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ENTERPRISE INFORMATION SYSTEMS: ISSUES, CHALLENGES AND VIEWPOINTS

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Abstract: This paper is based on a panel presentation to the first International Conference on Enterprise Information Systems (EIS). The panel intends to address important issues in EIS from the perspectives of research and industry. It has not only raised questions, concerns and topics related to the research, development and application of information technologies and systems, but also suggested approaches and solutions for the researchers and practitioners. This paper covers a wide range of topics, such as: the notion of enterprise information system; the scope, features, functions and components of EIS; strategic importance of an enterprise information system in industry in the twenty-first century; the role and contribution of the research scientists, engineers and practitioners; factors affecting successful deployment and development of EIS in both organisational and technological aspects; the state-of-the-art enabling technologies for EIS; and the future of EIS in research and industry. The paper consists of sections contributed by the panel members, each addressing several issues from a viewpoint.

1. THE ROLES AND FEATURES OF ENTERPRISE INFORMATION SYSTEMS

Kecheng Liu

The emergence of enterprise information systems represents a rich notion related to a whole range of technological and organisational issues. Implementation of a system of this kind will normally involve proper systems development methodologies and information technologies; and a successful use of the system will depend on a right match between the technical systems and the organisational structure and management.

- Enterprise information systems exist within organisations, to fulfil their operational needs and to support their strategic objectives. To understand enterprise information systems, we therefore need to understand organisations in their domain principles, components, structure and behaviour. Information systems are specific sub-systems of organisational systems. From the FRISCO report (Falkenberg et al. 1998), there are several disciplines that offer us help in this respect: organisational science, computer science, system science, cognitive science, semiotics and certain aspects of philosophy.

- Enterprise information systems exist as part of an organisation. They have direct impact on the organisation at all levels, such as operational, tactical and strategic level. They are often built in the organisational infrastructure and are expected to operate for a long period in order to enhance the organisational competitiveness. Therefore the development of such systems must take into consideration the organisational objectives and long-term goals.

- Enterprise information systems enable new concepts of business, such as virtual organisations and distributed enterprise. They have far-reaching impacts on the business and industry themselves and also opened up new possibilities for the use of technologies.
- The development of enterprise information systems has benefited from the advent of a whole range of information technologies. The push from technology is as important as the pull from the business needs. Experience shows that a development of such systems will utilise technologies derived from many disciplines. Input should be drawn from all the stakeholders concerned, right from the project's conception, through requirements engineering, system construction, to system testing and acceptance.
- The development of enterprise information systems cannot deal only with "green field" systems that are built from a scratch, it also has to take into account the existing or "legacy" systems and current processes in the organisation. Enterprise information systems are normally large in size and of connectivity with various system components; comprehensive in covering business functions; complex in the technologies involved; and strategic in supporting current and long-term objectives. Caution and strategic thinking are more often required in developing these systems than the systems which standalone for use in the department level or functional areas.

Enterprise information systems did not only originate in academic research, but they have also been stimulated and adopted by the industry. This has been corroborated by the papers and participation of both academia and practitioners at this conference and other conferences addressing similar topics (e.g. ICIS, CoopIS, VLDB and CSCW conferences). One message becomes clear from this panel discussion: sustainable competitive advantages can only be achieved from a coherent organisational structure, effective business processes and appropriate IT systems.

2. MANAGING CHAOS

Mark S. Fox

I have been asked to predict where the future lies in Enterprise Information Systems. Being no more qualified than anyone else, I believe that provides me with "carte blanche" to say whatever I believe without fear of anyone taking me seriously. My crystal ball is actually the hundreds of science fiction novels I have read since I was young.

But before going further, it is important that we understand the assumptions I am labouring under. First, processor speed will continue to grow, reaching gigahertz speed and beyond coupled with amazing graphics. Second, our network connections will also operate a gigahertz speed and be accessible without physical connections. Third, computing will be ubiquitous and mobile. Nano-computers will be embedded in our clothes, the walls of our homes and offices, furniture, and even in our bodies. Fourth, people will be fully interfaced with computers. All of our senses, e.g., taste, smell, hearing, seeing, feeling, etc. will be stimulated through interfaces with computers. Fifth, computer reasoning will continue to grow in sophistication so that many decision-making tasks will be performed by computers rather than people. Finally, change will continue to occur at a rapid pace.

The end result is that people will increasingly occupy two worlds simultaneously: the physical world and the virtual world. Within the latter, we will have many virtual worlds to operate in. For example, a virtual world in which we work, and a virtual world in which we will play. Some of these worlds will operate in a manner where the laws of physics appear to hold, and others will invent their own laws of physics, cultural norms, etc.

What will be impact of these changes on Enterprise Systems? First, and most important, as members of an enterprise, we will have ubiquitous access to information. No longer will our decision making be limited by what we personally know. Instead, we will be able to reach out to acquire whatever information is relevant to the task at hand. The flip side of this is the spectre of information overload. We have seen with the growth of the web that search engines, like Lycos and Infoseek, have become almost useless in their ability to return relevant information; there is too much information out there and the algorithms these systems use are too "stupid." This is only a small indication of the overload to come.

Second, with the ascendancy of artificial intelligence, more and more of the operational decisions will be made by intelligent agents. These agents will be distributed across the enterprise and coordinating their decision making in real time. The humans that remain in the organisation will be able to communicate with these agents, ask questions and influence their decision-making.

Third, every member of the enterprise will have their own personal agent that will explore, extract and perhaps discover information relevant to their role in the organisation. They will even participate in meetings as their representatives.

Finally, the effect of these trends will not be to eliminate people from the enterprise, but to instead allow them to focus their energies on the truly creative tasks that remain.

But the ultimate challenge for the Enterprise Information Systems of the future will be how they will operate in a chaotic world. Our systems will not operate correctly because we engineered them that way (from the ground up), but because we will have defined laws of behaviour that restrict how our ever evolving information systems will "behave."

3. ENTERPRISE INFORMATION SYSTEMS IN VIRTUAL ORGANISATIONS

Peter Apers

Commerce in the broad sense will require virtual organisations, new organisations defined on top of existing ones. The question to be addressed in this section is what are important research areas for information and communication technology (ICT) to support virtual organisations.

3.1 Virtual Organisations

Traditionally we had corporate information systems to support the core business of an organisation. The borders of organisations were clear, and so was the support by corporate information systems. Nowadays with virtual organisations to offer services or to produce product in a cross-organisational setting the borderlines are no longer clear. The main application in such an environment will be e-commerce from business to business and from business to customers. Let us first have a closer look at virtual organisations. From an ICT perspective a virtual organisation is comparable to a collection of information systems in a heterogeneous setting. Heterogeneity not only refers to hardware and software platforms but also to conceptual platforms. To support the primary process of a virtual organisation, exchange of data and processes is required.

3.2 Exchange of Data

Communication between and integration of heterogeneous databases has been a topic of research already for many years. The main issue was the fact that database systems used different data models and that schemas were developed independent of each other. In a virtual organisation it is not so much the goal to integrate databases (because they want to remain autonomous) but to communicate among them. To be able to communicate a common language is required, which until now was absent. Bilateral translations were therefore required. Now with the advent of XML (a child of SGML) we have such a common language. SGML was developed for the exchange of documents. It is a very extensive language and the tools developed for it are rather expensive. XML has taken 80% of the functionality of SGML, but is far simpler than SGML. Tools only cost a fraction. XML is a meta-language that allows, compared to HTML, semantic tagging. In practice this means that a database schema can be expressed in XML. In the DTDs of XML one can express data models (e.g. there exists one for UML) and describe how to translate one DTD to another DTD. In this way the exchange of data (documents) becomes easier. The problem of incompatible tags remains. However, because XML is developed in the WWW environment one can see that a lot of groups are active to define semantics tags for their own discipline, making exchange of data simple.

3.2 Exchange of Processes

Virtual organisations are created to better support new business processes. Workflow management is becoming very popular to support business process redesign. Running workflows in one organisation is far from trivial. The challenge now is to run inter-organisational workflows. The idea of workflow is to decouple the organisational structure into departments from the products and services provided. Inter- organisational workflow is of course the extreme where people working for different companies together provide a new product or service. To support inter- organisational workflow a mechanism is required to fork part of a workflow off and run it in an another organisation. This means that we have to deal with heterogeneity as far as workflow systems and workflow specification is concerned. A possible way of dealing with this heterogeneity of workflow system is that we should formalise contracts between workflow systems considering types of communications, for example, what is being asked, what is offered, and what type of monitoring.

3.3 The Future

ICT facilitates a highly distributed environment; virtual organisations will push this technology to the limits. Right on the turn of the millennium we are at the advent of quite a challenging period. Not only from an ICT perspective, but also for our community at large, the question is "How will electronic commerce affect us?" One thing is for sure, companies that are able to use ICT to get an appropriate support for virtual organisations will have a lead.

4. THE MULTI-AGENT APPROACH TO ENTERPRISE INFORMATION SYSTEMS: CHALLENGES & DIRECTIONS[1]

Mark Klein

4.1 The Challenge: Creating Rapidly Customisable Enterprise Information Systems

Enterprise information systems fundamentally require the integration of multiple heterogeneous systems into a coherent framework. The traditional approach has been to develop large monolithic ("stovepiped") systems, but this approach has become enormously difficult to operationalise. The boundaries of enterprises are increasingly prone to expand dynamically to take advantage of opportunistic collaborations (i.e. via "virtual enterprises"); conversely, the decentralisation of processes (e.g. supply chains) that used to be contained within a single organisation has become commonplace. Both tendencies have been given enormous impetus by the growing ubiquity of internet-based services. New

[1] Thanks are due to Prof. Chrysanthos Dellarocas of the MIT Sloan School of Management for his helpful comments on this section.

technologies that we may want to incorporate into our enterprise systems are coming out at an ever-increasing rate. The result is the need for rapid customisation, which is very difficult with monolithic systems. Monolithic systems also tend to stifle competition in the software market: witness for example the dearth of choices in ERP software.

4.2 The Trouble with Components

Component-based software has been proposed as a panacea for this, for some good reasons. The notion is that complex systems can be rapidly built up from "best of breed" components selected from a competitive software vendor marketplace. A critical problem with this approach, however, is that the availability of components does not in itself simplify the system design problem sufficiently. Software developers need to internalise the potentially vast and rapidly changing library of potential components, and need to manage the resource management and emergent behaviour issues that can lead to disastrous failures in complex systems. Component interfaces are also not sufficiently standardised, so it is difficult to "plug" in a new component as a replacement for an old one. The result is that we are led back to the creation of slow-changing monolithic systems, built from components this time.

4.3 The Multi-Agent Systems Approach: Emergent organisations

The promise of the multi-agent systems (MAS) approach is that one can create complex systems as collections of agents that dynamically organise themselves to solve complex problems efficiently. Such systems can thus be "developed" by ensuring the right agents are accessible, explaining the requirements, and standing back. The key "trick" is that the agents include, in addition to their expertise about how to solve a particular domain problem, expertise on how to coordinate with other agents. In other words, we can say that:

agents = components PLUS coordination

Using this coordination knowledge, agents decide among themselves who will do what when using what resources in order to most efficiently achieve the tasks at hand, given the inter-dependencies among the tasks, agents and resources.

Here are some examples of how this can work. Jack Rockart of the MIT Center for Information Systems Research has divided enterprise information systems into three categories:

Horizontal systems – internal operational processes

Vertical systems – decision support systems

External systems – connections to other enterprises

Horizontal systems such as logistics processes are increasingly being broken down into multiple components, which are often run by external entities (e.g. because of outsourcing). Agent-based approaches can be a natural fit, in that the business process can be viewed as a conversation between agents representing the possibly changing set of entities involved in the process.

Vertical systems for decision support can benefit from the use of agents to collate information from multiple sources, moving the agent (using 'mobile agents') to the source if necessitated by bandwidth or other concerns, coordinating multiple searches from multiple heterogeneous information sources of varying cost, responsiveness and quality.

External systems, for example for electronic commerce, are again a natural fit to agent-based approaches, with computer agents representing buyers and sellers engaging in automated negotiations such as auctions and other market-based coordination mechanisms.

4.4 Challenges to Achieving this Vision

Much work needs to be done in service of this vision of coordination-savvy agents and self-organising societies. Most MAS implementations to date are small-scale closed systems. Much of the recent most visible progress in the agents world has been mainly infrastructural, addressing issues like mobility, security, and standardisation of low-level agent communication languages, but not coordination per se. I see several key areas for future development:

Coordination-capable agents: effective coordination often requires that the agents are reflective (the agents know their own skills and needs) as well as adaptive (e.g. can offer a cost/quality trade-off for their results as required by a coordinated multi-agent process). A key question here is how can we simplify the job of creating such coordination-savvy agents out of components that may often be legacy systems.

Better understanding of coordination mechanism design space: the range of potentially useful coordination mechanisms is large, and has been studied in disciplines as diverse as operations research, distributed artificial intelligence, management science and anthropology. This design space needs to be systematised such that agent system designers, or the agents themselves, can select the coordination mechanisms best suited for their particular needs.

Civil agent societies: In the dynamic world that most enterprises face, errors occur, resources and requirements change, and unexpected emergent behaviours can have serious consequences. The traditional approach to this problem has been either to ignore it or develop “paranoid/survivalist” agents that use that incur large overheads. This problem needs much more attention; I believe innovative approaches such as creating the agent world equivalent of social institutions (e.g. the police, court system, trade commissions) is one promising direction.

Much work in these directions has been carried out by the Adaptive Systems and Evolutionary Software research group at MIT (ASES 1999).

5. ENTERPRISE INFORMATION SYSTEMS AS EMBEDDED SYSTEMS IN ORGANISATIONS

Albert M. K. Cheng

An enterprise information system (EIS) can be viewed as a system embedded in an organisation. This embedded system interacts closely and reactively with the organisation. Therefore, both the logical and timing correctness of the EIS must be satisfied in order to meet the objectives of the organisation.

The following model of a real-time decision system can be viewed as a model of EIS's. A real-time decision system (the EIS) interacts with the context (the organisation) by taking inputs and computing decisions based on these inputs and stored state information (history of the EIS and organisation). We can characterise a real-time system with 7 components:

(1) an input vector x,

(2) a decision vector y,

(3) a system state vector s,

(4) a set of context constraints A,

(5) a decision map D, D: S * X -> S * Y,

(6) a set of timing constraints T, and

(7) a set of integrity constraints I.

In this model, X is the space of input values, Y is the space of decision values, and S is the space of system state values. (We shall use x(t) to denote the value of the sensor input x at time t, etc.) The context constraints A are relations over X, Y, S and are assertions about the effect of a decision on the external world (the organisation) which in turn affect future input values. Context constraints are usually imposed by the physical context in which the real-time decision system functions. The decision map D relates y(t+1), s(t+1) to x(t), s(t); i.e., given the current system state and input, D determines the next decisions and system state values. For our purpose, decision maps are implemented by the software of the EIS. The decisions specified by D must conform to a set of integrity constraints I. Integrity constraints are relations over X, S, Y and are assertions that the decision map D must satisfy in order to ensure safe operation of the physical context (the organisation). The implementation of the decision map D is subject to a set of timing constraints T which are assertions about how fast the map D has to be performed.

Let us consider a simple example of a real-time decision system, which is a distributed (maybe wired, wireless, or both) computer system in an organisation that manufactures and sells a variety of products. Depending on the quantity of sales in the recent past (maybe a few days or weeks) in different geographic regions, components of this real-time system have to be reconfigured so that the computing resources are focused on the high-sales geographic regions to meet consumer demand and service. Suppose we want to automate this reconfiguration as much as possible while still allowing for full human control and the timely resolution of interoperability amongst existing components and new components (because of increased sales).

The input vector consists of variables denoting the current sales figures for each geographic region, the current allocation of computer and human resources, and the objectives of managers in each region. The decision vector consists of several variables including: one variable to indicate whether to maintain or change the current computer configuration and one structure variable to indicate the new configuration. The system state vector consists of variables denoting the previous sales figures for each region. The set of context constraints consists of assertions that express the economic laws governing the relationship of demand and supply, political and cultural features (especially in international organisations), and the long-term objectives of regional employers. The integrity constraints are assertions restricting how fast the computer reconfiguration can take place. The decision map may be implemented by some rule-based program. The input and decision variables of this program are respectively the sensor vector and decision vectors. The timing constraint consists of a bound on the length of the monitor-decide cycle of the program, i.e., the maximum number of rule firings (or other measures of time) before a decision is reached.

There are two problems of interest with respect to this model: (1) Analysis problem: Does a given rule-based program satisfy the integrity and timing constraints of the real-time decision system in a particular context? (2) Synthesis problem: Given a rule-based program that satisfies the integrity constraints but is not fast enough to meet the timing constraints, can we transform the given program into one which meets both the integrity and timing constraints?

Using this model, an EIS can be characterised more systematically and unambiguously at different phases of its implementation, from concept or prototype to an implemented and mature existing system. Then the EIS, represented by this embedded model, can be analysed, modified, optimised, or studied to meet new objectives or correct existing problems.

6. INFORMATION SYSTEMS ANALYSIS AND DESIGN IN THE NEW MILLENNIUM - A NEED FOR CHANGE

Ronald Stamper

The analysts and designers of enterprise information systems are neither scientists nor engineers applying scientific knowledge. Today, we are the handmaidens of software engineering and purveyors information technology. We are craftsmen and women more like medieval metal smiths. We employ, as they did, only methodological knowledge, without a theory or reliable instruments to guide us. The best among us learn to "spit in the furnace" to sense how well a system is working. This situation should alarm us as we stand on the threshold of a post-industrial society, living off an information-based economy.

Can we recreate ISAD in 2000 as a science on which we can build an engineering discipline that serves society rather than principally benefiting the IT industry?

From an engineering point of view, an enterprise information system employing computers is certainly different from one based on pen and paper, but for organisational purposes the technology is irrelevant except as regards efficiency. Technology can only provide meaningless, purposeless signals and tokens often worth physically no more than the paper they are printed on or electricity they transfer. Effective information systems change the behaviour of people. A science of information is essential if we are to understand how to do that.

When people began to invent ways of co-operating by expressing their intentions using meaningful signs, sometime in the stone age, we began to use information systems to support our enterprises. When people use information, the technology is less important than what they mean, what they intend and what effects they have on others. These aspects of information receive little attention in our ISAD methods. No wonder half our systems are organisational failures; technical excellence addresses a necessary but the less important part of the problem. We must do better. Utterly surprisingly, however, is that companies continue to have faith in a technology unable to add value commensurate with the financial investment it absorbs (Strassmann 1997). Our success seems to be sustained more by the 'hype' of fashion than by real competence in the use of IT. To evolve from craft-workers of the information age into scientifically enlightened information engineers, we must rethink our discipline. Let us begin by discarding the mumbo-jumbo language that talks vaguely about various mystical fluids - "information", "meaning", "knowledge" and how they 'flow' as we "communicate" them - as though these were all simple, primitive notions we all understand. We use technical terms in our discipline much as medieval scholars talked of "the vital force" to explain the motion of objects, "phlogiston" to explain fire, "caloric" to explain heat and all kinds of "essences" and "humours" to account for almost everything else.

Instead, let us use the notion of a sign as a primitive concept. This notion is easily explained by demonstrating how people using one thing (a sign) to stand for something else (what it represents). As physicists use the primitive notion of a body and then introduce various physical properties of bodies in order to develop their theories on a sound empirical basis, we can deal with the properties of signs to develop many precise meanings for "information" and those other difficult terms. By this route we can build an organisational semiotics (Stamper 1996) to explain how we get things done by using information.

On the familiar technical side, signs have properties on three distinct levels. They have the physical properties that account for their costs. They have statistical properties governing their reliability. And they have structural or syntactic properties. These aspects of signs are already handled and scientifically by those concerned, respectively, with hardware, telecommunications and data- and program-structures. The lacuna lies with our understanding of the human and social properties of signs. Semantic issues concern the making of meanings and how we maintain and use them. Once we can form meaningful signs we can use them to express our intentions; we must understand in detail how we do so. On their highest level, signs produce the effects that account for their value - they change people's beliefs, mutual commitments, values and even their perceptions, their understanding of what there is, what is true, what is right and wrong, good and bad, and of how to behave. We shall only begin to create a genuine, empirically testable science of information systems when we have a clear understanding of the properties of signs on all six levels of the 'semiotic framework'.

The old trades of the information smiths - requirements specification and computer systems development - will remain. We shall still prepare the ground for software engineering but we shall do these jobs on a scientific basis instead of having to rely only on our assimilated methodological skills. We shall have a scientific understanding of why our methods succeed or fail. Skill and craftsmanship will still be valued but adding science and engineering will make our field far more exciting and fulfilling. Information systems are integral to our society. They provide safety in aircraft and nuclear power stations, they protect our livelihood through pensions insurance, they enable us to exploit each other's labour through trade, and they enable us to build trusting and mutually supportive communities. Far more important than efficiency are such information systems properties as openness, honesty, trust, fairness, justice, accountability, responsibility and truthfulness. These are not even registered by our current methods.

Above all, information systems are the instruments we use for creating relationships between people, the communities in which we live, and the vast, evolving, global social fabric. The problems of technically efficient computing remain interesting, but they are relatively minor compared with the other problems that we have hardly begun to address. The future is ours to choose. Do we want to remain the servants of industry using IT to increase efficiency? Or do we want to become the architects of the organisations and institutions in which we shall live our post-industrial lives, enjoying with others greater openness, trust, fairness, justice but also greater individual self-realisation, power and responsibility? These are also qualities of information systems.

7. ARE WE READY FOR THE NEW CHALLENGES?

Satya P. Chattopadhyay

7.1 New Millennium, New Challenges

In the 20th century we moved businesses from the age of the quill and abacus to analogue and digital computing and made previously unimaginable number crunching capability routinely accessible. Impressive miniaturisation has made it possible to downsize the behemoth early computers to user-friendly information appliances, just as we have developed software that turn vast amounts of data into actionable information. As we enter the third millennium, the platforms of promise that will host the complex enterprise wide integrated information management systems include network computing, artificial intelligence, and of course last but not the least important: the hydra-headed internet. We must however remind ourselves once more that information systems can best be viewed as enablers whose domain is the overlap between managerial need of information for decision support and extant technology. It is very difficult to state at the close of the 20th century which of the two is the driver and which is the driven. It is this question that needs to be addressed. Ideally, the two work in tandem with frequent switching of the leadership role. It is my impression though, complexities of business information requirements notwithstanding, technology with a life of its own is really dictating and defining the information resource utilisation in many cases. This is not to be confused with technology limiting the availability or use of information.

Rather, pressures to find immediate applications for state-of-the-art information technology has a way of stripping decision domains of troublesome unexplained interactions that cannot be accounted for or modelled using it.

There has been many an unexpected problem that has developed as we increase the pace of introducing intensive technology based solutions into an environment that is living and ever-changing in a rather unpredictable manner. We are yet to be in a position where we can discount with absolute confidence and accuracy, that a butterfly flapping its gossamer wings in a garden in Kyoto will ultimately lead to a storm in Brazil (Lorenz 1996). Technology solutions may very well lead to unforeseen problems that a helpful peer looking over the shoulder would have prevented.

7.2 What about solutions?

The risk is all too real that the problem will be tailored to suit the technology rather than the other way around. The danger in introducing apparently elegant technological solutions into real live problem situations lie in over-engineering, over-standardising, myopic reduction of diversity in the hope of attaining elusive magnitudes of efficiency and devaluing and downgrading the "uncontrollable" to arrive at intuitively appealing "best practice" solutions. Technology based solutions are quick to embrace the cold logic of IT based solutions to complex business problems over difficult to quantify warm and fuzzy aspects of a cognitive-behavioural minefield.

However, the impact of any solution mode on the ability of the enterprise to innovate and change to adapt to the evolving environment of business is a concern that cannot be overlooked. This is the problem that is faced by the decision-makers of the millennium cusp. The quality of decision-making ability is as critical, if not more so, to enterprise survival as it has ever been before. Literature as well as handed down and experiential management savvy reinforces the wisdom that the quality of the decisions made depends on the appropriate specification of the problem domain and the quality and completeness of the information. The choice is between an "expertly developed, imposed from above, right way approach that uses a generically specified model with pre-defined linkages" and a "chaotic environment of competing mini-systems that seek to influence an imprecise satisfying solution through evolving and adapting patterns of complex, less than perfect intersystem communication." (Stambaugh 1998). The former is admittedly low risk, but advancement of knowledge has always depended on enough support for the latter.

The enterprise information system (EIS) of the new millennium will have to be particularly conscious of the peril outlined above. The complex mechanism of information acquisition, transfer and management among and within the various levels of decision-makers within and (increasingly) between enterprises that contribute to enterprise success are under-specified and compromise decision quality as we increase our dependence on "received wisdom" of best practice models that come with formalised enterprise resource planning (ERP) solutions.

Brown and Duguid (1990) proposed a conceptual framework that would seek to address the EIS issues of the new millennium. They posit that the use, organisation and flow of information in enterprises differ significantly from both how the " organisational manuals" describe them and how the decision-makers themselves report them. According to the authors, the acquisition, dissemination and use of information in enterprises occurs as much at least around informal and dynamic loosely structured configurations as they do through formal functional/process oriented entities.

These continuously evolving entities deal with the dynamic changes taking place in the environment through talking, changing, improvising and learning as they collectively seek to get from point ‘A’ to point ‘B’ by steering through the plethora of day-to-day operational crises as well as strategic options that present themselves regularly with infuriating lack of precise information that appear to be relevant to their resolution. Brown and Duguid (1990) call these informal group entity “communities of practice” (COP). The COP are not policy mandated but appear to form around water coolers and coffee-pots that seek to address specific business problems or exploit evolving opportunities that appear to be within the domain of their collective expertise. They seek to do so using more often than not, a specialised vocabulary that has meaning relevant to the problem only within the group.

As a group, the COPs resist any efforts at imposition of outside authority formal or informal. The boundaries of the group, while they may exist at any given time are not easily discerned. Members enter and leave through the periphery. The departures may be caused by physical dislocations and or by the nature of issue at hand. New members enter the COP only through the periphery, and a rigorous process of vetting ensures that the focus of the group is not compromised. At the same time new ideas that may help speed the solution to problems are likely to make it through. The COPs must thus be recognised for what they are: a very effective but porous, unstructured distributed decision support system that is continuously evolving. In ways, the problem mirrors the one that spurred the development of the Internet: the need to access diverse repositories of data on a real-time as-needed basis. Except here, the repositories are immensely complex cognitive entities that interact simultaneously as individual, social and organisational beings. This “COPnet” will provide the flesh, muscle and aesthetic elegance to information technology skeletal structure.

Merged data from Intranets, Internet and “COPnet” will become part of routine decision support mechanisms and authentication and security issues will of course need to be addressed. More importantly, workflow tools that support acquisition, digesting and configuration of information through the likes of storyboarding and multi-media visualisation and promote the acquisition, enhancement and transfer of knowledge will be the major components of information technology contribution. It will be then possible to support the needs of managers across business processes as they coordinate their efforts to serve globally dispersed customer settings.

At the cost of falling into the cliché trap, these "fuzzy, soft and transient" aspects of the intersection between managerial information, innovative continuous-learning domain, and quantum technological progress will be the defining characteristics of the 21^{st} century. Artificial Intelligence, facilitation of all forms and levels of communication among managers, machines and particularly the interfaces will become the critical proving ground for the success of information systems of the new millennium. We will rapidly switch to the concept of knowledge management systems as opposed to information management systems. Successful knowledge management applications will provide access to heterogeneous unstructured information through user-friendly sophisticated search capabilities.

8. HUMAN ENTERPRISE INFORMATION SYSTEMS

Thomas Greene

As indicated by the title of this conference, another wave of technology is about to sweep through the information space of the planet. Waves come in a variety of sizes and shapes. The technology wave carrying Enterprise Information systems, is a huge roaring wave that will have dramatic effects as it sweeps through the affairs of humanity. 40 years ago, another huge wave appeared, the wave of corporate mainframe computing carrying with it corporate information systems. The work of the earlier installers of this technology is still with us today.

Benefits from their work includes the freeing up of the information work force from manual tasks, internationalisation of many businesses, cost reductions in many aspects of business, and a larger varieties of goods to wider markets. Some costs of their work have been a de-personalisation of the work experience for many people, and a yet unknown cost resulting from the failure of the early developers to properly plan for the future by anticipating the longevity of the programs they wrote. This unknown cost will be visible on 1/JAN/00. Early programmers achieved a memory and storage cost savings in their systems by using a 2-digit field to represent years. This “savings” created a looming disaster (or hopefully, a minor event) known as Y2K.

Those of us gathered here to discuss the issues of EIS, have an obligation to stretch the time horizon and scope of issues we include in our designs. Let us work to insure that 40 years from now a total celebration of this beginning and our work and will not be coloured by the threat of some other looming disaster.

EIS when fully implemented many mean that all people in an enterprise may find what was formerly the tedious challenge of assembling all the facts for decisions as “just getting the information” by asking their machines. Until now, the emphasis in the development of systems has been focussed on the machine side of the Man-Machine spectrum, but the installation of EIS may be a true paradigm shift. The design technology systems should begin with human issues. The past error in system design of a machine based issue, 2- digits for the year, may seem minor in the future compared to a failure to properly design systems that include more human issues such as Privacy, Security, Feelings, quality of life, Nationalism, human job satisfaction etc. At present, traditional system design techniques are able to rapidly incorporate the knowledge of researchers in Science and engineering. EIS systems design must include new insights with input by Sociologists, Psychologists and others in the Human studies fields. How this will be done is not known, but the need to do this is clear.

As we absorb and ponder networks, faster machines, voice recognition interfaces, mobile computing and other technologies, including the incredible possibilities of relational database driven web sites, let us also find ways to deal with the harder issues of human needs. These issues include making people happier, guaranteeing that the privacy of our workers and our customers is not violated. We must incorporate in our designs insights and breakthroughs in research in fields other than the obvious ones of computer science and engineering. The access to enormous information provided by the World Wide Web should mean that more collaboration is possible and that individual designers should be able to address wider design spaces.

The justification of EIS should be not only the traditional success measures of reduced cash expenditure, but should now include improved job satisfaction. Building systems that not only improve the profit of the Enterprise but rather systems that improve the human conditions of all the people involved should be our goal. To emphasise this issue for ourselves and our colleagues a renaming of our endeavours from Enterprise Information Systems (EIS) to Human Enterprise Information Systems (HEIS) might be appropriate. This refocus could help us avoid the possible design and implementation errors that could make the Y2K problem seem small.

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