: threat event, impact, frequency, and uncertainty.

With such risk modeling, decision makers are well on their way to making well-informed decisions either to accept, avoid, or transfer associated risk.

There are two general categories of approach to these questions, qualitative and quantitative:

Qualitative – The definitive characteristic of the qualitative approach is the use of metrics that are subjective, such as ordinal ranking low, medium, high, etc;

Quantitative – The definitive characteristic of quantitative approaches is the use of independently objective metrics and significant consideration given to minimizing the subjectivity that is inherent in any risk assessment.

2.9. Management Involvement and Guidance

Organizational culture plays a key role in determining, first, whether to assess risk, and second, whether to use qualitative or quantitative approaches. Many firms' management organizations see themselves as "entrepreneurial" and have an aggressive bottom line culture. Their basic attitude is to minimize all costs, take the chance that nothing horrendous happens, and assume they can deal with it if it does happen.

Other firms, particularly the larger, more mature organizations, will be more interested in a replicable process that puts the results in management language such as monetary terms, cost/benefit assessment, and expected loss. Terms that support budgetary planning.

It is very useful to understand the organizational culture when attempting to plan for a risk assessment and get necessary management support. While a quantitative approach will provide, generally speaking, much more useful information, the culture may not be ready to assess risk in significant depth.

In any case, with the involvement, support, and guidance of management, more utility will be gained from the risk assessment, regardless of its qualitative or quantitative nature. And, as management gains understanding of the concepts and issues of risk assessment and begins to realize the value to be gained, reservations about quantitative approaches will

diminish, and they will increasingly look toward those quantitative approaches to provide more credible, defensible budgetary support.

3. Conclusions

Management of the organization, basing on their organizational culture, should make every effort to assess the risks in the subject IT environments using automated, quantitatively oriented tools. If there is strong resistance to using quantitative tools, then proceed with an initial approach using a qualitative tool.

Work on automated tools continues to improve their utility and credibility. More and more of the companies are offering risk assessment services using, or planning to use, quantitative tools. Managing risk is the central issue of information security. Risk assessment with automated tools provides organizational management with sound insight on their risks and how best to manage them and reduce liability costs effectively.

An Integration of R&D Activities and Flexible Project Planning

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Abstract

A new approach is proposed for tackling nondeterministic aspects of high-tech research-and-development (R&D) project planning. Two kinds of the degrees of freedom are considered: that of the structure of the object of engineering and that of the R&D technology. For optimum employment of resources, R&D activities are focused to develop most crucial, critical parts of the object of engineering by means of a suitable mix of methodologies and tools.

Keywords: research-and-development, planning, resource allocation

1. Introduction

The purpose of this paper is to propose a novel and more effective approach to R&D planning based on closer integration of project management and R&D decision-making. All R&D organizations usually have to make their planning decisions, especially decisions about how to allocate their limited resources, in situations of permanent informational uncertainty and lack of determinism. This is true because R&D work typically deals with fuzzy and problematic objects.

There are two kinds of R&D uncertainties:

- Uncertainties of the object of R&D, especially its structural uncertainty;
- Technological uncertainties, which pose the question of what methodology and tools are to be used for each R&D activity.

The traditional approach to project management is usually based on some suppositions. For instance, it is believed that management is able to more or less easily compile a list of activities constituting a project, a list of necessary equipment and tools to be used and give a more or less accurate estimate of required time, labor and other resources. Thus, the traditional approach is based on intuitive decisions about the structure of an R&D object offered to management by researchers and engineers. This means that a large number of possible decisions are cut down by a forcible act and the existence of alternatives may be even not recognized.

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A different approach is when to tackle these uncertainties meaningfully an R&D worker collects all available expertise on alternative structural and parametric decisions, formulates all possible combinations of R&D activities for implementing these alternatives, including alternative R&D methods, tools, and associated resources. We believe that in all stages, and especially earlier stages, of developing a new object (product, system) there exist many alternative principles and structures of the future object, many alternative implementations of its components and alternative methods of R&D.

When creating a very complex system, resource limitations make researchers and engineers focus their efforts and other means on most crucial, critical parts of the system being created. These are usually parts involving scientific and/or technological breakthroughs, perhaps, at the expense of those parts of the system whose design features a comparatively high degree of certainty. It means that resource allocation in planning high-tech R&D activities is strongly influenced by scientific and technological expertise in the problem domain. Such expertise should be used for determining a rational degree of detailed elaboration to be reached for various parts of a complex system being developed.

Management should be given the means for determining the structure of the future system, for breaking it down into a list of subsystems or parts, for determining a rational degree of detailed elaboration for all the subsystems, and also the means for choosing optimal combinations of R&D methods and tools. Information about the structure of the system and possible combinations of technological means is necessary for breaking down a project into a list of activities, and determining for each activity its immediate predecessors and estimating required time, labor, and other resources.

To formalize the problem of an R&D project planning one has:

- To formulate an objective of the R&D project;
- To collect and use expertise on alternative courses of action, one of which will achieve the objective;
- To clarify resource limitations of the R&D team (organization);
- To express the objective of the R&D project and the constraints on resources as mathematical equations or inequalities;
- To express the available expertise on alternative realizations (structures) of the object of the R&D project as knowledge-engineering formalisms using some kind of knowledge representation model.

A typical objective of an R&D project is to create a new or improve an existing object (product, system) meeting the requirements of a customer. An R&D project objective consists of two parts:

- Formulation of requirements specification for the R&D object
- Formulation of requirements specification for the R&D process

Requirements for the R&D object are usually aimed at improving some performance criteria. Requirements for the R&D process determine such resource constraints of the R&D organization as labor, time and money. The input of an R&D process is an initial description of the R&D object, namely, the requirements specification for the R&D object. The output is an R&D object's final technical description for creating the R&D object and usually a pre-production model. The R&D process consists of a sequence of stages and substages, which transform an initial description into a final description through a series of intermediary ones.

For building knowledge-based models of alternative realizations of the R&D object and R&D technologies, an advanced morphological technique, called 'logical-combinatorial approach' (LCA), is proposed in this paper. The task of engineers is, using preliminary morphological analysis and the top-down methodology, to select a most preferable structural description of the R&D object. Such a description is usually based on differentiated decomposition, i.e., various parts of the project are subject to different levels of decomposition. The task of management is to evaluate resource consumption by various parts of the project.

2. A Model of R&D Object Structure

The multi-level hierarchical description (model) of the R&D object can be represented by a set of double-level modules and single-level terminal components. The R&D object is symbolized as a double-level module M. Its components are $M_1,...,M_N$. Each $M_i\ (t \in 1:N)$ may be either a double-level module or a single-level component. Any double-level module M_α can be represented as $M_\alpha =< S_\alpha, P_\alpha >$, where α is a hierarchical subscript; S_α is a structural description (block-diagram or shape description) of M_α, P_α is its parametric description. A hierarchical subscript α is a string of subscripts separated by dots. It can be represented as $\alpha = \beta.i$, where β is the hierarchical subscript of the higher-level component M_β, to which component $M_\alpha = M_{\beta.i}$ belongs. For the entire system M subscript α is empty.

The structural block-diagram description of any double-level module M_α can be represented using the plex notation (Ankoudinov, 1979, 1986) $S_\alpha = \Psi_\alpha \Gamma_\alpha S_{\alpha.1}...S_{\alpha.N\alpha}$, where $S_{\alpha.1}...S_{\alpha.N\alpha}$ is a list of N_α components (submodules or parts) of S_α; Γ_α is a concatenation matrix describing how components $S_{\alpha.1},...,S_{\alpha.N\alpha}$ are mutually interconnected; Ψ_α is a substitution matrix showing how the external contacts of plex $\Gamma_\alpha S_{\alpha.1}...S_{\alpha.N\alpha}$ correspond to the external contacts of module S_α.

The parametric description of module M_α may be represented as $P_\alpha =< R_\alpha, Y_\alpha, F_\alpha, X_\alpha >$, where R_α is a formulation of requirements (required performance parameters) for M_α, Y_α are attained performance parameters of M_α, F_α is a functional dependence of Y_α on X_α, X_α are parameters of components $M_{\alpha.1},...,M_{\alpha.N\alpha}$.

Initially, the values of X_α and Y_α are not known. In the process of design they may be assigned concrete values X_α^* and Y_α^*, so that $Y_\alpha^* = F(X_\alpha^*)$.

The R&D activity for component S_α can be represented as $< R_\alpha, I_\alpha >$, where R_α is an initial activity of formulating requirements for M_α; I_α is an accomplishing activity of implementing M_α, $I_\alpha \in \{\Lambda_\alpha, V_\alpha, Z_\alpha\}$.

There exist in general the following alternatives of I_α:

1. Activity I_α may be absent $(I_\alpha = \Lambda_\alpha)$ because, for instance, available resources are insufficient for implementing M_α.
2. M_α is regarded as a single-level component $(I_\alpha = V_\alpha)$ either as a ready-made component available on the market or a component to be designed using a well-defined technology.
3. Activity I_α may take the form of designing and engineering M_α as a complex component based on decomposing M_α into a group of components $M_{\alpha.1},...,M_{\alpha.N\alpha}$, where each component is either a double-level module or a single-level part. In this case $I_\alpha = Z_\alpha$ and $Z_\alpha =< L_\alpha, K_\alpha >$, where L_α is an activity of building and analyzing a double level model for M_α and K_α is an activity of developing components $M_{\alpha.1},...,M_{\alpha.N\alpha}$ of M_α.

3. A Model of a Complex of R&D Activities

A complex of activities constituting an R&D process corresponds to the hierarchical structure of the R&D object. Each R&D activity requires a certain technology based on a set of methodologies (scientific methods, modeling techniques, etc.) and tools (instruments, computer software, etc.) for implementing it. In general, alternative technologies exist for each R&D activity. Let T be a set of all technologies, H be a set of all methodologies and tools.

Let also $T(R_\alpha), T(V_\alpha)$, and $T(L_\alpha)$ be subsets of technologies for activities R_α, V_α, and L_α, respectively. For each technology $t \in T(R_\alpha), t \in T(V_\alpha)$, or $t \in T(L_\alpha)$, a subset $H_t \subset H$ of methodologies and tools is used.

Alternative variants of R&D activities for module M_α can be presented by the following logical expression:

$$y_\alpha = x_\alpha \,\&\, (\lambda_\alpha \vee \nu_\alpha \,\&\, (\bigvee_{t \in T(V\alpha)} u_t \,\&\, u_{t,V\alpha}) \vee z_\alpha \,\&\, (\bigvee_{t \in T(L\alpha)} u_t \,\&\, u_{t,L\alpha})), \qquad (1)$$

where "V" and "&" are logical disjunction and conjunction, correspondingly.

Variables x_α, λ_α, ν_α, $u_{t,R\alpha}$, $u_{t,V\alpha}$, and $u_{t,L\alpha}$ are independent Boolean variables:

λ_α = "Implementation activity for M_α is not fulfilled";

ν_α = "M_α is selected as a ready-made component or designed as a new component following a well-determined technology";

$u_{t,R\alpha}$, $u_{t,V\alpha}$, $u_{t,L\alpha}$ = "Technology t is used for a corresponding activity for M_α".

Variables x_α, z_α, y_α and u_t are functions of other Boolean variables:

x_α = "Requirements for M_α are formulated";

y_α = "Activities on module M_α are accomplished";

z_α = "M_α is designed as a complex component on the basis of breaking down M_α into a group of components $M_{\alpha.1} \ldots M_{\alpha.N\alpha}$";

u_t = "Technology t is used for some activity on M_α".

Variables x_α depend on variables u_t and $u_t, u_{t,R\alpha}$: $x_\alpha = \bigvee_{t \in T(R\alpha)} u_t \,\&\, u_{t,R\alpha}$.

Variables u_t are defined by the conjunction $u_t = \&_{h \in Ht} w_h$, where w_h = "Methodology or tool h is used". Variables z_α depend on variables $y_{\alpha.i}$: $z_\alpha = \&_{i \in 1:N\alpha} y_{\alpha.i}$. Further in this paper, all these variables will also be treated as (0,1)-variables.

Suppose that associated with each $t \in T$ and R_α, V_α, or L_α are the following parameters:

- Effectiveness $e_{t,R\alpha}, e_{t,V\alpha}$, or $e_{t,L\alpha}$ of applying technology t to a corresponding R&D activity;

- Required labor effort $q_{t,R\alpha}, q_{t,V\alpha}$, or $q_{t,L\alpha}$ usually expressed in man-days or man-weeks;
- Required expenditure $c_{t,R\alpha}, c_{t,V\alpha}$, or $c_{t,L\alpha}$;

Parameters $q_{t,R\alpha}, q_{t,V\alpha}$, or $q_{t,L\alpha}$ include only labor effort directly necessary for implementing a corresponding R&D activity, without labor for mastering new methods and tools. Parameters $c_{t,R\alpha}, c_{t,V\alpha}$, or $c_{t,L\alpha}$ do not comprise money to be spent on purchasing or renting all the tools and instruments needed for implementing technology t.

To evaluate any R&D plan, one needs some measure of resource utilization efficacy for the chosen differentiated detailed elaboration of the R&D project. Efficacy of an implementation of any R&D activity depends on absolute significance (importance) of developing the corresponding module or its part and adequacy (sufficiency, acceptability) $a_{t,R\alpha}, a_{t,V\alpha}$, or $a_{t,L\alpha} \in [0,1]$ of R&D technology being used for implementing activities R_α, V_α, or L_α for module M_α.

Efficacy of an implementation of R&D activities R_α and I_α depends on absolute significance (weight) W_α of developing module M_α: $W_\alpha = W_{R\alpha} + W_{I\alpha}$, where $W_{R\alpha}$ and $W_{I\alpha}$ are absolute significance estimates for R_α and I_α, respectively. If module M_α is described as a structure $S_\alpha = \Psi_\alpha \Gamma_\alpha S_{\alpha.1} ... S_{\alpha.N\alpha}$, then $W_{I\alpha} = W_{L\alpha} + \sum_{i \in 1:N\alpha} W_{\alpha.i}$, where $W_{L\alpha}$ is an absolute significance of building a double level model of M_α, to be followed by, at least, determining the requirements specification for and, at most, developing components $M_{\alpha.i}\ (i \in 1:N_\alpha)$ of M_α; $W_{\alpha.i}$ is an absolute significance of developing component $M_{\alpha.i}\ (i \in 1:N_\alpha)$ of M_α. Absolute significance of a total project M is $W = 1$.

To obtain absolute values of significance for all modules, experts should provide relative normalized importance estimates (weights) $w_\alpha, w_{R\alpha}, w_{I\alpha}$, etc., for components of activities. Thus, we assume $w_\alpha = w_{R\alpha} + w_{I\alpha} = 1$, $W_{R\alpha} = w_{R\alpha} * W_\alpha$, and $W_{I\alpha} = w_{I\alpha} * W_\alpha$. We also assume $w_{L\alpha} + w_{K\alpha} = 1$, $\sum_{i \in 1:N\alpha} w_{\varepsilon.i} = 1$, $W_{L\alpha} = w_{L\alpha} * W_\alpha$, and $W_{\alpha.i} = w_{\alpha.i} * W_{K\alpha}$. Efficacy values of separate R&D activities for module M_α based on technology t are expressed as follows: $e_{t,R\alpha} = W_{R\alpha} * a_{t,\alpha}$ for $t \in T(R_\alpha)$, $e_{t,V\alpha} = W_{V\alpha} * a_{t,\alpha}$ for $t \in T(V_\alpha)$, $e_{t,L\alpha} = W_{L\alpha} * a_{t,\alpha}$ for $t \in T(L_\alpha)$.

Efficacy of developing module M_α is equal to

- $e_{t,R\alpha}$ for $I_\alpha = \Lambda_\alpha$;

- $e_{t,R\alpha} + e_{u,V\alpha}$ for $I_\alpha = V_\alpha$, where $t \in T(R\alpha)$ and $u \in T(V\alpha)$;
- $e_{t,R\alpha} + e_{u,L\alpha} + \sum_{i \in \mathrm{l}:N\alpha} e_{\alpha.i}$ for $I_\alpha =< L_\alpha, K_\alpha >$, where $t \in T(R\alpha)$ and $u \in T(V\alpha)$.

Using the Boolean variables introduced above, efficacy of a selected variant of developing module M_α is given by the formula:

$$E_\alpha = x_\alpha \sum_{t \in T(R\alpha)} e_{t,R\alpha} u_{t,R\alpha} + \nu_\alpha \sum_{t \in T(V\alpha)} e_{t,V\alpha} u_{t,V\alpha} + z_\alpha \left(\sum_{t \in T(L\alpha)} e_{t,L\alpha} u_{t,L\alpha} + \sum_{i \in \mathrm{l}:N\alpha} E_{\alpha.i} \right). \qquad (2)$$

Efficacy E of a total project is given by (2), where α is empty.

Labor required for the selected variant of developing module M_α (without that required for mastering technological factors involved) is given by the formula:

$$Q'_\alpha = x_\alpha \sum_{t \in T(R\alpha)} q_{t,R\alpha} u_{t,R\alpha} + \nu_\alpha \sum_{t \in T(V\alpha)} q_{t,V\varepsilon} u_{t,V\alpha} + z_\alpha \left(\sum_{t \in T(L\alpha)} q_{t,L\alpha} u_{t,L\alpha} + \sum_{i \in \mathrm{l}:N\alpha} Q'_{\alpha.i} \right).$$

Total labor required for a project:

$$Q = Q' + \sum_{h \in H} w_h q_h, \qquad (3)$$

where q_h is labor effort required for mastering technological factor h.

Weight	M_α		
	M	M_1	M_2
w_α	–	0.625	0.375
W_α	1	0.25	0.15
$w_{\mathrm{R}\alpha}$	0.3	0.2	0.2
$w_{\mathrm{I}\alpha}$	0.7	0.8	0.8
$W_{\mathrm{R}\alpha}$	0.3	0.05	0.03
$W_{\mathrm{I}\alpha}$	0.7	0.2	0.12
$w_{\mathrm{L}\alpha}$	0.43	–	–
$w_{\mathrm{K}\alpha}$	0.57	–	–
$W_{\mathrm{L}\alpha}$	0.3	–	–
$W_{\mathrm{K}\alpha}$	0.4	–	–

Table 1.

A_α	W_α	t	$a_{\mathrm{t,A}\alpha}$	$e_{\mathrm{t,A}\alpha}$	$q_{\mathrm{t,A}\alpha}$	$c_{\mathrm{t,A}\alpha}$
R	0.3	1	0.8	0.24	70	110
		2	0.9	0.27	120	90
V	0.7	3	0.7	0.49	310	220
		4	0.8	0.56	520	370
L	0.3	5	0.7	0.21	130	200
		6	0.9	0.27	190	210
R_1	0.05	1	0.8	0.04	50	90
		2	0.7	0.035	40	80
V_1	0.2	7	0.9	0.18	400	80
		8	0.7	0.14	350	150
R_2	0.03	1	0.8	0.024	40	80
		2	0.9	0.027	60	90
V_2	0.12	9	0.6	0.072	350	210
		10	0.8	0.096	410	170

Table 2.

Expenses required for a selected variant of developing module M_α (without expenses for buying or renting technological factors) are given by the formula:

$$C'_\alpha = x_\alpha \sum_{t \in T(R\alpha)} c_{t,R\alpha} u_{t,R\alpha} + v_\alpha \sum_{t \in T(V\alpha)} c_{t,V\varepsilon} u_{t,V\alpha} + z_\alpha \Big(\sum_{t \in T(L\alpha)} c_{t,L\alpha} u_{t,L\alpha} + \sum_{i \in \mathrm{l}:N\alpha} C'_{\alpha.i} \Big).$$

Total expenditure for a project

$$C = C' + \sum_{h \in H} w_h c_h, \tag{4}$$

where C_h is money required for buying or renting technological factor h.

The mathematical problem of finding an optimum solution can be formulated as follows:

$$\{E \to \max,\ y = \text{"true"}, Q \le Q^*, C \le C^*\}, \tag{5}$$

where y, E, Q, and C are defined above by formulae (1-4); $y = \text{"true"}$ is a logical constraint determining all alternative complexes of R&D activities; Q^* and C^* are constraints on total project labor and expenditure.

The Logical-Combinatorial Approach and an experimental software package SYMFOR (Ankoudinov, 1982, 1983, 2001) allow one to solve the problem (5).

Let us consider an example of using the LCA for determining an optimum degree of elaboration and mix of technologies for a system M made up of two subsystems M_1 and M_2. Table 1 presents the results of determining the weights for R&D activities, Table 2 presents types of technologies $t \in \{1,...,10\}$, adequacy, efficacy, labor, and expense estimates for alternatives of activities $A_\alpha \in \{R_\alpha, V_\alpha, L_\alpha\}$.

Table 3 gives the sets of methodologies and tools for every technology t, and Table 4 gives the estimates of cost and labor required for methodologies and tools.

t	1	2	3	4	5	6	7	8	9	10
H_t	1	2	3	4	5,6	5,7	8	9	0	11

Table 3.

For constraints $Q^* = 500$ and $C^* = 400$ an optimum alternative is to use technology 2 for the formulation of requirements and to create a project for system M using a well-defined technology 3.

A special feature of the LCA is that it allows one to find the set Ω_{opt} of all formally optimum alternatives for (5), as well as the set Ω_{subopt} of some sub-optimum solutions. This

property is important because coefficients w_α, $a_{t,A\alpha}$, $e_{t,A\alpha}$, $q_{t,A\alpha}$, and $c_{t,A\alpha}$ are determined with an error. The final alternative should be selected by an informal procedure, using informal criteria.

h	1	2	3	4	5	6	7	8	9	10	11
c_h	30	45	40	60	30	95	50	70	75	90	80
q_h	25	30	15	20	45	30	35	40	20	10	15

Table 4.

Another example of optimizing a complex of CASE technologies by means of the LCA is available in (Ankoudinov et al., 2001).

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Modeling and Analysis Tools

GIS Fuzzy Methods for Regional Planning

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Abstract

Regional planning is associated with uncertainty analysis on the one hand and with a consideration of geo-located characteristics on the other hand. Uncertainty is natural in decision-making processes, which involve data and model uncertainty. It originates from the features of objects (variability, instability, etc) and also from the way of obtaining data (measurement accuracy, processing error, quality of data source, etc). With the use of fuzzy modelling in the GIS environment several GIS fuzzy algorithms (GISFA) have been developed. GISFA extend traditional planning support algorithms by providing adequate tools for spatial fuzzy analysis and interactive cartographic interfaces. The examples applications of GISFA presented in this paper prove useful for the analysis of competing solutions in the field of spatial planning.

Keywords: GIS, fuzzy modelling, regional planning

1. Introduction

The set of decision-makers' solutions is typically limited by their experience, time, creativity, and motivation. Many elements of regional planning have uncertainties on the one hand and geo-located characteristics on the other hand. Scenario analysis of spatial planning is associated with uncertainty analysis. Uncertainty is natural in decision-making processes, which involve data and model uncertainty. It originates from the features of objects (variability, instability, etc) and also from the way of obtaining data (measurement accuracy, processing error, quality of data source, etc).

Fuzzy modelling is a useful approach for dealing with uncertainty and imprecision. Fuzzy sets are especially useful when insufficient data exists and when it is impossible to characterise uncertainty using standard statistical measures (e.g., mean, standard deviation, and distribution type) (May et al., 1997). Recently, fuzzy modelling has been developed very intensively for scenario analysis of real world planning. An analysis of the current

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situation in the field of spatial planning methodology shows that there is a lag in the development of theoretical approaches based on fuzzy modelling in a GIS environment.

Let us call fuzzy modelling (FM) in a GIS environment as GIS fuzzy modelling (GISFM). The GISFM approach provides the basis for scenario analysis characterized by some degrees of uncertainty, non-linearity, and complexity. GISFM is realized practically by fuzzy algorithms (FA) integrated into GIS (GISFA). This paper includes the description of several GIS fuzzy algorithms and illustrates the benefits of GISFA with some examples.

2. GIS Fuzzy Algorithms

2.1. Structure of GISFA

The structure of GIS fuzzy algorithms (GISFA) is shown on Fig. 1. GISFA includes two main parts: a module for obtaining missing data; a module for fuzzy analysis. The first module contains a library of models and expert systems that are needed for obtaining missing data. The second module includes fuzzy models and is intended for obtaining new data, new information and new knowledge taking into account the imprecision and uncertainty of the information used. All models used in GISFA have an interface with GIS.

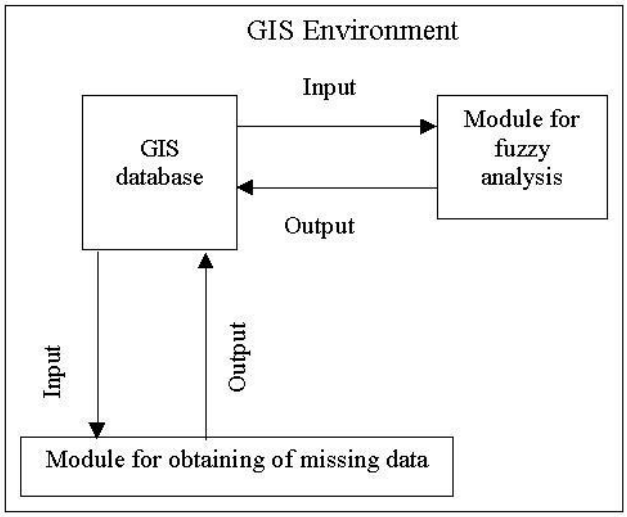


Figure 1: Structure of the GIS fuzzy algorithms.

2.2. Description of the Fuzzy Models

It is well known that imprecision is inherent in the planning process. It originates from the features of objects (variability, instability, etc) and also from the way of obtaining data (measurement accuracy, processing error, quality of data source, etc). Fuzzy sets theory (FST) and fuzzy logic (FL) are mathematical disciplines used to characterize uncertainty of data and functional relationships. Currently, FST is under intensive development.

FL emerged as a more general form of logic that can handle the concept of partial truth. Truth here takes intermediate values between "completely true" and "completely false". FL is used as a modelling methodology that allows an easier transition between humans and computers for decision-making, and a better way to handle imprecise and uncertain information. Fuzzy sets are especially useful when insufficient data exists and it is impossible to characterize uncertainty using standard statistical measures (e.g., mean, standard deviation, and distribution type). The main advantage of fuzzy modelling is the use of linguistics to represent the relationship being modelled, instead of the quantitative variables used in traditional methods.

The central concept of the FST is the membership function (MF), which represents the relationship of an element to a set. MF of a fuzzy set is expressed on a continuous scale from 1 (full membership) to 0 (full non-membership). The advantage of the application of FST for scenario analysis of regional planning is that the main indices of the planning process could be estimated by MF. Taking this information into consideration we suggest, that the term fuzzy model (FMOD) be used as an umbrella term to describe a combination of various applications of FST and a concept of the planning process.

2.3. GISFA Software

All models used in GISFA should have the interface with GIS. According to (Hartkamp et al., 1999), the terms interface and interfacing may be used as umbrella words for the simultaneous use of GIS and modelling tools, since they do not imply a specific level of interaction between them. GISFA software is built up in accordance with this kind of interfacing. In particular realization of integrating implies that a programming language used both in GIS software and GISFA software should be the same. For example, if it is assumed that GISFA will be used on the basis of MapInfo software, then it is appropriate to use MapBasic language for programming of fuzzy models and other components of GISFA. Recently, programs using GISFA were designed using MapBasic (Kurtener et al., 2000).

2.4. The use of GISFA

Generally the use of GISFA consists of the following procedures: 1) Selection of the appropriated GISFA from GISFA library; 2) Collection of data used as input data; 3) Obtaining missing data needed as input data; 4) Calculation and mapping of the indices of the planning process using the custom developed GISFA software.

3. Application of GISFA

3.1. Estimation of Land Drainage Plots

Objectives. In the design of renovation of land drainage systems it is necessary to solve the problems of allocation of investment between parts of the system (named drainage plots) that need renovations. It is necessary to solve the following problem: how to allocate the available capital between these parts. Solution of the problem include consideration of the following items: 1) Evaluation of the efficient use of funds for the transformation of the land drainage system; 2) Evaluation of possible ecological effects, if the transformations will not

be carried out; 3) Evaluation of social reaction to this activity. Consideration of the items is associated with the following variants of scenario analysis: 1) To carry out a multiple evaluation of land drainage systems for special cases when ecological criterion is more important; 2) To make a similar analysis for other cases in which economical criterion is more important.

Module for Fuzzy Analysis. The module for fuzzy analysis includes two fuzzy models. The first is the linguistic model. Linguistic or fuzzy variables are variables with names that characterize the semantics of the underlying concept and these names are represented mathematically by fuzzy sets (Corne et al., 1999). The second fuzzy model is intended for multiple evaluations of land drainage plots. It is based on the section of fuzzy sets theory, which is devoted to multi-criteria assessment and choice of alternatives (Borisov et al., 1989). Let us assume that there is a set of land drainage plots:

$$A = \{a_1, a_2, \ldots, a_m\}, \tag{1}$$

and a fuzzy set for a specific criterion C:

$$C = \{\mu_C(a_1)/a_1, \mu_C(a_2)/a_2, \ldots, \mu_C(a_m)/a_m\}, \tag{2}$$

where the membership function $\mu_C(a_i)/a_i$ expresses the expert knowledge about the grade of satisfaction of land drainage plot a_i to the criterion C. If there are several criteria $C_1, C_2, \ldots, C_n$ and there are coefficients of relative significance of these criteria $\alpha_1, \alpha_2, \ldots, \alpha_n$, then the rule for the selection of the best drainage plot taking into account α_i will be written as an intersection of $C_i^{\alpha_i}$. Coefficients of relative significance α_i are determined by the procedure of comparison of a pair of criteria. This procedure starts with the forming of matrix B. Elements b_{ij} of matrix B are defined in Table 1 and must satisfy the conditions: $b_{ii} = 1$, $b_{ij} = 1/b_{ij}$.

Relative importance of criteria C_i and C_j	**Element b_{ij}**
Equilibrium	1
Very of little importance	3
Of little importance	5
Importance	7
Great importance	9
Intermediate value	2, 4, 6, 8

Table 1: Scale of evaluation of the relative importance of criteria.

For example, if the user (or expert) estimates the relative importance of criteria C_i and C_j as equilibrium then element $b_{ij} = 1$; if the user (or expert) estimates the relative importance of criteria C_i and C_j as great importance then element $b_{ij} = 9$.

Then, the eigenvector of the matrix B is determined from the solution of the following equation:

$$Bw = \lambda_{\max} w, \tag{3}$$

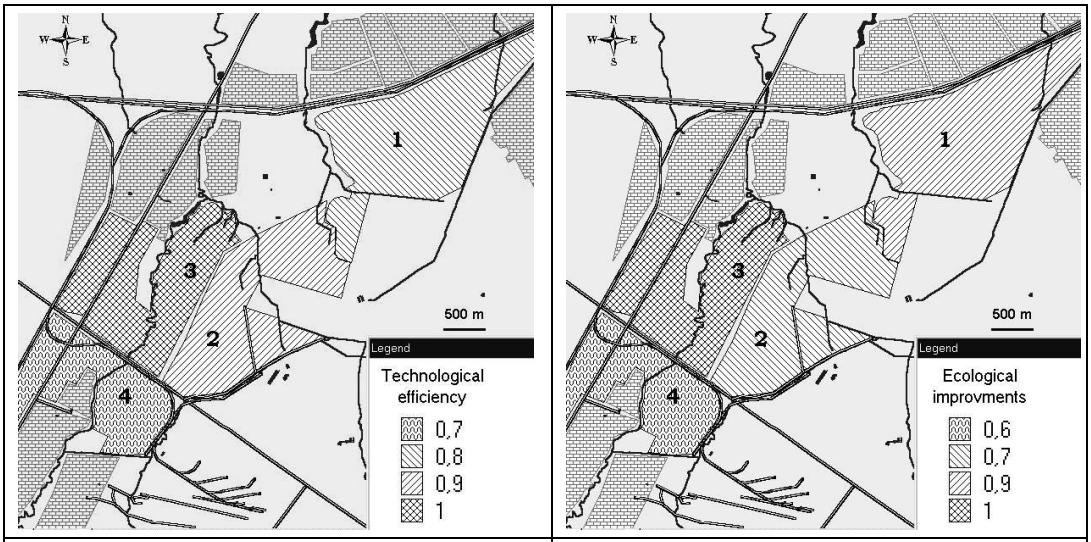
where $\lambda_{\max}$ is the maximum of eigenvalues of the matrix. The solution is given by $a_i = nw_i$, where n is a number of the criteria. The mathematical operation for the intersection of fuzzy sets is in agreement with the operation for the quest of minimum of the membership functions of these fuzzy sets. In this specific problem, the preference is given to the drainage plot characterized by the greatest value of the membership function.

Scenario Analysis. The scenario analysis was carried out by four criteria: Technological criterion (TC); Economical criterion (EC); Ecological criterion (ECC); Social criterion (SC). These criteria are evaluated by the membership function for the fuzzy set: "the best land drainage plots for investment". Values of these criteria are calculated using the expert system. Then these values were added to the GIS database. The corresponding thematic maps are presented on Fig. 2.

The results of the scenario analysis are calculated and mapped with the use of the software developed by the authors in an environment of MapInfo software. It is shown (Fig. 3) that in the first variant the allocation of investment has to carry out in the following order: plot#3, plot#1, plot#2, and plot#4. In the second variant the allocation of investment has to follow this order: plot#1, plot#4, plot#3, and plot#2.

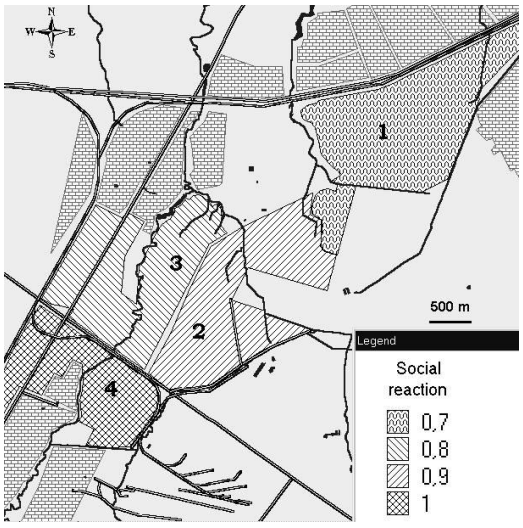
4. Conclusions

GIS fuzzy algorithms (GISFA) extend traditional planning support algorithms by providing adequate tools for spatial fuzzy analysis and interactive cartographic interfaces. It is known that the set of decision-makers' solutions is typically limited by their experience, time, creativity, and motivation. Also, it is noted that many elements of planning have uncertainties on one hand and geo-located characteristics on other hand. Uncertainty is inherent in the processes of planning that involve data and model uncertainty. The developed approach provides the basis for spatial scenario analysis characterized by high degrees of uncertainty, non-linearity and complexity, i.e., the planning process described by fuzzy models that are linking (or integrating) with GIS. The SPSFA is powerful tool for scenario analysis that takes into account technological, economic, ecological and social factors. This work provides a basis for future applications and research not only on the spatial scenario analysis, but also on wider fields.

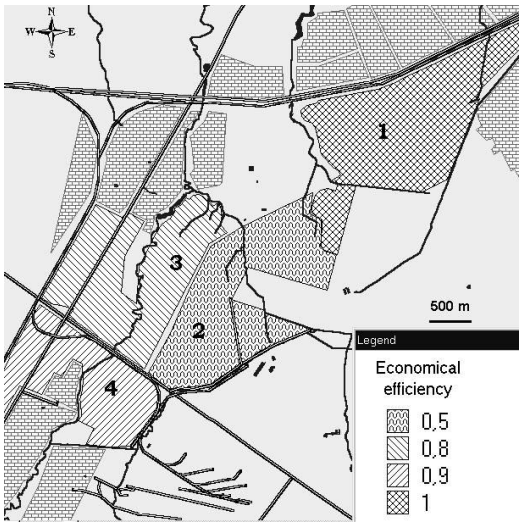


a) Index of technological efficiency.

b) Index of ecological improvements.

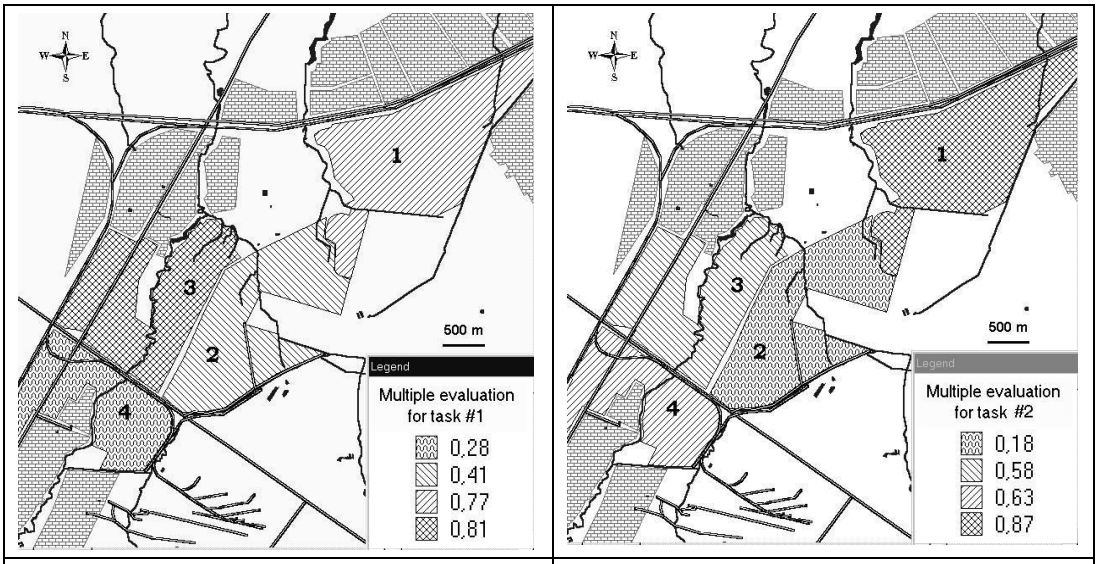


c) Index of social reaction.



d) Index of economical efficiency.

Figure 2: Scenario analysis of land drainage plots.



a) Index of the multiple evaluation of land drainage plots for special cases when the ecological factor is more important

b) Index of the multiple evaluation of land drainage plots for special cases when the economical factor is more important.

Figure 3: Scenario analysis of land drainage plots.

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Time Series Analysis in Decision Making

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Abstract

Time series analysis plays an important role in decision-making process in modern management. It is now being developed as a part of Data Mining technologies in order to automate descriptive models construction and forecasting. But a number of features of time series analysis are not currently presented in statistical software and require some specific econometric knowledge from user, i.e. human participation in construction of models. One of the key features, the stationarity test, is described in this paper with the example of macroeconomic model.

Keywords: time series, multiple regression, stationarity, Dickey-Fuller test, Data Mining

1. Introduction

Modeling is one of the key elements of decision-making process. When dealing with historical data (financial management, in state or municipal government practice, etc.) the descriptive model, that can be further used for extrapolation and forecasting, is constructed on the basis of econometric time series analysis. In modern database management systems and decision support systems time series analysis (sequence-based analysis, or, sequential association) is used as one of the Data Mining methods. This method is used in target markets analysis, price flexibility management, customer lifecycle management. However when using software, which is capable of time series processing, one can face some difficulties, particularly non-stationarity problem. That problem is illustrated further with the specific example.

The research presented in this paper has been devoted to the analysis of macroeconomic factors of Russian economy. During 1992-1999 high rates of unemployment and inflation were the most important problems of Russian economy, having influenced both on economic crisis and caused some negative consequences in social sphere. That is why these factors have been chosen as main variables of the research.

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2. Construction of the Model

2.1. Macroeconomic Theory

It was A. Phillips, who first empirically found the negative dependence "between the rate of unemployment and the rate of change of money wages" (Phillips, 1958). The empirical curve was later called after his name (To be more precise, this negative dependence was firstly discovered by I. Fisher (1926), but his paper had been unknown to economists for a long time.). Samuelson and Solow contributed to the theory of Phillips curve next. They formulated the dependence between the rate of unemployment and inflation rate (it is the formula which is called "Phillips curve" in modern macroeconomics). Phelps and Friedman postulated that in case of steady inflation Phillips curve was not functioning and only one level of unemployment existed in the long-term equilibrium. So the NAIRU ("Non-Accelerating Inflation Rate of Unemployment") concept appeared, which is still actively used by macroeconomists (see, e.g., Melberg, 1996).

In 1990-s Layard, Nickell and Jackman proposed a theory that integrated various ideas about Phillips curve (Layard et al., 1991, 1994). There modern Phillips curve equations were theoretically stated and some practical disturbances were explained (e.g. possible change of both unemployment and inflation rates in one direction). It was also shown that it's possible to describe the influence of various macroeconomic variables (such as wages, productivity, import prices, taxes, etc.) on the dependence between the rate of unemployment and changes in inflation rate in a single theoretical framework.

In the research presented in this paper the above macroeconomic ideas were used in attempt to model Russian economy. It was clear that one could not just use western authors conclusions for Russian macroeconomic data, because our economy had a number of specific features: higher inflation (especially in the beginning of the investigated period, e.g. in 1992 inflation rate was equal to 2500 per cent), smaller share of wages in production costs, non-correspondence of inflation and wages growth, steady growth of unemployment during the considered period, raw materials-oriented export, etc. Keeping these features in mind it was absolutely impossible to predict whether our empirical model would correspond general macroeconomic theory or not.

2.2. Preliminary Analysis of Data and Selection of Variables

"Russian Economic Trends", the program of monitoring Russian economy (maintained by Stockholm School of Economics web-site), was used as a main source of macroeconomic information. As authors state (and it was verified) the data presented on the site are being collected from official publications of State Statistics Committee (Goskomstat), State Employment Service (GSZ), Central Bank of Russian Federation, the Ministry of Finances, State Custom Committee and from International Monetary Fund reports.

After considering the available data some basic variables were calculated: the rate of unemployment (Fig. 1), monthly inflation rate (Fig. 2), labor productivity, average real wages (Fig. 3), cash amount (M0), volumes of import and export in roubles. It should be mentioned that there two different unemployment rates could be calculated: basing on

official number of unemployed (which is published by the Employment Service) and unofficial one (defined by the International Labor Organization standardized questionnaires, that number was closer to real situation; see Fig. 1). The latter was chosen as main unemployment variable of the model.

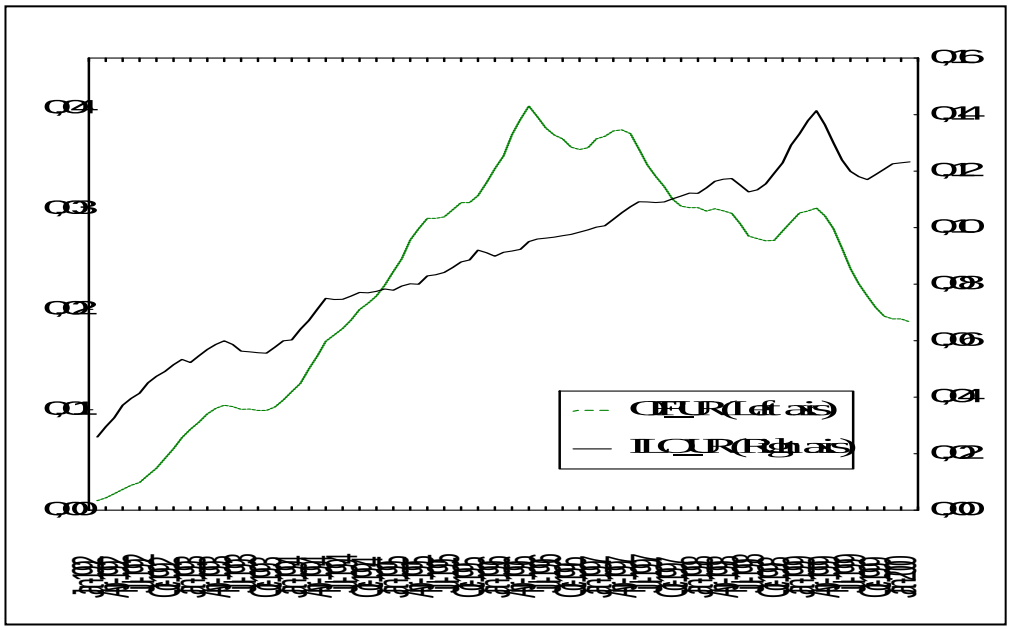

Figure 1. The rates of registered unemployment (OFF_UR) and unemployment calculated on International Labor Organization standards (ILO_UR) in Russia.

In fact, the very important and time-consuming part of the research consisted in preliminary processing of data (maximum length of all time series and sequence of manipulations made are presented in Table 1) and careful examination of chosen variables (including visual analysis of graphs; e.g., see Fig. 2 – the outlier in September 1998 was replaced by mean of two adjacent points). Extra attention drawn to the above problem was caused by the consideration that any model constructed on raw data (without preprocessing) could not be treated as of appropriate quality and any results received from such a kind of model are not worth the trust.

There were monthly data used, so it was necessary to remove any seasonal distortions (e.g. see Fig. 3). So all time series were seasonally adjusted (multiplicative adjustment in EconometricViews statistical software package). And multiple regression analysis methods (in STATISTICA program) were used further in order to construct the descriptive model based on these seasonally adjusted data.

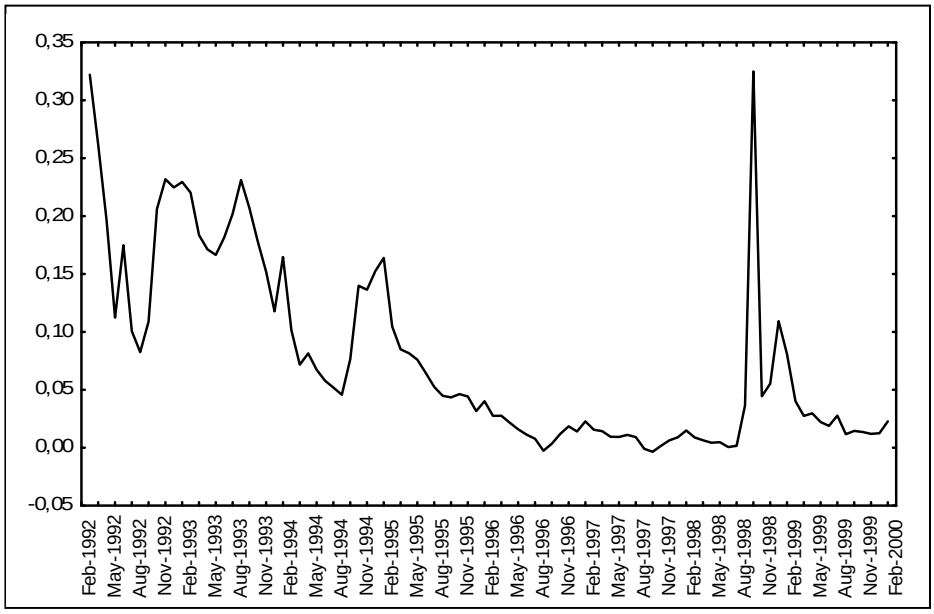

Figure 2: Monthly inflation rate in Russia.

Next step of research is usually missed in Russian economical literature. It was necessary to determine an order of integration of time series considered in order to decide whether raw time series are stationary or not.

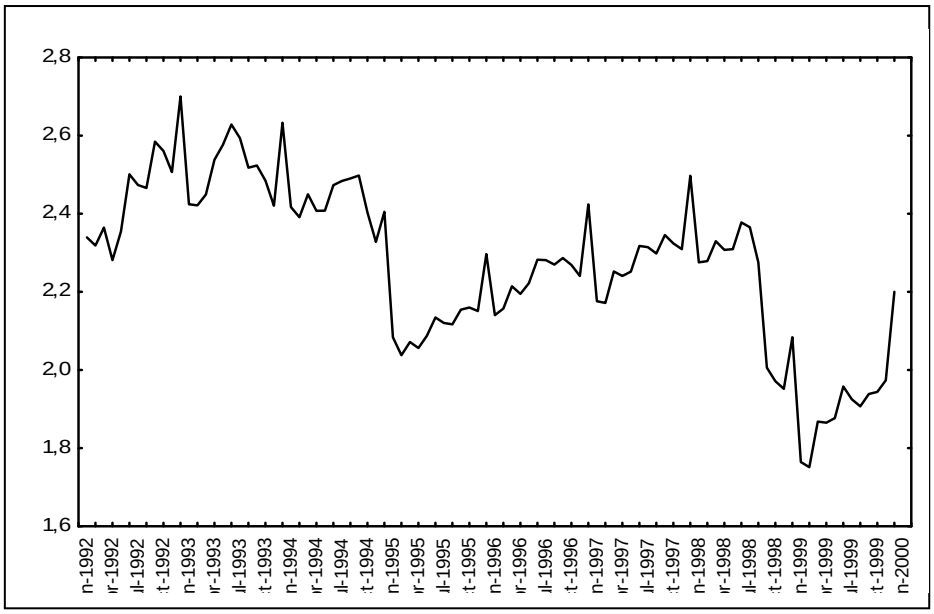

Figure 3: Average real wages in Russia.

Among macroeconomic time series analysis publications in Russia neither paper included data stationarity tests so far. It is common that authors use regression analysis methods to validate their theoretical models, but often forget that regression of non-stationary series is false and it's results do not worth trust. Such kind of equation can have high determination coefficient and significant t-statistics, but residuals would be autocorrelated and the whole model would be inadequate (so-called "false regression" case). As an example of such model so called "NAIRU estimation" was made.

Variable	Abbrev.	Length of time series	Points	Manipulations made	Order of integration
Unemployment rate according to ILO	UR, u_t	Jan 1992 – Jan 2000	97	Seasonal, ln	I(1)
Demand inflation	INFL, π_t	Feb 1992 – Jan 2000	96	$\Delta \ln CPI$, replacement of the outlier	I(1)
Labor productivity in constant prices	PROD, $prod_t$	Jan 1992 – Dec 1999	96	$: CPI$, seasonal, ln	I(1)
Average accounted real wages	WAGE, w_t	Jan 1992 – Dec 1999	96	$: CPI$, seasonal, ln	I(1)
Cash amount (M0)	M0, m_t	Jan 1992 – Dec 1999	96	Seasonal, ln	I(1)
Volume of import in constant prices	IMP, imp_t	Jan 1992 – Nov 1999	95	→roubles, $: CPI$, seasonal, ln	I(1)
Volume of export in constant prices	EXP, exp_t	Jan 1992 – Nov 1999	95	→roubles, $: CPI$, seasonal, ln	I(1)

Table 1: Table of variables used.

Abbreviations:

- seasonal – multiplicative seasonal adjustment made with EconometricViews;
- ln – natural logarithm;
- $\Delta \ln CPI$ – demand inflation rate was calculated as $\pi_t = \ln(CPI_t / CPI_{t-1})$;
- $: CPI$ – deflation on Consumer Product Index;

- $\rightarrow$roubles – recalculation of dollar sums into roubles by monthly average Moscow Interbank Currency Exchange (MICEX, or MMVB) exchange rate;
- I(1) – first order of integration.

2.3. NAIRU Estimation

Theoretically Phillips curve with inflation expectations can be expressed as in equation (1):

$$\pi_t = \pi^e - b\left(u_t - u^*\right) = a\pi_{t-1} - b\left(u_t - u^*\right), \quad (1)$$

where π_t – inflation rate in year t, u_t – rate of unemployment in year t, u^* – NAIRU (constant value), $\pi^e = a\pi_{t-1}$ – inflation rate, expected in year t with taking into account inflation in $t-1$, a, b – regression coefficients to be estimated.

Russian monthly data were used to estimate the equation (1), the results presented by equation (2). Hereinafter t-statistics are shown in brackets. Adjusted determination coefficient is high $(R^2_{adj} = 82{,}2\%)$, F-ratio is significant: $\mathrm{F}(2,92) = 217{,}89$.

$$\begin{array}{rccc} \pi_t = & 0{,}5780\pi_{t-1} & -0{,}9142u_t & +0{,}1103 \\ & (10{,}11) & (-5{,}46) & (5{,}87) \end{array} \quad (2)$$

where $bu^* = 0{,}1103$ as in equation (1). Hereof one can make a conclusion that $u^* = \dfrac{0{,}1103}{0{,}9142} = 0{,}1207$, i.e. during 1992-1999 the value of NAIRU was equal 12,07% for Russian economy. Moreover if we limit the period, consider shortened time series (ending in August 1998, the month of well-known crisis) and proceed analysis, the model will give the value of about 11%. That result (i.e. rising of NAIRU by 1 per cent after crisis) fairly corresponds to simultaneous decrease of inflation rate (negative correlation, mentioned above in 2.1). So, why do not make the conclusion?

2.4. Stationary Time Series Model

However, even while constructing the simplest model of time series multiple regression, one can make significant conclusions only if model variables are stationary series. That is why some stationarity tests (Dickey-Fuller and Augmented Dickey-Fuller tests; General schemes of these tests can be found in (Charemza, Deadman, 1997)) in EconometricViews program) were made during the research. The results were as follows. Time series of 7 main variables were found to have 1st order of integration (see Table 1), i.e. it was only possible to include first differences of the series in model. That made the research more complicated, because the way of dependence between changing rates of considered macroeconomic factors was absolutely unknown in advance. Therefore methods of forward and backward stepwise (STATISTICA program) were used. A set of considered variables included first differences of raw time series and lagged series of these first differences (from 4 to 6 lags, i.e. from 4 to 6 months delayed influence).

So a number of models were constructed (with dependent variable either difference of inflation rate or difference of the rate of unemployment), and most adequate model is expressed by equations (3) and (4) – for 2 different periods of time. The equation (3) explains about 62 per cent of the inflation rate differences variation $(R^2_{adj} = 62{,}4\%)$ and F-ratio is significant: $F(8,82) = 16{,}82$.

$$\begin{array}{llll} \Delta\pi_t = & -0{,}5313\Delta w_t & +0{,}3247\Delta m_t & -0{,}5344\Delta\pi_{t-1} \quad -0{,}0823\Delta exp_t - \\ & (-6{,}31) & (4{,}43) & (-8{,}56) \qquad (2{,}64) \\ -0{,}1077\Delta exp_{t-1} & +0{,}2213\Delta m_{t-3} & +0{,}0737\Delta imp_{t-2} & +0{,}0757\Delta imp_{t-4} \\ (-3{,}62) & (3{,}37) & (2{,}77) & (2{,}98) \end{array} \tag{3}$$

If one take into account that used variables are macroeconomic data characterizing unpredictable Russian economy, the significance of the equation should be treated as satisfactory. It should also be mentioned that the model is quite stable with respect to changing the period of research. Moreover, if we shorten the period to 1995-1999 (i.e. removing early years of economy in transition) and construct similar equation (4), its quality would be much better (with minimum changes of independent variables coefficients). The adjusted determination coefficient of regression (4) is almost 80% $(R^2_{adj} = 79{,}8\%)$, F-ratio is significant: $F(8,51) = 30{,}17$

$$\begin{array}{llll} \Delta\pi_t = & -0{,}6501\Delta w_t & +0{,}3625\Delta m_t & -0{,}6970\Delta\pi_{t-1} \quad -0{,}1174\Delta exp_t - \\ & (-7{,}77) & (4{,}57) & (-10{,}69) \qquad (3{,}46) \\ -0{,}1118\Delta exp_{t-1} & +0{,}1409\Delta m_{t-3} & +0{,}1220\Delta imp_{t-2} & +0{,}0695\Delta imp_{t-4} \\ (-3{,}39) & (2{,}08) & (3{,}51) & (2{,}05) \end{array} \tag{4}$$

3. Conclusions

Time series analysis is now included in Data Mining technologies which are used in multidimensional database management systems and OLAP products with increasing activity. However the research presented in this paper makes clear that treatment of historical (macroeconomic or financial) information and construction of predictive models can not be diminished to just regression and further extrapolation of time series. It is rather search of dependencies which has a number of time-consuming and complicated procedures such as stationarity tests. And surely some specific econometric knowledge and skills are required from any user of statistic software (if he, of course, doesn't want to construct "false regressions"). It is now hard to say whether this problem would be decided in the nearest future, but it may be considered that some decisions can be found in idea of including artificial intelligence elements (intelligent agents).

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‘Caterpillar’-SSA Technique for Analysis of Time Series in Economics

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Abstract

We demonstrate capabilities of ‘Caterpillar’-SSA, a novel and powerful model-free method of time series analysis and forecasting. The main tasks which `Caterpillar’-SSA can be used for include finding time series structure (for example, extraction of trend and/or oscillatory components of the series), smoothing, detection of structural changes, continuation of time series. Several examples of application of the ‘Caterpillar’-SSA technique to retail sales/inventories time series are presented.

Keywords: time series, Singular Spectrum Analysis, decomposition, forecast, change-point detection

1. Introduction

Ideas of ‘Caterpillar’-SSA method were independently developed in Russia (St. Petersburg, Moscow) and in UK and USA (under the name of SSA; that is, Singular Spectrum Analysis). The thorough description of theoretical and practical foundations of the ‘Caterpillar’-SSA technique (with a lot of examples) can be found in (Danilov and Zhigljavsky, 1997; Golyandina et al., 2001). For a sort of elementary introduction to the method see (Elsner and Tsonis, 1996).

‘Caterpillar’-SSA as a method of analysis performs four steps. At the first step (called the embedding step), a one-dimensional series $F = (f_1, \ldots, f_N)$ is transferred to the L-dimensional series $X_i = (f_i, \ldots, f_{i+L-1})^{\mathrm{T}}$, $i = 1, \ldots, K = N - L + 1$. This delay procedure gives the first name to the whole technique. The sole (and very important) parameter of the embedding step is the window length L. It should be big enough but not greater than a half of series length. Vectors X_i form columns of the trajectory matrix: $\boldsymbol{X} = [X_1 : \ldots : X_K]$.

The second step, SVD step, is the singular value decomposition of the trajectory matrix into a sum of rank-one bi-orthogonal elementary matrices and gives the second name of the technique:

$$\boldsymbol{X} = \boldsymbol{X}_1 + \ldots + \boldsymbol{X}_L.$$

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Elementary matrix $\boldsymbol{X}_i$ is determined by the equality $\boldsymbol{X}_i = s_i U_i V_i^{\mathrm{T}}$, where s_i (i th singular value) is the square root of the i th eigenvalue of the matrix $\boldsymbol{X}\boldsymbol{X}^{\mathrm{T}}$; U_i and V_i stand for left and right singular vectors of the trajectory matrix. We assume that eigenvalues s_i^2 are arranged in the decreasing order of their magnitude. The collection (s_i, U_i, V_i) is called the i th eigentriple of the matrix $\boldsymbol{X}$.

The first two steps together are considered as the decomposition stage of 'Caterpillar'-SSA.

The next two steps form the reconstruction stage. The grouping step corresponds to splitting the elementary matrices into several groups and summing the matrices within each group. The result of the step is a representation of the trajectory matrix as a sum of several resultant matrices: $\boldsymbol{X} = \boldsymbol{Y}_1 + \ldots + \boldsymbol{Y}_m$.

The last step (diagonal averaging) transfers each resultant matrix into a time series, which is an additive component of the initial series F. If y_{ij} stands for an element of a matrix $\boldsymbol{Y}$, then the k th term of the resulting series is obtained by averaging of y_{ij} over all i, j such that $i + j = k - 1$.

Diagonal averaging is a linear operation and maps the trajectory matrix of the initial series into the initial series itself. In this way we obtain a decomposition of the initial series into several additive components. The result is the expansion

$$F = F_1 + \ldots + F_m. \qquad (1)$$

The general purpose of the 'Caterpillar'-SSA analysis is the decomposition (1) with additive components F_i that are 'independent' and 'identifiable' time series; this is what we mean when we talk about analyzing the structure of time series by 'Caterpillar'-SSA. Sometimes, one can also be interested in particular tasks, such as 'extraction of signal from noise', 'extraction of oscillatory components' and 'smoothing'. For a properly made 'Caterpillar'-SSA expansion, a component F_i in (1) can be identified as a trend of the original series F, an oscillatory series (for example, seasonality) or noise.

There are two parameters in 'Caterpillar'-SSA: the first is an integer L, the window length, and the second parameter is structural; loosely speaking, it is the way of grouping of elementary matrices. (Since each matrix component of the SVD is completely determined by the corresponding eigentriple, we shall talk about grouping of the eigentriples rather than grouping of the elementary matrices.)

The problem of selection of 'Caterpillar'-SSA parameters is thoroughly discussed (from theoretical and practical viewpoints) in (Golyandina et al., 2001; Danilov and Zhigljavsky, 1997). As for the way of grouping, it is useful to mention that under the proper choice of window length L singular vectors in a sense 'repeat' the behavior of the corresponding time series components. In particular, trend of the series corresponds to slowly varying singular

vectors. Harmonic component produces a pair of left (and right) harmonic singular vectors with the same frequency, etc.

Depending on the specifics of time series and the choice of parameters, a lot of problems related to additive expansion of time series can be solved by means of the 'Caterpillar'-SSA technique. Among others, we can mention:

- Finding trends of different resolution;
- Smoothing;
- Extraction of seasonality components;
- Simultaneous extraction of cycles with small and large periods;
- Extraction of periodicities with varying amplitudes;
- Simultaneous extraction of complex trends and periodicities;
- Finding structure in short time series.

All these tasks correspond to basic capabilities of 'Caterpillar'-SSA. In addition, the method has several essential extensions. First, the multivariate version of the method admits simultaneous expansion of several time series; see, for example, (Broomhead and King, 1986; Danilov and Zhigljavsky, 1997). Second, the 'Caterpillar'-SSA ideas lead to several forecasting procedures for time series; see (Danilov and Zhigljavsky, 1997; Golyandina et al., 2001). Lastly, the same ideas are used in (Golyandina et al., 2001) for the purpose of change-point detection.

2. Examples

The 'Caterpillar'-SSA technique can be applied for various time series arising in economics. Our aim is to demonstrate the capabilities of the method on the example of not adjusted monthly time series of US retail sales and inventories measured in millions of dollars (see http://www.economagic.com/). The data covers the time from late 60s up to February-March 2001.

2.1. Time Series Decomposition: Trend, Seasonality and Residuals

Fig. 1 demonstrates the decomposition of inventories/sales ratio time series for nondurable goods (monthly data from January 1981 till February 2001) obtained under the choice of the window length $L = 120$. Top graph shows the extracted trend on the background of the ratio series, the one-year cycle of the series can be found in the middle graph and the bottom graph shows the residuals. If we add together the trend and the residuals we come to the ratio series adjusted for seasonal variations.

Standard methods of time series analysis can give similar results. Yet the 'Caterpillar'-SSA technique does not need any a priori parametric model for trend and oscillations. Moreover, trend and periodicities are simultaneously obtained by the sole procedure.

Let us comment on actions that lead us to extraction of both trend and seasonality. Due to the 'Caterpillar'-SSA algorithm, we start with the choice of the window length L. Theoretical results tell us that L should be big enough. Furthermore, if we know that the time series has a periodic component with an integer period (for example, if this component is a seasonal component), then it is better to take the window length proportional to that period. (For monthly data the period of seasonal component is equal to 12.) Therefore we take $L = 120$.

Singular Value Decomposition of the trajectory matrix gives us 120 eigentriples, ordered by their contribution (share) into the decomposition. Since in most cases the eigentriples with small share are related to the noise component of the series, we identify the set of leading eigentriples. Slowly varying behavior of the left (and right) singular vectors with numbers 1 and 11-13 points out that the corresponding components are related to the trend. Eigentriples with numbers 2-10, 14, 15, 18, and 19 are identified (also by the analysis of their singular vectors) as 'seasonal' eigentriples. Note that though some low-frequency non-seasonal oscillations are referred to the residual series, they can be extracted together with trend and seasonality components.

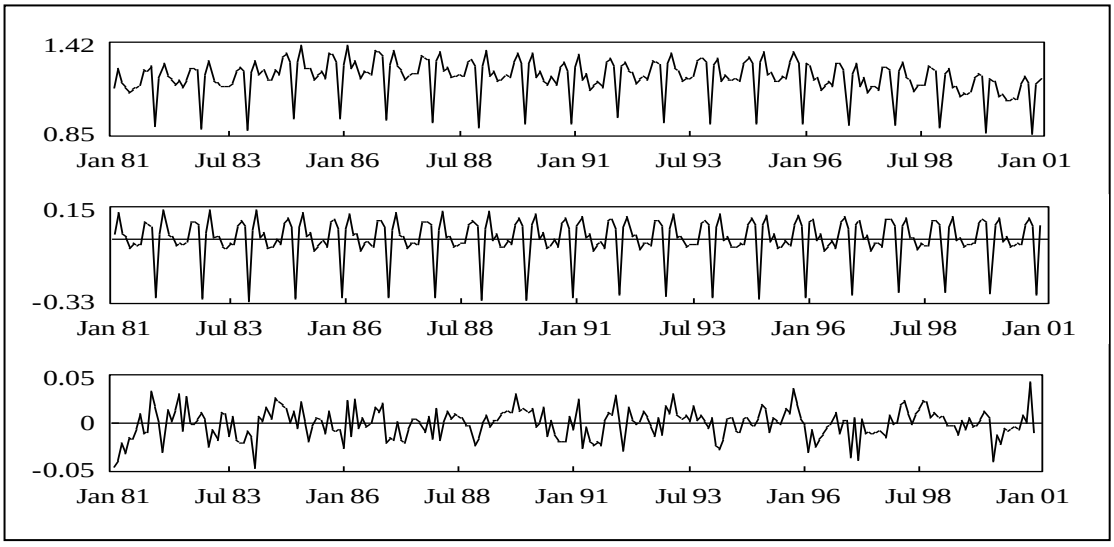

Figure 1.

2.2. Simultaneous Analysis of Several Time Series

Suppose we have several time series with the same time domain (for example, sales and inventories, sales of durable and nondurable goods, sales and advertising). Then we can be interested in finding concurrent components of all series. Multidimensional 'Caterpillar'-SSA method seems to give good solution of the problem. Fig. 2 shows the concurrent seasonalities of US retail sales and inventories for durable goods (top graph) and both trends on the background of the initial sales/inventories series (bottom graph). Top plots of both graphs correspond to inventories.

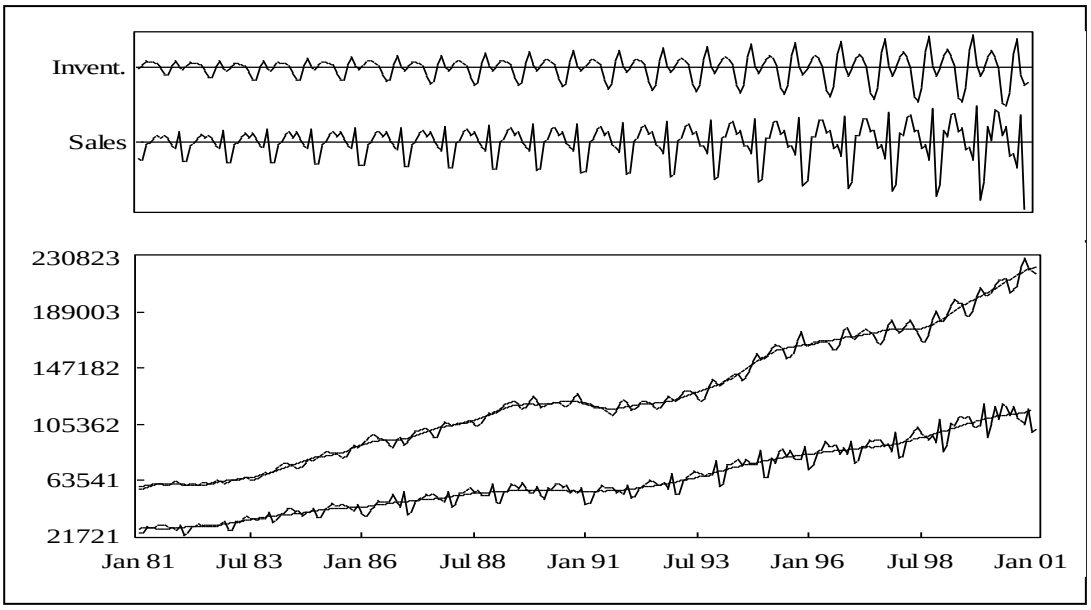

Figure 2.

The relations between two pairs of concurrent seasonal components of sales and inventories series are depicted in Fig. 3.

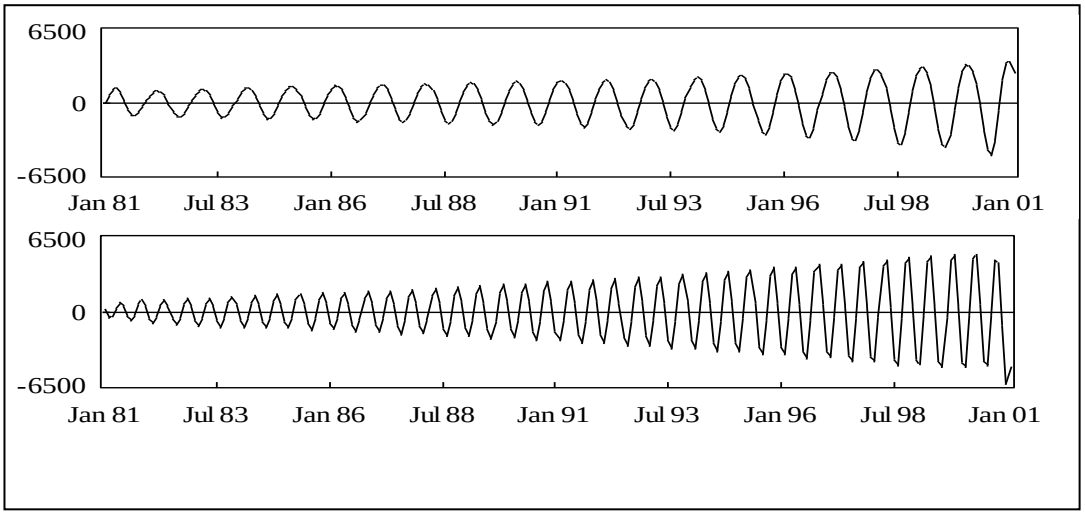

Figure 3.

Fig. 3 shows that 6-months amplitude-modulated oscillations of both series are synchronous (bottom graph), while pure annual oscillations are almost opposite (top graph). In both graphs thick lines correspond to sales series.

Further development of the technique gives rise to efficient algorithms of change-point detection and forecasting of time series.

2.3. Forecasting

Suppose we have extracted some additive component of a time series. Theory shows that under natural conditions (and under proper choice of parameters) this component can be approximately described by a certain linear recurrent formula (equation). The 'Caterpillar'-SSA method allows both extracting the component and finding the corresponding linear recurrent formula. This formula can be used to forecast the series component.

Consider the inventories/sales ratio time series for durable goods (monthly data from January 1981 till February 2001; see Fig. 4). To estimate the forecast quality, we cut off the last 12 terms of the series (that is, we start forecasting from March 2000).

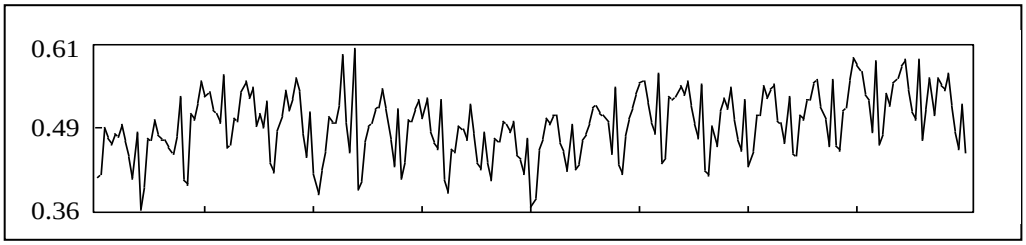

Figure 4.

We select window length $L = 108$ for decomposition and take 16 leading eigentriples for the reconstruction (that is, for the approximation) of the ratio series.

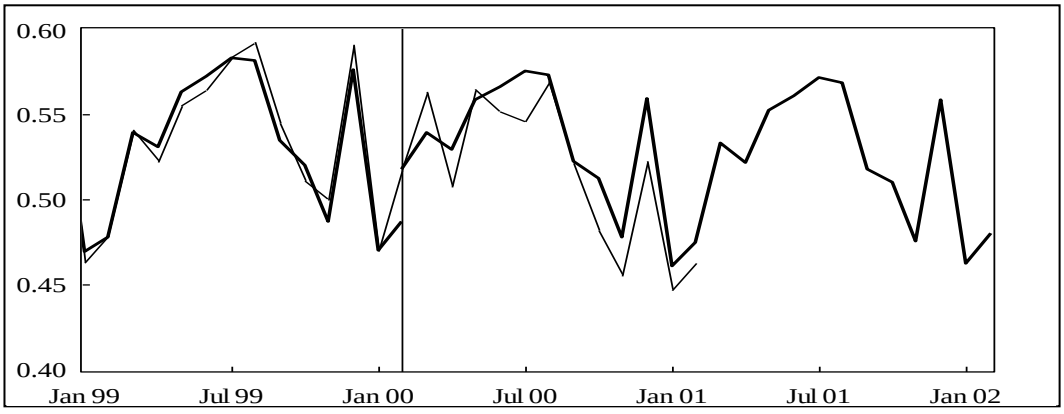

Figure 5.

Fig. 5 and 6 show the result of prediction for two years (from March 2000 till February 2002). In Fig. 5 thin line corresponds to the last 26 terms of the initial ratio series while thick solid indicates the reconstruction (up to February 2000) and forecast. Vertical line shows the truncation point. The first 12 forecasted values are very close to real ratios for the

period from March 2000 till February 2001. Therefore it is natural to suppose that the subsequent 12 values of forecast would describe the future with good precision.

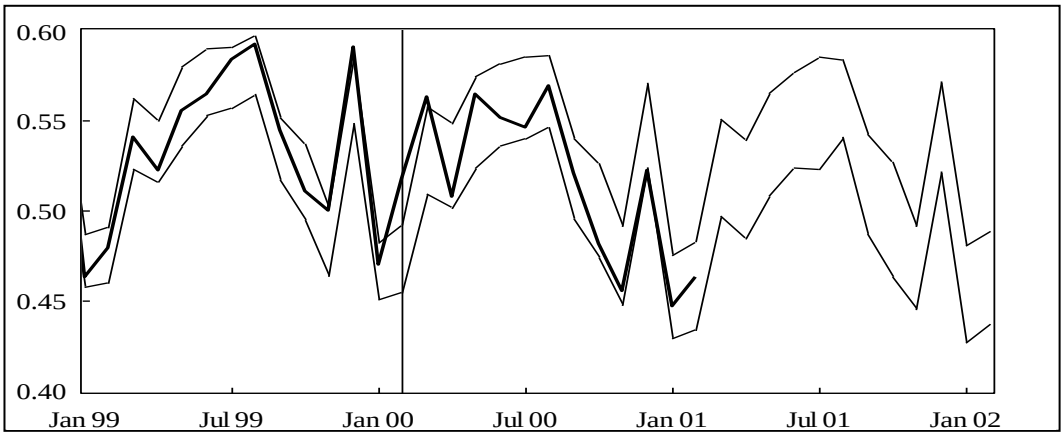

Figure 6.

Fig. 6 shows 95% bootstrap confidence intervals of reconstruction and forecast (thin lines; thick solid corresponds to the initial ratio series). Confidence intervals are obtained by simulation under the hypothesis that the residuals of the reconstruction form a normal white noise series.

2.4. Change-Point Detection

Since the 'Caterpillar'-SSA method can identify the structure of time series, it is possible to analyze the structure of time series intervals and to find out similarities and differences in these structures. That calls forth the change-point detection method based on the 'Caterpillar'-SSA ideas. The method allows finding changes in trends of different series as well as in periods or phases of their oscillatory components.

The problem of change-point detection in trends is very important in economics. Let us consider the series US retail sales for gasoline service stations (monthly data from January 1967 till March 2001, see bottom graph of Fig. 7).

Fig. 7 (top graph) demonstrates the characteristic ('detection function') that reflects the difference in main tendencies between moving time series intervals and the first interval of the gasoline series. All intervals have the length equal to 48 and describe 4-year behavior of the gasoline retail sales.

Labels of the axis X correspond to the last points of the moving intervals. Chosen eigentriples determine the trend and the main (annual) periodicity of each subseries. The start of the abrupt increase of the detection function indicates the change of the (initial) time series structure. Comparison of the detection function with the gasoline series shows that the dates May 1974, May 1979, January 1986, July 1990 and January 1998 (approximately) can be considered as the change-points of the trend of the series.

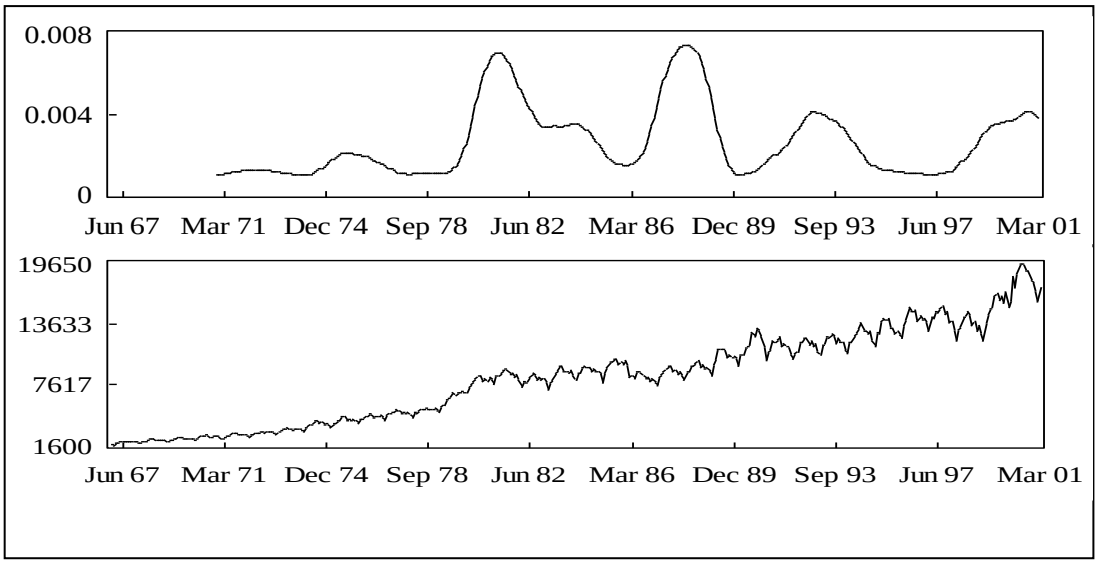

Figure 7.

To describe the detected changes in the trend it is useful to consider the estimates of local rates of exponentials approximating moving time series intervals. These estimates are also produced by the `Caterpillar'-SSA technique and are connected with the roots of characteristic polynomials related to the corresponding linear recurrent formulas.

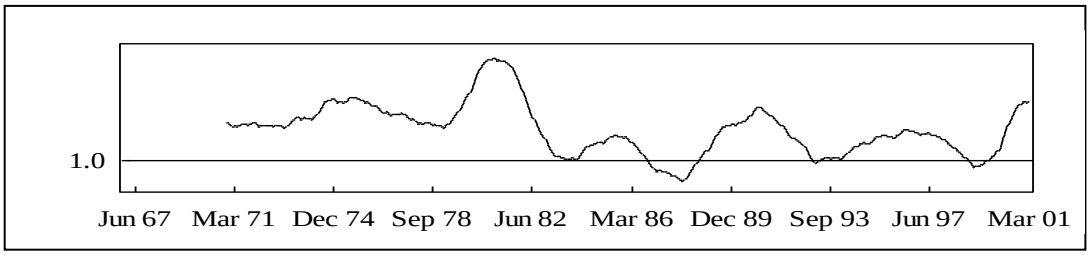

Figure 8.

Fig. 8 describes the dependence of local exponential rates on last dates of 48-months moving intervals. It shows that two largest peaks of the detection function have different origins. The first peak (starting at the middle of 1979) indicates the increase of the gasoline series trend (the exponential rate is greater than 1) while the second (1986) corresponds to the decrease of the trend (the exponential rate is less than 1).

Up-to-date information concerning the `Caterpillar'-SSA method/software can be found on the sites http://vega.math.spbu.ru/caterpillar/ (in English) and http://www.gistatgroup.com /gus/ (in Russian).

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Cutting Red Tape: Applying Mathematical Modeling to Legislation

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Abstract

Enterprises constantly seek streamlined business processes to improve productivity and, consequently, workflow modeling is a major focus of interest. This paper demonstrates the value of applying mathematical modeling to legislative procedures in particular. An appropriate technique AQUINO is selected and applied to a real-life case study – the application for a mining lease under Australian Native Title legislation.

The model provides rich insights into the procedure's effectiveness and highlights areas for improvement. The indicated solutions require legislative amendments, and post-analysis consultation with Native Title Services confirms that these are already in progress.

The paper emphasises the relevance of formal analysis to legislative procedures prior to enactment, and highlights the practical benefits of avoiding costly revisions to the complex processes of legislation.

1. Introduction

A transformation in the nature of organizations towards greater productivity has been occurring for some time, enabled by the overwhelming availability of information (Tapscott et al., 1993). With streamlining of organizational procedures for effectiveness and quality seen as a desirable goal, considerable research is devoted to the development of suitable tools for business process or workflow models, some more effective than others (Georgeakopoulos et al., 1995).

This paper has four objectives: firstly, to briefly assess some existing workflow modeling techniques; secondly, to select an appropriate technique and model a real-life organizational procedure; thirdly, to analyse the case study model for implications into the suitability of the modeling technique and, fourthly, to provide insights into the nature of the organizational procedure itself.

For the successful streamlining of procedures it is crucial that a suitable modeling technique is selected and ter Hofstede (1993) argues that essential features for suitability should be *conceptualization, formalization, comprehensibility* and *expressiveness*. These requirements

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provide a useful set of criteria for assessing some popular workflow modeling techniques and, on investigation, it is found that some do not meet the criteria.

2. Review of Some Modeling Techniques

Conceptual design is now considered an essential aspect of a modeling technique. The fundamental attributes of the design should be communicated, independent of both implementation and representation, as first advanced in the Conceptualization Principle of van Griethuysen (1982). An example of a modeling technique that does not meet this requirement is that of *FlowMark* (Leymann et al., 1994), developed by IBM to design, refine, document, and control the business process (IBM, 1995). Unfortunately, some aspects of FlowMark are implementation-dependent, and not conceptually based, with dangerous implications for applications in a business environment when the platform is changed.

Modeling techniques should also have a *formal foundation*, with the advantage that the model's correctness can be mathematically demonstrated before implementation (Barros et al., 1998). If correctness or error can be proved before implementation, there will be enormous savings in time and money. The modeling technique of *TEMPORA*, grounded on the entity-relationship modeling technique, claims to have such a formal foundation, for example: **"***Entity* is anything, concrete or abstract, uniquely identifiable and being of interest during a certain time period." (Theodoulidis et al., 1991, 406). With such a broad and imprecise definition of a basic modeling block of this technique, no correctness procedures can be undertaken prior to implementation. Thus the "conceptual modeling formalism" of Theodoulidis et al (1991) can be dismissed on the basis of this requirement.

A modeling technique should also be *comprehensible* to the users of the model in order to facilitate communication. Stakeholders familiar with the real-life procedure need to analyse and discuss the workflow model while it is being developed, and lack of understanding can lead to a breakdown in communication and effective design. *Petri Nets*, (Petri, 1962), are a graphical language used for modeling parallel processing systems (Peterson, 1981). While having a solid formal foundation and sufficient expressive power to meet most of the requirements, as a graphical technique they lack clarity for those unfamiliar with their representation. As He et al (1991, p. 859) states "the problem is that Petri net specifications easily become huge, complicated and unstructured." Although of considerable interest academically, they are not considered *comprehensible* in applications in the IS industry because of this weakness.

Modeling techniques should also have sufficient *expressive power* to enable all conceptualizations to be formed. An example of a popular modeling method that does not meet this requirement is that of *Data Flow Diagrams* (Zave, 1984). The processes in DFDs are defined in structured English, a narrowed syntax of English, restricting the language available for expressing business concepts such as, for example, parallel processes (Barros et al., 1998). This inability to model business processes accurately demonstrates the lack of expressiveness of DFDs.

According to Barros et al. (1997), the formal language AQUINO is specifically designed to meet all the above criteria of assessment, and is therefore appropriate for modeling a real-life case study. A brief description of AQUINO is outlined below, indicating its suitability to the criteria, and its application to the case study is illustrated.

3. Methodology

The modeling technique of AQUINO consists of three main areas – object, process and service modeling (Barros et al., 1997). Due to space restrictions, the data model description is omitted since its detail does not impinge upon the case study. However a brief overview of the process and service models is included. The process modeling technique is founded on Task Structures, a *formal* modeling technique with a *conceptual* specification language in Process Algebra (ter Hofstede et al., 1993). The main elements of Task Structures are processes, decisions, buffers and triggers (Barros et al., 1998). Such a full range of elements, including synchronizers for controlling parallel processing, demonstrates the full *expressive* power of AQUINO. Its simple graphical representation with full decomposition also provides a high level of *comprehensibility*.

The service modeling technique of AQUINO consists of a finite state machine representing the various workflow states, as perceived by the stakeholders (Barros et al., 1998). Progress from one state to another is by means of an *event*, for example, the receipt of a message, change in a database, or changes in time. Other *conditions* may be placed on the event before a responding *action* can take place. The event-condition-action (ECA) language developed by Barros is used to model the behavior of the service model (Barros et al., 1997), based upon active rule specification (Chakravarthy et al., 1990) and a conceptual specification language (Loucopoulos et al., 1991).

4. The Case Study: Native Title Application For a Mining Claim

4.1. The Significance of A Real-Life Case Study

The importance of case study research has been well argued in the literature (Yin, 1984; Eisenhardt, 1989; Walsham, 1995). This particular case study is of an exploratory nature, providing a rich description of a "real world" procedure without testing predetermined hypotheses (Pervan, 1994). The Native Title procedure does, however, test a suggested modeling technique and provide valuable insights for further investigation. The nature of the case study itself provides a rare opportunity to research a recently instituted organizational process and model its functionality for productivity and quality.

4.2. Overview of the Case Study: Native Title

The Australian Commonwealth Native Title Act amendments 1998 required a response from each State government to develop a Native Title policy. The Queensland Government formulated new Native Title processes encouraging all stakeholders to negotiate, resulting in a clear set of procedures for all stakeholders to follow (Native Title Services, 1998). In particular, the Native Title (Queensland) State Provisions Amendment Act (No 2) 1998 sets out the process to apply for mining claims. The initial stage of application for a mining

claim is the subject of this case study, selected on the basis of the complex time limitations involved and providing a valuable example for testing the selected modeling technique.

4.3. Procedure for Application of A Mining Claim under Native Title

The concepts involved in the process model are based on Task Structures (ter Hofstede et al., 1993). Processes are represented by rounded boxes, and triggers by arrowed lines. An example of a trigger is a message, represented by a rectangular box next to a short arrowed line. Decisions are represented by circles and databases by rhombi. The procedure consists of two major processes, Application Notification and Application Lodgement (Fig. 1).

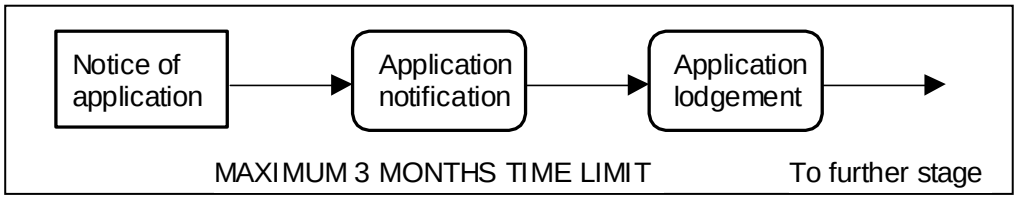

Figure 1: Top Level Process Model of Application for Mining Claim.

Initially, the mining claim applicant must give stakeholders written notification of the intended application, any time up to three months before lodgement. A further stage of negotiation and consultation follows, which is outside the bounds of this case study.

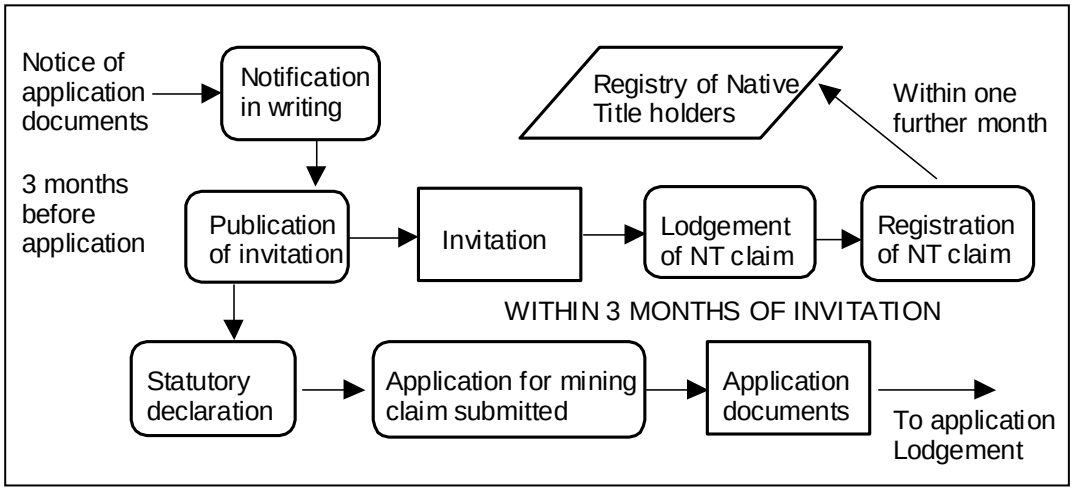

Figure 2: Application Notification.

4.4. AQUINO Process Model of Application Notification

The process of Application Notification is triggered by the issue of a notice of application to the various stakeholders (Fig. 2). The applicant then publishes a notice in local newspapers, inviting Native Titleholders to lodge Native Title claims. The applicant must lodge a

statutory declaration of compliance with this notification process. The submission of application documents acts as the trigger for the next process of Application Lodgement.

4.5. AQUINO Process Model of Application Lodgement

On receipt of the application documents, a check is made that the application is within three months of the initial notice (Fig. 3). If so, the application is stored in the application database, else the process is aborted. If a registered Native Titleholder exists, the process moves on to a further stage beyond the limits of this paper. If there are no registered Native Titleholders, the application proceeds under the provisions of the Mineral Resources Act.

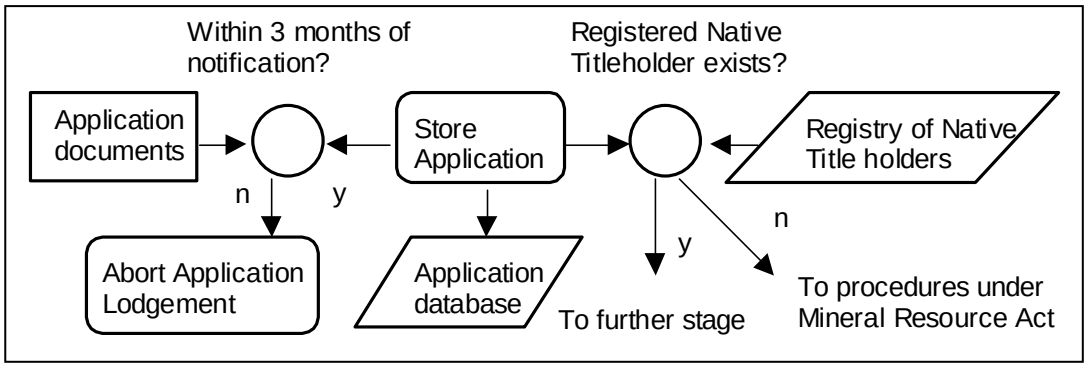

Figure 3: Application Lodgement.

4.6. AQUINO Service Model for Application of Mining Claim

States in the service model (Fig. 4) are represented by large white hexagons e.g., Published. The birth of a service is represented by a small white hexagon, and the death of a service by a small black hexagon.

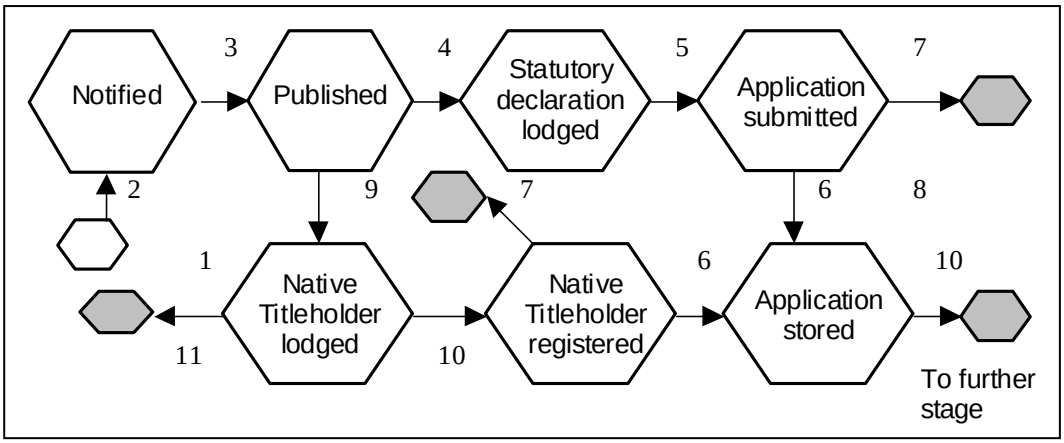

Figure 4: Service Model for Application of Mining Claim.

Events causing transitions between states are represented by directed arcs, governed by Event-Condition-Action rules with syntax of: WHEN <event ><possible condition> THEN <action> (Barros et al., 1997).

4.7. Syntax: WHEN <event><possible condition> THEN <action>

The Set of Event-Condition-Action Rules of Application of Mining Claim with their related syntax is presented in Fig. 5.

1. WHEN Notice of Application ISSUED ON Date of Notice THEN SEND Notice of Application TO PROCESS Application Notification
2. WHEN Notice of Application RECEIVED
3. WHEN Invitation ISSUED ON Date of Invitation THEN SEND Invitation TO PROCESS Lodgement of Native Title Claim
4. WHEN Statutory Declaration RECEIVED
5. WHEN Application SUBMITTED ON Date of Application THEN SEND Application TO PROCESS Application Lodgement
6. WHEN Application Date – Notification Date =< 3 MONTHS
7. WHEN Application Date – Notification Date > 3 MONTHS
8. WHEN NO Registration Date
9. WHEN Lodgement Date – Invitation Date =< 3 MONTHS
10. WHEN Registration Date – Lodgement Date =< 1 MONTH
11. WHEN Registration Date – Lodgement Date > 1 MONTH

Figure 5: Full Set of Event-Condition-Action Rules of Application of Mining Claim.

Initially, when the message Notice of Application is received, an instance of the service object is created in its birth state. This event-condition-action sequence is specified in ECA rule number 1:

1. WHEN Notice of Application ISSUED ON Date of Notice THEN SEND Notice of Application TO PROCESS Application Notification

Thus the message acts as a trigger to commence the process of Application Notification.

5. Implications on Effectiveness of Procedure

5.1. Temporal Functions

Event-Condition-Action rules for particular focus are those involving temporal constraints, for example, rule 6:

6. WHEN Application Date – Notification Date =< 3 MONTHS

For an application to be stored as valid, it must be submitted within three months of notification, a purely time-calculated event based on the dates of receipt of two documents. The first date required is that of lodgement in the Application database. Such a requirement leads to the necessity of a suitable temporal function. It is proposed that the temporal function *ENTRY-DATE* be specified that returns the date and time when a document is entered in a specified database:

ENTRY-DATE (Database, File Reference) where *Database* is the name of the database specified in the process model. *File Reference* is the key defined in the application data model (outside the scope of this paper).

The second date that of notification to stakeholders. This date can be identified as the date on which the Notification process terminated for a particular instance of the application. This leads to a requirement for another temporal function *END-DATE* that returns the process execution end time and date (Barros et al., 1997):

END-DATE (Process, File Reference) where *Process* is the name of the process specified in the process model and *File Reference* is as described earlier. With two such temporal functions specified, it is now possible to express the ECA rule as follows:

6. WHEN ENTRY-DATE(Application Database, File Reference) – END-DATE(Notification in writing, File Reference) < 3 MONTHS

The modeling of this procedure indicates that a full specification of its workflow requires the development of a range of temporal functions. The parameters of these functions are the relevant databases, processes and application references. The implication of this development in practicality is that this information must be available during the real-life procedure for the implementation to fully function.

5.2. Parallel Processes

A particularly rich insight is provided by the events of ECA rule 3, the issue of an invitation to become Registered Native Title Parties:

3. WHEN Invitation ISSUED ON Date of Invitation THEN SEND Invitation TO PROCESS Lodgement of Native Title Claim

The event of issuing the invitation results in the triggering of another process, Lodgement of Native Title Claim. The possibility now arises that this is a second process running in parallel execution to the ongoing process of Statutory declaration. One stakeholder, the mining claim applicant is progressing with the appropriate procedure for application, rules 4 and 5, whereas another stakeholder, a Native Titleholder, is proceeding with lodgement of a claim, rules 9 and 10 (Fig. 5). However, the essence of a finite state diagram is that only one state represents the overall current status of the workflow whereas in this case two states are required to represent the two parallel processes until they have both run to completion. The procedure as modeled successfully resolves the completion of these parallel processes, but not their dual parallel states.

One possible outcome is that the finite state service model in its current form is actually insufficiently expressive to represent parallel processes. A possible future line of research would be to model the procedure using colored Petri nets (Jensen, 1992), providing insights into developing the AQUINO technique further.

The implication of this result is that, if a procedure is inherently difficult to model, then its real-life implementation may also be difficult to follow procedurally for the stakeholders involved. This problem was voiced by the Premier of Queensland, Mr Peter Beattie, on May 26, 1999: "Mr Beattie expressed his frustration with the complicated processes...′We have led the country in dealing with this problem and we will introduce legislation this week in Parliament to remove the final obstacles to progress.′"

6. Conclusions and Directions for Further Research

In summary, this paper has reviewed some workflow modeling techniques and selected a suitable one, AQUINO, based on the desirable requirements of *conceptualization, formalization, comprehensibility* and *expressive power*. The AQUINO methodology was then applied to the real-life case study under Queensland Native Title legislation. The resulting model provided a sufficient degree of complexity for the AQUINO technique to be well tested in its application, resulting in two potential areas for further conceptual research (Pervan, 1994) – the development of temporal functions to express events involving timing conditions, and the further investigation of modeling parallel processes.

The final objective was to provide insight into the organizational procedure itself. This has been achieved by the focus on the parallel procedures of the mining application and also the Native Titleholders' registration. Confirmation of such practical complexities was offered in a timely manner by the Queensland Premier, Mr Peter Beattie: "The mining industry and the indigenous community need a clear signal ... about the rules for dealing with Native Title. It is vital for jobs, and vital for reconciliation that Queensland is allowed to put into practice the fair and balanced regime that has been developed."(Beattie, 1999).

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MORaD-net: A Visual Modelling Language for Business Processes

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Abstract

Petri nets are powerful techniques for modelling and studying discrete event systems. They are extensively used in both specification and quantitative analysis of such kind of systems. We introduce a layered modelling approach refers to here as MORaD-net. It is based on Coloured Petri Nets (CPNs). An integration of top-down and bottom-up approaches is applied to increase the usability of MORaD-net and to elucidate the relations between different objects in business processes.

MORaD-net comprises three layers: the system layer, the process layer, and the resource layer. It is a ready-to-simulate modelling technique. MORaD-net is able to trace the behaviour of each instance of a process and to report the performance of the system resources. To testify the effectiveness of MORaD-net, experiments have been run which prove that MORaD-net is a reliable visual modelling technique of processes in both design and execution phases. It allows the analysis of the process based on different scenarios.

Keywords: Business process modelling, Coloured Petri Nets, visual modelling language, hierarchical modelling.

1. Introduction

Business process model (BPM) (Jaeschke et al., 1993) is a less or more formal representation of a business process reflecting its static and dynamic aspects. It is basically used to design a business process, to validate it, and to evaluate the performance of the process. In any BPM three aspects should be considered: the process, organisational resources, and the customer. Process determines the logical order of all activities needed to be performed in order to the business process be completed. Execution of any activity needs some combination of organisation resources, including human resources and IT resources. An instance of a business process is executed for a particular customer during its lifecycle.

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MORaD-net is a layered modelling approach based on Coloured Petri nets (CPNs) (Jenkins, 1997). It combines the graphical representation of CPN with the layered view of the system. This modelling approach supports the specification of business processes including task structure, dependencies between tasks, task duration, resource utilisation, and routing paths.

It is shown (Van der Aalst, 1998; Salimifard and Wright, 1998) that PNs could potentially offer great modelling and analysing techniques for the design, implementation and evaluation of business processes and workflow systems. PNs provide a simple graphical interface making communication between modellers and clients easier whereas the strong mathematical background supports a series of analytical methods for both model validation and calculation of system properties. Petri nets software tools provide both analytical and simulation based analysis.

The rest of the paper is organised as follows. Section 2 covers a brief introduction to CPNs. An overview of the proposed modelling technique is given in Section 3. A nontrivial example is presented in Section 4. It demonstrates how MORaD-net can be used to model a business process. Conclusions and final remarks are given in Section 5.

2. Coloured Petri Nets

Petri nets (PNs) (Petri, 1962; Murata, 1989) are graphical modelling formalism. They can be used to model sequences, mutual exclusion, and synchronisation of system operations. There exist different types of PNs. Low level PNs (Brauer, 1987) offer an easy to understand graphical modelling technique, but unable to handle large and complex systems. High level PNs (Jensen and Rozenberg, 1991) provide a more compact description of the system. They allow integrated modelling of very large and complex systems. PNs are being extensively used for modelling and evaluation of discrete event systems in a wide range of applications. They have been applied in computing (Pinci and Shapiro, 1991), manufacturing (Genrich et al., 1994), military (Gordon and Billington, 1998) and communication (Villapol and Billington, 2000) systems. An extension of PNs is proposed for modelling the office information systems (Zissmann, 1977).

CPN is an extension of high level PN composed of the following elements:

- *Color*[*] *sets*: Analogous to types in programming languages determining characteristics and attributes of entities in the model.
- *Places*: The set of static element holding tokens. A place is a container for tokens of a certain color set. A place is drawn as an oval or circle.
- *Tokens*: Tuples holding data values which are contained in places and consistent with the place color.
- *Transitions*: Active elements of the model. They change the set of tokens in neighbouring places. A transition is graphically represented as a box. A transition may

[*] Color is a reserved word in CPN. It should not be replaced by “colour”.

be augmented with a code to control the modification and creation of tokens in output places of the transition.

- *Arcs*: They are arrows joining a place and a transition.
- *Inscriptions*: Expression containing constants, variables and functions associated with transitions and arcs. An inscription on a transition is called *guard*, which always evaluate to a boolean value. It controls the attributes of tokens in the input places of the transition.
- *Declarations*: Set of constants, variables, and functions defining color sets and values in the initialisation of the model.

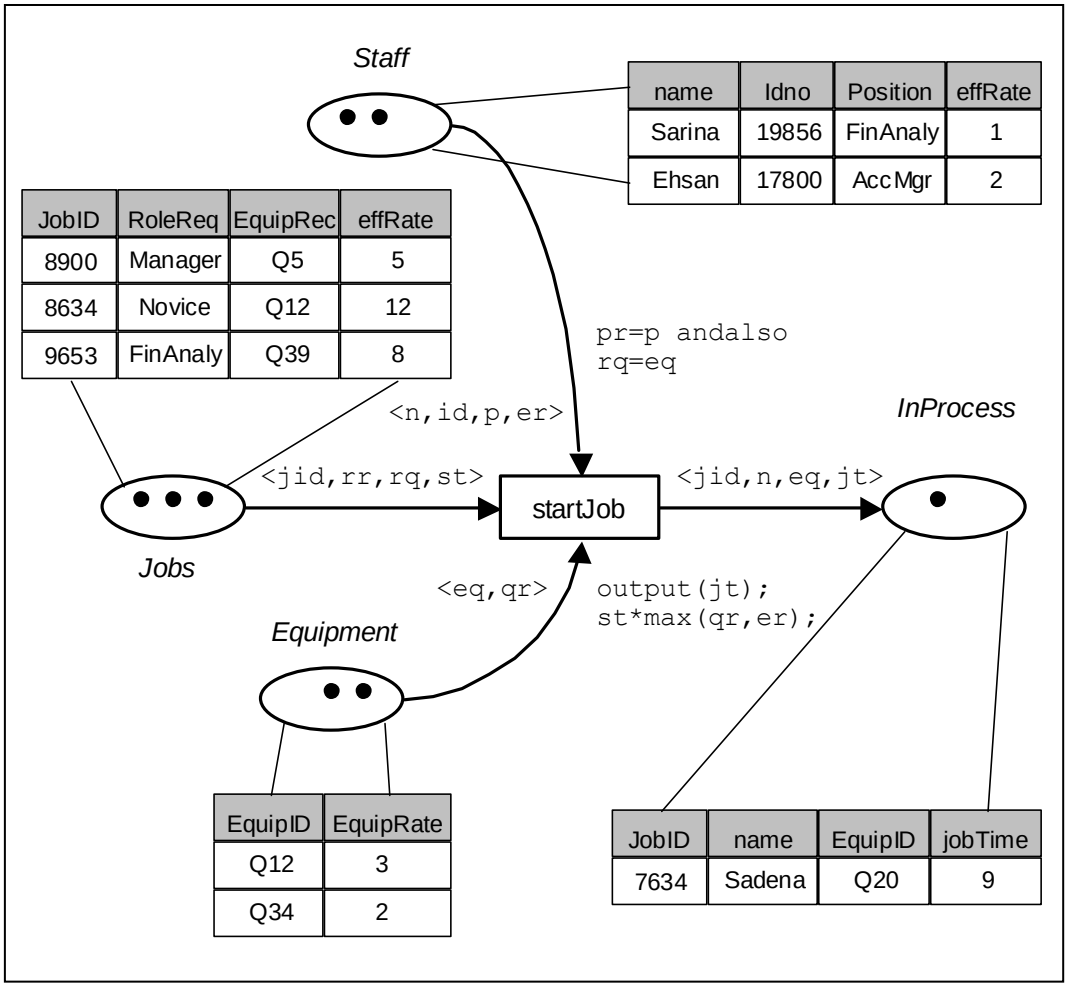

Figure 1: A CPN representation.

A function, so called *marking*, assigns to each place the set of tokens of the same color set currently held in the place. The set of all place markings at a given time describes the global system status. A transition in the CPN represents an operation on its input and output places. If the transition occurs, it removes tokens from its input places and inserts tokens in the output places. This removing and inserting operation is altered by the transition guard and code segment.

The net in Fig. 1 shows a very simple example. It models the job assignment process of employees in an organisation. Incoming job tokens are stored as a tuple <Job ID, Role Request, standard Time> in the place *Jobs*. Organisation resources tokens are stored as <name, ID no, Position, efficiency Rate> and <Equipment ID, Equipment Rate> tuples in places *Staff* and *Equipment*, respectively. A job may be assigned and to be performed if the staff position (*p*) is as the same as required role (*rr*) and the equipment (*eq*) is equal to required equipment (*rq*). These pre-conditions are checked by the transition guard appeared at the top of the transition. If the guard evaluated to true, the transition occurs and a new token <job ID, name, Equipment ID, job Time> is inserted in the place *InProcess*. The processing time of the job is determined in the code segment shown at the bottom of the transition.

3. Overview of MORaD-net Modelling Approach

The graphical representation of MORaD-net is composed of three layers called System Layer, Process Layer, and Resource Layer. Each layer is designed and modelled individually and finally integrated in the system model. Layered structure of MORaD-net allows the modeller to re-engineer the model and analyse different scenarios effectively.

3.1. System Layer

This layer offers an interface between MORaD-net and the modeller to clarify the relationship between system components and to determine execution parameters of the model in the analysis phase. It consists of three main components each represented by a transition, as shown in Fig. 2. Initialisation is the first transition to fire as soon as the model execution is triggered using the underlying software. Firing this transition sends appropriate tokens to places of type *Workflow*, *Staff* and *Equipment*. It enables the transition *processing* and determines the total number of staff of each class, and total number of equipment of each type, receptively. Another token is sent to the place of type *Number_of_Instances* determining the total number of instances which will be generated during the analysis phase.

Each transition is augmented with a *code region* specifying activities should be done as the result of the firing of the transition. These activities modify consuming tokens and generate new tokens to be sent to appropriate output places.

3.2. Process Layer

This layer is a decomposed view of the *process* transition of the System Layer. It captures an abstraction of business process into process tasks and the flow of information between tasks. This layer determines the sequence, conditions and states of the process activities.

Each activity is modelled by a substitution transition representing the underlying resource layer. The link between activities is represented by places. A place, except the place *end*, of the process is of *Workflow* color. As soon as a token of color *Workflow* is deposited in the place *beg*, its output transition is enabled.

Process Layer represents the functional aspects of the process and the interdependencies between activities. All the routine possibilities including sequence of activities, branches, parallel execution of activities, synchronisation and replication could be modelled.

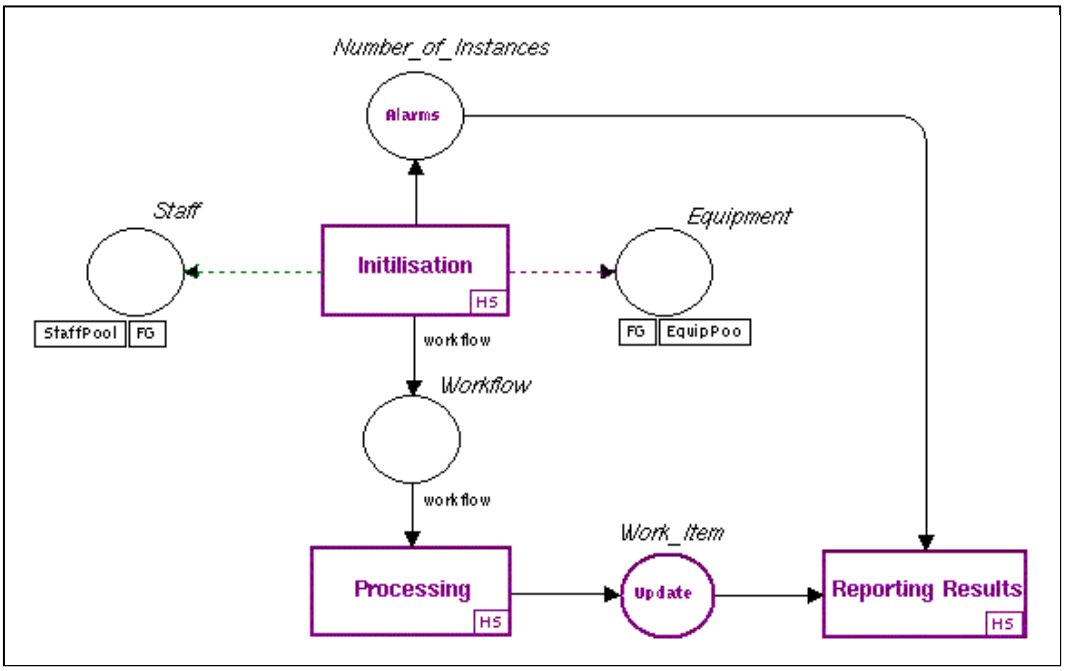

Figure 2: MORaD-net System Layer.

3.3. Resource Layer

The Resource Layer is the operational component of the model. It integrates the process activities with the organisation resources. The structure of each task is the key element in this layer. The task *template* allows the modeller to structure any individual task by a simple modification. The *template* consists of *input* place(s), a *start* transition, an *internal* place, a *fin* transition and *output* place(s). Links to the *organisation resources* are represented by dashed arcs to *socket* places. Appropriate resources are assigned to the task by *start* transition and released by *fin* transition.

Resources are classified into different classes and subclasses. *Staff* is the class of human resources including subclasses for example Manager, Expert, and Novice. Other organisation resources are of class *Equipment* which has subclasses for example printers, fax machine, communication devices, etc.

An *efficiency ratio* is assigned to any subclass determining how fast the subclass is. The lower the ratio the faster the subclass. The duration of an activity equals to the estimated task time times the maximum ratios of allocated resource subclasses. These values are used in performance analysis of the process.

4. An Example: Credit Request Business Process

A nontrivial example is depicted in Fig. 3. It describes how MORaD-net can be used to model and evaluate a business process. It is a simplified version of a process in which a client requests a credit from a bank.

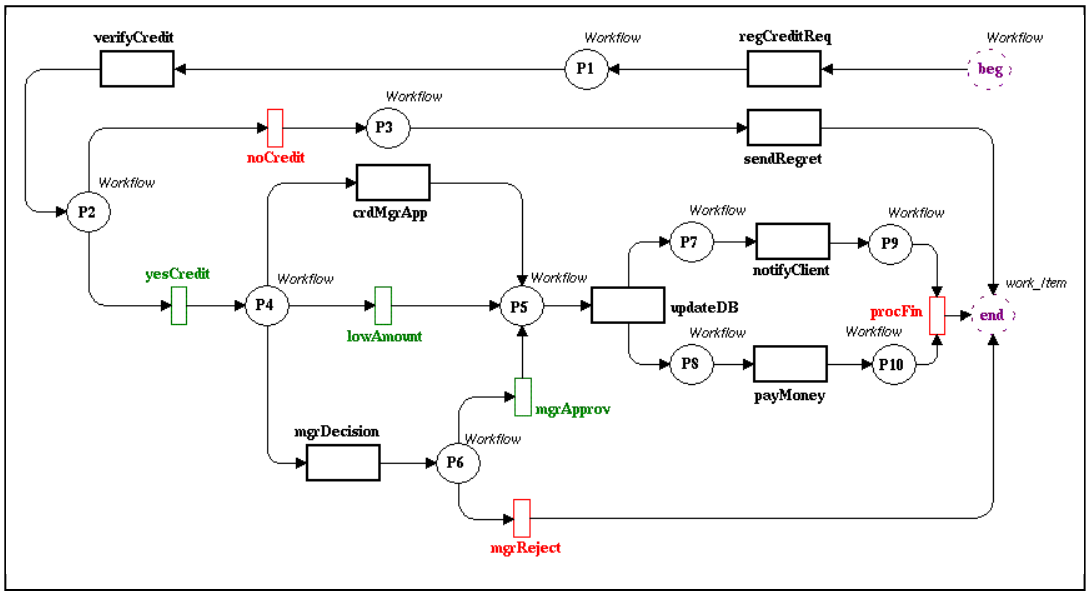

Figure 3: Credit request business process representation in the Process Layer.

4.1. Credit Request Process Layer

The process begins when the client submits the request and it is registered through the activity *regCreditReq*. Then the registered request is delivered to the next step where a credit analyst, transition *verifyCredit*, verifies whether the credit can be granted. If the answer is negative, transition *noCredit*, the client will be notified by receiving regret letter through activity *sendRegret* and the process is finished. Otherwise, transition yesCredit fires and a decision have to be made based on the range of the credit amount. If the credit amount is high, for example greater than £5000, the bank manager has to approve the credit. This step is modelled by transition *mgrDecision*. The bank manager may approve or deny the credit. If he denies, transition *mgrReject* fires and the process is finished, otherwise the process continues trough firing the transition *mgrApprov*.

If the credit amount is in a middle range, e.g. less than £5000 and greater than £500, the credit manager, transition *crdMgrApp*, must review and approve it, otherwise the process continues and the database is updated by firing the transition *updateDB*. After that, two

tasks must be done in parallel. A credit clerk must prepare the document and notify the client and the financial clerk prepares the money cheque and give it to the client. The process is finished if the client receives the cheque and transition *procFin* fires. This transition synchronises the execution of parallel activities. Inserting a token in the place *end*, means that the process is finished through one of its possible execution paths.

4.2. Credit Request Resource Layer

This layer represents how organisation resources are allocated to perform activities and models the structure of all activities of the process. It is assumed that the bank in the example has two resources classes, Staff and equipment. Staff are classified in three subclasses, namely Manager, Expert, and Novice whereas Fast and Slow are two subclasses of the IT class.

Fig. 4 shows how activity *regCredReg* utilises the required resources.

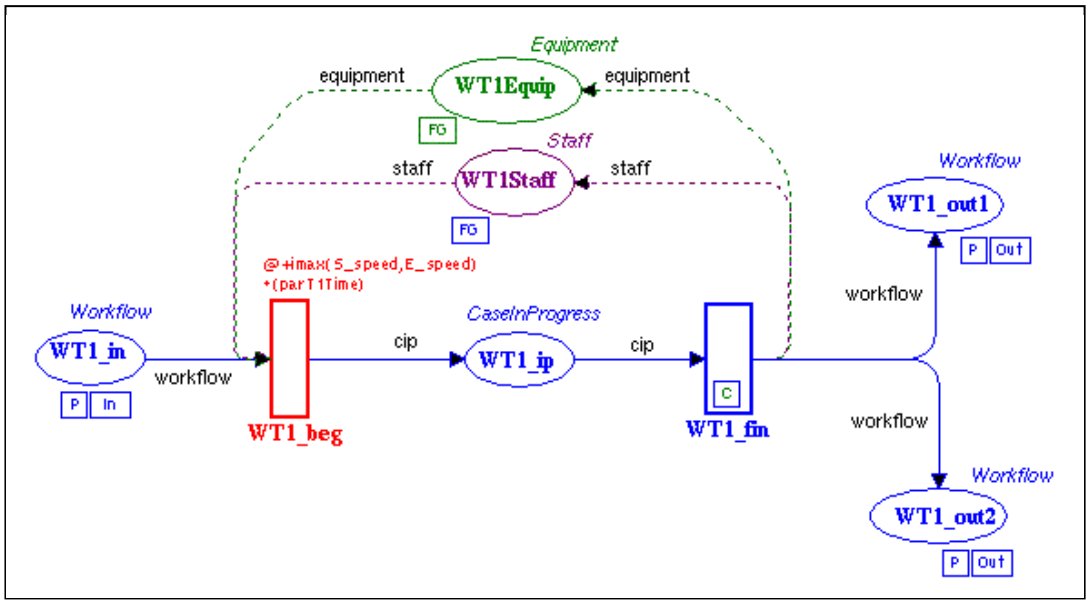

Figure 4: Task structure and resource utilisation of the Resource Layer.

As soon as a token received in *T1_in*, transition *T1_start* is enabled if the required staff and equipment is available in *T1_Staff* and *T1_Equip*, respectively. Firing this transition consumes one token from each of its input places and puts a new token in the internal place *T1_ip*. The token remains there up to the duration of the activity. As soon as the duration elapsed, transition *T1_fin* fires and consumes the token in *T1_ip* and generates token in *T1_out*. At the same time the allocated resources are released and sent back to resource pools.

4.3. Performance Analysis

Effective business process necessitates a consistent and valid flow of the jobs and acceptable performance of the process. Considering that we are interested in the performance evaluation of business process, it is crucial that this study be done in early design phase of the process. The modelling technique, therefore, should provide facilities to perform the performance analysis of the process. MORaD-net supports simulation based performance analysis of the process. MORaD-net uses Design/CPN (Design/CPN Reference Manual, 1993) software package.

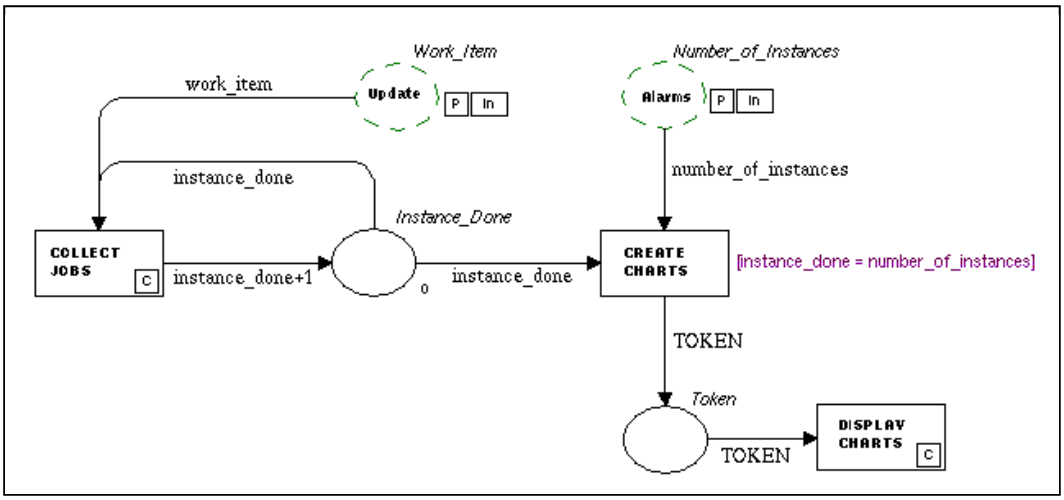

Figure 5: The reporter component of the System Layer.

As soon as a token is inserted in the place *end* of the Process Layer, a copy of the token is inserted in the place of type *Work_Item* in the Reporter component of the System Layer. The transition *CollectJobs* counts the number of finished processes and put the record in *Instance_Done*. If the number of completed processes in *Instance_Done* is equal to the token in *Number_of_Instances*, transition *CreateCharts* fires and a bar chart is created. The chart is displayed through firing the transition *DisplayCharts*.

Simulation run is based on the parameters provided through firing transition *initialisation* in the System Layer. These parameters are shown in Table 1.

Parameters	Value	Parameters	Value
Number of instances	2000	Number of novices	5
Number of managers	1	Number of fast equipment	1
Number of experts	2	Number of slow equipment	3

Table 1: Simulation parameters.

A series of statistics is reported. The chart facility of the underlying software enables MORaD-net to automatically generate different bar and line charts.

Fig. 6 depicts a chart displayed by firing transition *DisplayCharts* at the end of the simulation run. It shows average working time and waiting time of system entities. Productivity measures such as costs related to resources and income earned by performing the process can be calculated. The aforementioned statistics together with chart facility gives the decision-makers to decide whether to re-engineer the process.

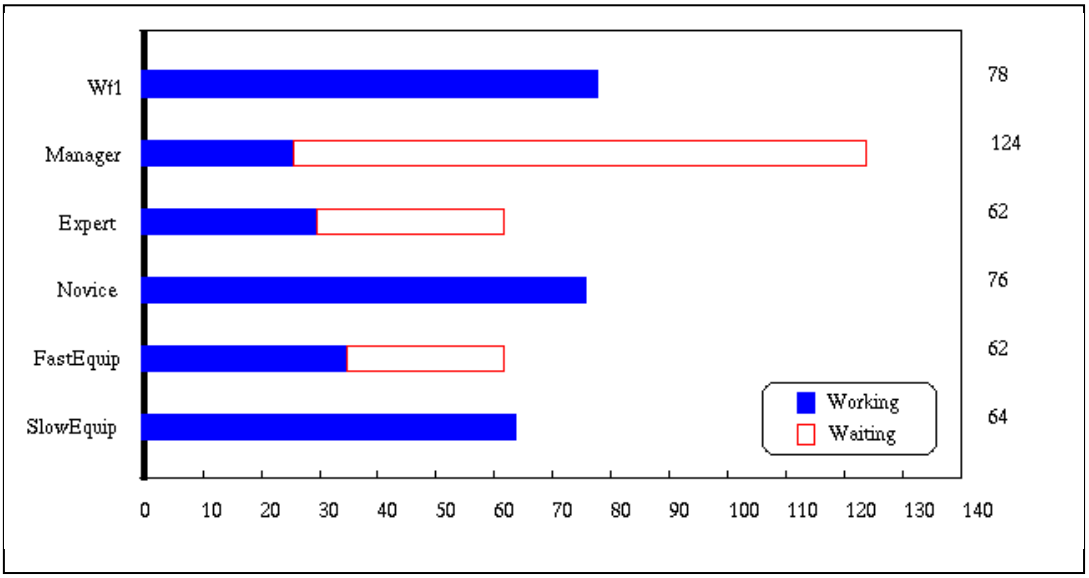

Figure 6: Average working and waiting time of system entities.

5. Conclusion

In this paper we presented modelling techniques for analysing business processes using a novel approach based on Coloured Petri net. This approach includes a modular view of the system represented in three interconnected layers. System Layer represents the general framework of the system and parameterises the rest of the model. Business process is modelled in Process Layer representing the flow of the work and all routing paths. Task structure and resource utilisation of the process is represented in the Resource Layer.

Performance measures of the designed process including resource utilisation calculated using simulation runs and results are automatically displayed in bar charts. It is possible to run different scenarios by simply changing parameters in the System Layer.

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TutMod: A Tutoring Program in Mathematical Modeling of Business Processes

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Abstract

Mathematical modeling presents an efficient tool in analysis and design of business processes. In many cases, the development of an appropriate model to describe a business process appears to be a difficult problem. We propose a unified methodological approach to formal description of business processes. Based on the above approach, an intelligent tutoring program TutMod is developed which allows the user to gain basic skills in model construction with or without the help of an instructor.

Keywords: system modeling, business process, tutoring program

1. Introduction

System formalization or transition from the verbal description to the formal scheme is one of the most difficult stages in model design. The success of modeling depends on the ability to select the substantial system elements, and to define links between them.

The computer based teaching technologies are widely used in education now. These technologies require not only the access to information resources, but also the development of the automated tools for professional tasks solving, information processing and convenient results representation. These tools allows of increasing efficiency in knowledge assimilation and usage.

Both an apprentice and a specialist working in the sphere of system analysis often have no skills in formalization of models. In this situation, a tutoring program system based on a unified approach to modeling can be implemented to form, develop and consolidate modeling skills.

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The key steps of our approach can be summarized as follows. The user first has to represent the overall process as a hierarchy of sub-processes. The lowest hierarchical level consists of the elementary processes that cannot be broken down into further sub-processes. For actual processes, each elementary process is represented by an enumerable set of elements. Each element can be in a state from a finite set of states. The elements with the equal set of states are consolidated in a group. The set of elements together with their states define a state of the group. At least the number of elements in each group, which are in a fixed state, describes the state of the process. The modification of process states depends on the number of elements, which change their states in a time unit. Such modifications of states are represented by an oriented graph with vertices corresponding to the states and arcs corresponding to the intensities of transition of the element to a new state. The method of handling weights at the vertices determines a class of models.

2. System Formalization

The unified approach to modeling proposed in (Kropacheva and Sushkov, 1999) is briefly described below. Assume that the system can be represented as a hierarchy of sub-systems. The elementary sub-systems, which cannot be decomposed at the current level of the system investigation, occupy the lowest level of the hierarchy. For actual systems, we suppose that each elementary system is represented as a numerable set of interconnected elements. The elements can be in different states; the set of element states determines the system state. The state characteristics describe the most important features, which are typical for the process in the system under investigation. The evolution of the system involves transition of elements from one state to another.

System elements are combined into groups on the basis of the possible states of elements in the groups so that elements in different groups have different sets of states.

Let us consider a system with m groups of elements. We assume the set of element states $S = \{s_1, s_2 ..., s_k\}$ to be finite. Denote by $x_i(t)$ a numerical value, which describes the state s_i at the time instant t. Then the vector $X(t) = \langle x_1(t), x_2(t), ..., x_k(t) \rangle$ describes the system state at time t.

For actual systems, $x_i(t)$ may represent a particular system parameter, depending on the purpose of investigation. For example, $x_i(t)$ can be the probability $P_{m_i}(t)$ that m elements are in the state s_i at time t, the mathematical expectation $\overline{m_i}(t)$ of the random variable $m_i(t)$ representing the number of elements in the state s_i, or the variance $D_{m_i}(t)$ of $m_i(t)$.

The transition of elements from one state to another can be described as a graph with the vertices representing the states s_i together with its associated value x_i, and the arcs (i, j) representing possible transition from the state s_i to the state s_j. We denote by Λ^{ij} the

number of elements, which change state s_i to s_j per unit time. Each path in the graph from a vertex, which corresponds to the initial state, to a vertex, which corresponds the final state, is one of the possible realizations of system dynamics. The initial and final states are chosen according to the purpose of the study.

Let $x_i(t) = \overline{m_i}(t)$, and Λ^{ij} be an average number of elements, which go from the state s_i to the state s_j per unit time. Let A_i^+ be a set of states from which it is possible for an element to come to the state s_i and A_i^- is a set of states to which it is possible to go from the state s_i.

The dynamic of system can be represented through the differential equations

$$\frac{d\overline{m_i}}{dt} = -\sum_{j \in A_i^-} \Lambda_{ij} + \sum_{j \in A_j^+} \Lambda_{ji}, \quad i = 1,...,k.$$

Denote by λ_{ij} the intensity of state transitions from s_i to s_j. Then we can write

$$\frac{d\overline{m_i}}{dt} = -\sum_{j \in A_i^-} \lambda_{ij}\overline{m_i} + \sum_{j \in A_j^+} \lambda_{ji}\overline{m_j}, \quad i = 1,...,k.$$

The above equations together with initial conditions $m_i(t_0)$ present a model of system state transition.

In the general case, the intensities λ_{ij} can be functions of the number of elements in various states, i.e. functions of the vector

$$m(t) = \langle m_1(t), m_2(t),..., m_k(t) \rangle,$$

where $m_i(t)$ are random values for each fixed t. In that case, the intensities $\lambda_{ij}(m(t))$ also present random values.

In order to handle the problem, we replace $\lambda_{ij}(m(t))$ with $\lambda_{ij}(\overline{m}(t))$, assuming that $E(\lambda_{ij}(m(t))) \approx \lambda_{ij}(E(m(t)))$. This gives equations, which are typical for the method of average dynamics (Ventcel, 1972), and for the method of system dynamics (Forrester, 1961).

Suppose that $P_i(t)$ is the probability that some element of the system is in the state s_i at time t. With $m_i(t) = P_i(t)$, and the transition intensity λ_{ij} we arrive at the equations

$$\frac{dP_i}{dt} = -\sum_{j \in A_i^-} \lambda_{ij} P_i + \sum_{j \in A_j^+} \lambda_{ji} P_j, \quad i = 1,...,k .$$

Similar models are widely used in analysis of mass service systems (Kemeny and Snell, 1959).

Our experience shows that there are a vide range of actual systems which can be described using the above approach. This unified approach allows one to implement common procedures and algorithms of system modeling. It can be taken as the basis for automated procedures of teaching and training in the area of modeling of business processes.

3. Tutoring Program

The proposed unified approach to modeling business processes has been implemented in automated tutoring system TutMod for personal computers. The tutoring program TutMod presents an interactive application with a user-friendly intelligent interface, which allows a user to pass through all the basic stages of the model formalization process. TutMod is developed based on the Visual C++ (version of 5.0) integrated environment using the MFC class library. The database interface is realized using DAO (version 3.5). The document interface is realized using OLE. This approach allows the program to handle objects of any OLE server (specifically, MS Word or MS Excel) and to store tasks in a structured container.

The system works in three modes: 1) administrator mode; 2) mode of task package construction; and 3) tutor mode. The availability of a particular mode depends on the user access rights.

The main administrator features are: 1) user registration: administrator registers the user and provide the user with NAME, PASSWORD and LEVEL of RIGHTS; 2) construction and editing of the standard list of system actions to possible user errors during the tutoring session; 3) editing of the user list and user rights; 4) editing of the task package for particular instructor; 5) viewing and editing of any task from task packages; 6) database management.

Each instructor can develop a task package, perform testing and approbation of the package, control activities of an apprentice in the mode “teaching with control” and “testing”. All users with instructor rights can work with the system in two modes: 1) “teacher” to prepare and edit a task package; 2) “teaching” to teach system modeling to apprentices, based on previously formed task packages.

Each apprentice can with the system according to one of the tutoring modes: 1) teaching with control; 2) teaching without control; 3) testing. The tutoring session consists in consecutive formalized steps of system modeling.

The interaction between the system and the apprentice is performed based on test tasks (the reply action is required from the apprentice) or through information messages (the attentive acquainting is required from the apprentice). The apprentice has to pass through main stages

of system formalization. Each stage offers its own set of test tasks and information messages. The transition to the next stage depends on the apprentice actions on the previous stage.

During the session, the apprentice can meet some difficulties in task understanding and in method implementation. That is why the system performs the analysis of apprentice actions on each step and, based on this analysis, the system allows for transition to the next step or performs an action, which helps the apprentice to understand and correct mistakes. The tutoring system prompts the required action and even explains what and how to do if needed. Such approach is the fundamental in the individual teaching. If on some stage, the apprentice is unable to perform task even with system help, the system advises him or her to consult with a teacher, and finishes the session.

There are two approaches in task generating.

4. Use of library, when modeling schemes and their parameters are selected from the previously created database at random.
5. Synthesis of tasks schemes through selection (probably at random) of elements, communication (links) between elements, substantial parameters and filling the derived schemes with actual meaningful content.

Assume that a task is described by three objects: 1) the description of the service procedure defined by a graph; 2) the aim of decision (what is to be found as the result of the task performance); 3) the actual meaningful interpretation of elements and communications.

The service module which proceeds an order corresponds to each vertex in the system graph. It has three parameters: the module name, the service time and its expected value. The arc between two vertices exists only if there is a possible transition to a service module.

The proposed method of task generating allows of constructing tasks of system modeling for a variety of actual systems. The program implementation of the generator allows every interested person to construct a task collection with the various meaningful content, and it appears to be very useful in teaching of courses in business system modeling.

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