PROCESS-AWARE E-GOVERNMENT SERVICES MANAGEMENT: RECONCILING CITIZEN, BUSINESS AND TECHNOLOGY DYNAMICS: A RESEARCH NOTE

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Abstract

E-government is becoming a reality rather than a theoretical ambition; however, achieving the e-government anticipated benefits is still illusive, which is exacerbated by the continuous and ever changing business processes, IT and user requirements. This paper outlines current state of e-government research and the challenges emerging from the need to integrating citizen, business and technology into seamless e-government solutions and services. In addition, the paper proposes a semiotics-informed framework for process-oriented e-government services modelling and management, which is used and tested on laboratory-based case studies.

Keywords: e-government, process modelling, semiotics, autonomic computing..

1 THE CURRENT STATUS OF E-GOVERNMENT

E-government is often seen as an instrument for public sector modernisation including efficiency improvement and wider-access to national and regional public services via ICT (Liu et al. 2005b). Though, as reported in early studies (Adeshara *et al*., 2004; Cohen and Eimicke, 2002; Dittrich *et al*., 2002; Huang *et al*., 2005; UNEAS 2003, Wagner *et al*. 2006) the level of adoption of e-government varies widely across regional and national boundaries, and is very much affected by economics and socio-technical factors with little to no citizen's involvement in the design of e-government services[1]. Such a participative approach is already provided in many e-commerce portals, and been highlighted in the UK 7-point action plan (Prime Minister's Strategy Unit, 2005) setting a priority to implementation personalisation of eServices as highlighted by (Leadbeater, 2004): "…*by putting users*

[1] Such an approach is attributed to many successful Canadian's eGovernment implementations (Accenture, 2005).

at the heart of services, enabling them to become participants in the design and delivery, services will be more effective by mobilising millions of people as co-producers of the public goods they value."

Whilst, much research and development is now underway focusing on many aspects of E-government ranging from e-citizen, e-services to e-administration, with focus of many research concerns including; risk management, data and knowledge management and interoperation, information interchange standards and design frameworks for e-government systems such as: - Yet, numerous recent reports are still reporting on the general "software crisis" (Gibbs, 1994; RAE and BCS, 2004) with in e-government, that is, e-government services are fail to deliver promised functionality (The Economist Reportage, 2000; Heeks, 2003) including being delivered on cost and on time.

2 RESEARCH CHALLENGES

Addressing the e-government "software crisis" is a long-standing research problem, which is exacerbated by the complex tight coupling of "Citizen, Business and Technology" requirements, and their often unpredictable and rapid changes. Such concerns can be grouped as follows:

- Integrating Citizen, Business and Technology into E-government: E-government services can be categorised as: access to information, transaction services, and citizen participation (Marchionini *et al*., 2003), each built on its previous form, along the line of the five phases described in the last section. To achieve the perceived benefits, all forms of e-government have to be exploited. Access to information by the citizen is clearly less challenging than providing transactional services. For the latter will involve not only the technological provisioning, assurance and viability (accounting), the success of which are heavily reliant on a number of factors including; organisation (including people), process and systems' integration. Furthermore, improvement of citizen participation is even more challenging as it is concerned with social, political, and cultural factors. The development of e-government strategy has to consider three important motivating questions. First, in the political arena, whether or not there is a political urgency which may be from the international environment and neighbouring countries. The support from the top level such as the central government is essential. The citizen demand and readiness to accept e-government is the key to the success. Secondly, there is a technical constraint, such as network infrastructure, computer availability and the use of computer and network accessibility. This is closely determined by the economic capability of a region or a country. Finally, legal infrastructure is another determinant, which includes privacy law, security law, trust in government, and accepted decision-making processes (Chen and Knepper, 2005).
- Facilitating E-government Services implementation: At a recent international expert round-table discussion at an international workshop on e-government implementation (Liu et al., 2005) from many countries identified the following issues that are particularly relevant to the integration concerns of business and technology, namely:
- Organisational strategies, planning and resourcing: This indicates that national and/or local government departments must set strategic policies (with varying horizon (short to a long-term vision), and facilitate the development and provisioning of associated plans and resources[2] necessary for the implementation, introduction and management of e-government and services.
- Contextual readiness for e-government: This implies the readiness for implementation and introduction of e-government solutions, which is not only concerned with the technical infrastructure and connectivity, but also the "people" dimension including; social and cultural factors associated to the e-government service providers (government) and consumer (citizen). The citizen participation and acceptance of e-services as indicated by Accenture (2005) can only be achieved by extensive education, demonstration of added value and quality of services

[2] High priority must be placed on the resources required as the implementation is carried out in parallel to other normal government services.

provided by e-government solutions, and/or a true citizen-centric design of e-services via customisation?

- Business model evolution: This highlights the need for change (see co-evolution) such as in organisation structure, regulations and policies, and business processes. Such changes may be profound and painful which may lead to loss of powers of some departments even jobs.
- Assurance: To ensure any specified citizen, business and technology requirements to be monitored throughout e-government services life-cycle development and re-engineering processes. It is important to ensure that "non-functional" requirements including; dependability, resilience, security, etc. to be guarantied (Evangelidis *et al*., *2002*). Such a model is increasingly researched, and was proposed by the authors at one of the EU-funded E-government Interoperation Observatory Meeting (Interop, 2004). Auditing: To develop required mechanisms for measurement, monitoring, accounting and tuning/adjustments of systems and/or plans to co-evolve or adapt to changes, etc.

In line with the above high-level research concerns, an integrative framework and associated tools and methods are required to support the three pillars of next generation e-government services: Provision, Assurance and Auditing. Provision of high-quality services achieves cost-saving, more efficient administrative procedures, pro-active service delivery, which is the essential part of next generation e-government. As to assurance, to attain a secure e-government service plays a vital role in success of future e-government service. E-government service must be designed, employed and operated in a secure manner. All threats and vulnerabilities must be evaluated by imperative assurance in e-government services. Auditing of e-government services is necessary to prevent the public resources from being used improperly. It is a crucial issue to assure transparency and accountability of the public empowerment.

To this end, an integrative modelling and design framework needs to be developed, which is outlined below.

3 A FRAMEWORK FOR PROCESS-ORIENTED E-GOVERNMENT SERVICE PROVISIONING AND ASSURANCE

A social system such as a region, a local community and a business organisation consists of human actors and instruments (e.g. ICT and others) used in social and economic activities. Activities carried out in such a system will either be substantive (e.g. production and consumption of physical goods) or communicative (e.g. provision and consumption of information and services). For the social systems to achieve the set objectives, activities will have to be coordinated through use of information. E-Government as a complex socio-technical system can be modelled by the semiotic framework (Stamper, 2000), and designed using advanced autonomic software engineering principles (Laws *et al*., 2002; Taleb-Bendiab *et al*., 2005) with continuous support for process-oriented Provision, Assurance and Auditing (Randles *et al*., 2005b). Each of these are detailed below.

3.1 Modelling e-Government Services via Semiotics

Semiotics is the study of signs (Peirce, 1931-1935), with one of the main objectives is to examine how information is represented by using all kinds of signs such as icons, symbols, and language (natural and other formal and informal languages used in human communication). Signs are seen as the basic units for human and machine-based communication. A sub-discipline of semiotics, Organisational Semiotics, is emerging to study the properties and behaviour of signs in organisational contexts and business practice (Liu *et al*., 2001; Gazendam *et al*., 2005). The semiotic framework of Stamper (2000) is applied here to investigate the implementation of e-government implementation from six layers.

The development of e-government in a social system implies the implementation of architecture in multiple layers, three of which constitute the technical infrastructure:

- *physical* devices and their interconnections - the computer hardware, the network, the optical fibres, the satellites, etc., which generate and carry a cause-and-effect chain of events quickly and cheaply, across the globe if necessary;
- *signalling* protocols, the validation, authentication and encryption routines that exploit the basic physical phenomena, so that a varied stream of patterns originating in one place can be reproduced, ideally without error, at another place, or corrected in case of error;
- *structures* which enable signals to be combined into messages, to be analysed into parts (parsed), stored in files, retrieved, used in calculations, recombined into new messages.

With the technical infrastructure in place, we can then design the further three layers, which are more directly related to the content of e-government:

- *meanings* of the numbers, words and expressions that form a message, and the ways that individual components combine to create the meaning of the message as a whole;
- *communicating* the intentions of the message, through interaction, clarification and negotiation between appropriate actors;
- *social consequence* in the form of established commitment, obligation and responsibility between the people involved.

Integration between business processes and IT systems is the key toward an advanced e-government services. Organisational semiotics advocates an approach of business and IT system co-design (Liu *et al*., 2002). The approach of co-design treats the ICT as part of the infrastructure as well as business processes, which lends vertical integration within an organisation. Horizontal integration refers to the network between different agencies and collaboration with other government offices. This can be benefited from the semiotic model of virtual organisations (Gazendam, 2001).

3.2 Designing E-government as Situated Autonomic Systems

Maintaining integrity with often-changing processes and practice produces many challenges in software design and development. Software is traditionally fragile to changes in its requirements, with after deployment maintenance estimated to consume at least 70% of a 5 year budget for enterprise software (Gartner Group, 2005). Whilst semiotic constructs and infrastructure provide the requisite structures and mechanisms to represent and co-ordinate eGovernment concerns, the software implementation itself must be able to adapt and consume these concerns in a predictable, assured manner, so that the desired range and quality of service can be delivered to citizens and users of eServices.

For such a challenge, autonomic software, which are imbued with autonomous behaviour often observed in natural organisms (Ganek, 2003). As such, an autonomic system is one that is robust against internal malfunction or external disturbance, having the ability to respond and adapt to unexpected stimuli, allowing it to survive in a changing and unpredictable environment. In nature, many organisms, including humans, have an autonomic nervous system that responds to events automatically, often to protect or secure the functions of the organism.

Hence, autonomic design is here used to sense and track the execution of eGovernment business process flows to regulate the process or simply to notify and expose how the state of supporting IT systems and resources is enabling performance monitoring, business health check or for human users to take corrective to a detected malfunction.

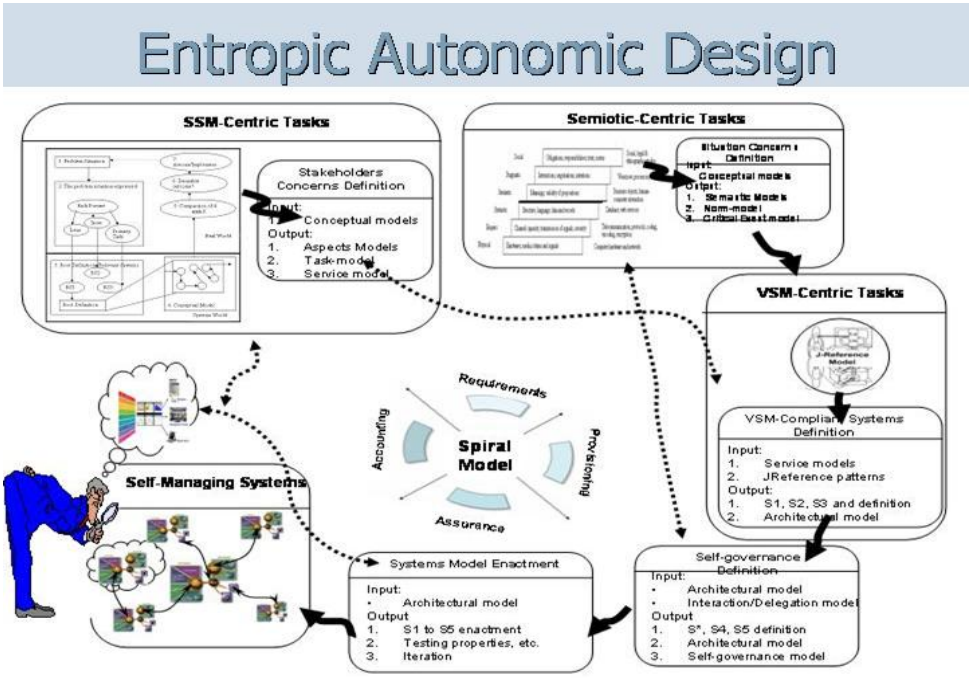

Figure 1: Schematic of the Entropic Design

As illustrated by Figure 1, the authors proposed a design model which combines autonomic design and organisational semiotic principles to provide a complete framework for interpreting and enacting process-oriented software with self-management capabilities. In that, the entropic autonomic design allows for requirements and tasks needed from software to be interpreted using a variety of semiotic techniques, which in turn are used to provide a task and workflow model that is afforded by a set of software services. Business knowledge such as rules, norms and regulations that determine the behaviour of government organisations, collaborative agencies and individual staff are captured (Stamper, 1993) and encoded using the Neptune environment (Sec. 3.3).

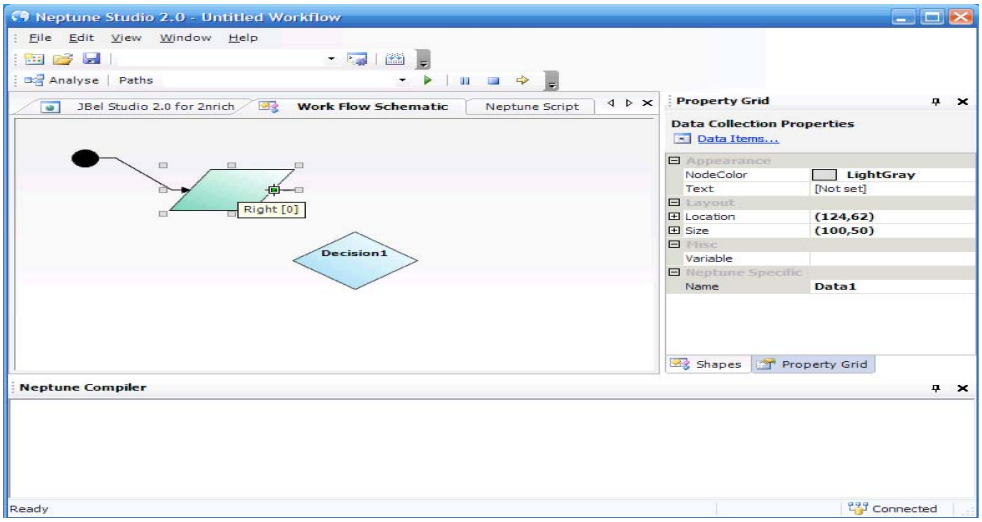

Figure 2: The Neptune IDE

3.3 Programming Support

A programming paradigm Neptune was shown to be successful in representing and enacting requirements represented using graphical, semiotic concepts (Miseldine *et al*., 2005a). Using flow chart icons, the software (Figure 2) provides the user with simple drag and drop interpretation of process flows, and their relationship with each other. Flow objects themselves can be one of 3 different types, though the facilities exist so that new types can be created as desired. The first type is the "Input" object that specifies what data is required, and when it is to be obtained by the software. The software can itself ascertain where this data should come from, for example from data repositories, or whether the information is to be elicited directly by the software. The "Decision" object is linked directly to logical statements encoded in the Neptune language, with the branches coming from the decision object containing the corresponding result of these logical statements. The final object "Action", provides either feedback to the user, or provides a link to execute other parts of the software, such as to show a web page, or run a database query. In summary, by dropping these shapes, linking them, and encoding the logic behind the model, a complete decision process can be created and adapted externally from a software system. The software then executes this model, and behaves according to the model.

As these models can be externalised, changes to their construction therefore does not require changes to the underlying software, allowing processes to be updated efficiently. Whilst human interaction is vital for the initial design of requirements and process models, for Neptune to support the autonomous behaviours discussed, it needs to provide a significant level of introspection to allow the system itself to reason upon its own construction and the form of the process models provided to it. Each object created in a decision process is represented computationally as in-memory objects. The resultant object model exposes the attributes assigned to each flow object (such as the required data to elicit, or the feedback to provide the user), and their interactions (such as which object follows which object in the process flow). The software can create or modify these flow objects computationally, without human intervention, to change its own behaviour. Relating to the autonomic features discussed at the beginning of the section, the VSM model provides the sensors of autonomous behaviour, whilst the Neptune object model discussed provides the enactor of the behaviour.

As a complement to the environmental sensing afforded by VSM, Neptune includes an audit trail for each execution of a process model. Called Mercury, every interaction and decision made whilst progressing through the process model is captured and stored in an open XML format. These audit trails can be analysed to provide statistics on which paths are being taken through a process, as well as profiling behaviours that might be an indirect consequence of the current process flow. Mercury trails can be passed on to other process models to provide persistent storage between process models. In an eGovernment scenario, these trails could be linked to eCitizens, so their usage and requirements of eServices can be monitored.

Neptune environment provides support to co-ordinated autonomic design, and representation of business processes. With Neptune providing the building blocks, and VSM providing the blueprint, many interesting questions still require answering before the full vision can be built and realised.

The entropic design proposed is dependent on an accurate task model. Failure to elicit the correct requirements will produce failures within the software to fulfil the desired functionality. Similarly, incorrect interpretation of the task model using the semiotic constructs used in the Neptune software by a user will produce undesired behaviour. As such, validating the task models interpreted in the software against the proposed task models will increase the quality of the processes. These issues are fundamental questions of science, and many are dealt with in the field of Requirements Engineering and by use of semiotic technology.

The relationship between sensors and actuators for adaptation in the autonomic paradigm also require research. Questions such as "When should a policy be altered?" and "When does an unplanned behaviour become detrimental to citizens?" can be expanded into many diverse areas of research.

Danger theory and cognitive immunity can categorise behaviours and promote or demote their importance within a system. Work has been undertaken by the authors to provide Neptune with the requisite semantics to represent dangerous signals or behaviours (Randles *et al.*, 2005b) and thereby allow for their eventual promotion or demotion within the process models.

Indeed validation plays a key role within autonomic behaviour. Not only should the computational effect of an adaptation be assessed, but the wider effect of the change upon the full system of services needs to be considered. In eGovernment, this is a big challenge, where many different components and services interoperate to provide a complete solution for a citizen: changes to one service might negatively impact upon the processes of another service. Thus the context of operation must be extended beyond the boundaries of one system, into the federation of services to which the service belongs. Some initial work has been carried out by the authors into providing a framework, Rainbow, capable of exposing and co-ordinating such information (Miseldine *et al.*, 2005b) so that the autonomic features can access and reason upon its complete role within the system.

In summary, using Neptune users can provide concrete requirements using semiotic concepts, whilst the system can adapt these to provide autonomic behaviours based on the constantly evolving environment of the software sensed and interpreted using the VSM architecture. Assurance is provided by both the use of natural modelling and that adaptations made by the software can be re-interpreted and analysed by users using the same familiar, semiotic concepts (such as flow chart icons). Thus, the provision and assurance eGovernment services are afforded, whilst Mercury provides a mechanism for auditing interactions with services, as required by the three pillars of eGovernment discussed in Section 2.

4 A CASE-STUDY – WITSA E-GOVERNMENT SURVEY

This case study is used to conduct an early test of the proposed task-oriented e-government services management approach described above. For the purpose of the case study an e-survey application was developed, deployed and managed using the proposed framework. The survey is sponsored by WITSA and JMU to create a networked repository of contacts, e-government solutions and experiences for WITSA members to learn from participating countries (WITSA, 2006).

4.1 Development and Discussion

The survey tool consists of a Neptune object representing the questions that are required to be asked, complete with possible response options, and data validation requirements. The entirety of this information is encapsulated within a flow model. The logic model includes the logical instructions used to ascertain the actual flow through the model based on responses. Responses made by participants are stored within Mercury auditing trails, as the responses were made. Thus, partial responses can be viewed, as well as complete responses. In addition, the self-regulation layer and rules were formally modelled and implemented using our Concept-Aided Situation Prediction Action (CASPA model). This provided for instance a supervisory operation of the application and to log performance profile, interaction and errors, which triggers a self-healing process to correct error and alert as necessary.

During the participative development process of the survey (content), it was necessary for changes to made to the structure. These changes were required to take into account feedback gathered by the organisers and designers of the survey, requesting alterations, additions, and deletions of questions from the survey. Due to the flexibility of the Neptune model, the changes were implemented using the Neptune IDE by use of drag and drop, and saved directly to the object referenced by the survey software. Thus, no manual changes were needed to the software that required re-engineering. This has been compared against a traditional, ASP.NET web application deployment of a survey, which saw the same changes requiring over 100 code changes, and a recompile of the application.

In addition, the survey also employed the autonomous capabilities afforded by the Neptune model. After sensing redundancy in part of the model (specifically that one set of questions could not be answered if the user had answered a previous question using a certain value), Neptune re-wrote part of the logic model to remove the redundancy. In addition, it was sensed via responses gathered that participants who answered true to a particular question all answered true to a later question. In anticipation of this relationship, when the question was next answered true by a participant, Neptune adapted its interface to move the particular answer to the top of the list, to aid in the delivery usability of the survey.

5 SUMMARY AND FUTURE WORK

Only few governments have opted to use e-government applications for transactional services or networking. Even fewer governments use it to support the genuine participation of citizens in politics. Those who do, in most cases, apply it at a very rudimentary level (UNESA, 2003).

As e-commerce and b-business, e-government has become a reality rather than theory. However, the real value of the e-government is far from fully exploited. This is due to limitations from many facets: social, legal, economic, cultural as well as technical. Perceived value of e-government has driven the development of e-government for a long while. But there is still a great deal of research issues which have to be resolved before exploitation of its full benefits.

6 ACKNOLWDGEMENT

Part of the proposed framework has been developed and sponsored by EPSRC-funded project grant reference: GR/R86782/01, 2nrich Project, URL: http://www.cms.livjm.ac.uk/2nrich/

References

2nrich Project (2005). Project Web site (http://www.cms.livjm.ac.uk/2nrich/). Last accessed: 26-Mar-06.

Andersen, P. (2006). Activity-based design, *European Journal of Information Systems*, 15(1), 4-9.

Accenture (2005). e-Government Leadership - Realizing the Vision. http://www.accenture.com/Global/Research_and_Insights/By_Industry/Government/EGovVision.htm

Adeshara, P., R. Juric, J. Kuljis and R. Paul (2004). A Survey of Acceptance of e-Government Services in the UK, in *Proceedings of the 26th International Conference on Information Technology Interfaces*, Cavtat, Croatia.

Avgerou, C. and G. Walsham (2000). IT in developing countries. *Information Technology in Context*.

Badr, N., A. Taleb-Bendiab and D. Reilly (2004). Policy-Based Autonomic Control Service, in *Proceedings of the Fifth IEEE International Workshop on Policies for Distributed Systems and Networks*, June 7-9, 2004, Yorktown Heights, New York, pp. 99-102.

Chen, Y. and R. Knepper (2005). Digital Government Development Strategies: lessons for policy makers from a comparative perspective, in Huang *et al*. (eds.) *Digital Government: Strategies and Implementation from Developing and Developed Countries*. Hershey, PA. Idea Group Publishing.

Cohen, S. and W. Eimicke (2002). The Future of E-Government: a project of potential trends and issues, in *Proceedings of the 36th Hawaii International Conference on Systems Sciences*, the IEEE Computer Society.

Dittrich, Y., A. Ekelin, P. Elovaara, S. Eriksen, and C. Hansson (2002). Making e-Government Happen, in *Proceedings of the 36th Hawaii International Conference on Systems Sciences*, the IEEE Computer Society.

Evangelidis, A., J. Akomode, A. Taleb-Bendiab and M. Taylor (2002). Risk Assessment & Success Factors for e-Government in a UK Establishment, in *Proceedings of Electronic Government, First International Conference*, Aix-en-Provence, France, September 2-6, 2002, pp.395-402.

Interop (2004). Research Clustering Workshop on eGovernment Interoperability, March 1, 2004, Brussels, Belgium, http://www.egovinterop.net/.

Ganek, A. and T. Corbi (2003). The dawning of the autonomic computing era. *IBM Systems Journal*, 42(1).

Gartner Group (2005). *Avoid the Most Common E-Service Implementation Problem: Lack of TCO Planning*. March 2005.

Gazendam, H. (2001). Semiotics, Virtual Organisations, and Information Systems. In: Liu *et al*. (eds.). *Information, Organisation and Technology: Studies in Organisational Semiotics.* Boston: Kluwer Academic Publishers, 1- 48.

Gibbs, W. (1994). Software's Chronic Crisis. *Scientific American*, **271**(3), 72-81.

Heeks, R. (2003a). Most eGovernment-for-Development projects fail: how can risks be reduced? Institute for Development Policy and Management (IDPM): Manchester.

Heeks, R. (2003b). Success and Failure Rates of eGovernment in Developing and Transitional Countries: Overview. University of Manchester, Manchester.

Gazendam, H., R. Jorna and K. Liu (2005). Organisational Semiotics, Round Table Workshop 'An organizational semiotic view on interculturality and globalization', in *Proceedings of the IASS 2004 Conference*, Lyon (available at www.irc.rdg.ac.uk/Research/Publications.htm).

Huang, W., K. Siau and K. Wei eds. (2005). Electronic Government Strategies and Implementation, Idea Group, Hershey.

Jan, B. (2000) Personalization: a taxonomy, in *Proceeding of CHI 2000: Conference on Human Factors in Computing Systems*, Hague, Netherlands, ACM Press, 313-314.

Lane, K. and J. Wheatley (2005). Citizens Advice, Money with your name on it? CAB clients' experience of tax credits. Citizens Advice Bureau: Scotland.

Leadbeater, C. (2004). Learning about Personalisation. Demos: London.

Laws, A., A. Taleb-Bendiab, S. Wade and D. Reilly (2002). Bridging the gap: the cybernetics of self-adaptive software systems, Self-adaptive software systems, *Lecture Notes in Computer Science*, Springer-Verlag.

Liu, K. (2000). *Semiotics in Information Systems Engineering*, Cambridge University Press, Cambridge.

Liu, K., R.Clarke, R. Stamper and P. Anderson (eds.) (2001). *Information, Organisation and Technology: Studies in Organisational Semiotics*, Kluwer Academic Publishers, Boston.

Liu, K., L Sun. and K. Bennett (2002). Co-Design of Business and IT Systems, *Journal of Information Systems Frontiers*, 4(3), 251-256.

Liu, K. and M. Hu (2004). A Semiotic Analysis of E-Policing Strategies in the United Kingdom, In W. Huang, K. Siau, K. Wei (eds.), Digital Government: Strategies and Implementations in Developed and Developing Countries, Idea Group Publishing, USA.

Liu, K., R. Hackney, R. Gan and W. Huang (2005a). Round table on e-government implementation, in *Proceeding of the Conference on Digital Environment (CoDE2005)*, July 29-30, 2005, Shanghai, China

K. Liu, A. Taleb-Bendiab (2005b), "Presenting a Case for a Principled Approach to *Citizen, Business and Technology Integration* in e-Government Services: Challenges and Research Opportunities", Egov'05, 2005.

Marchionini, G., H. Samet and L. Bradit (2003). Introduction, *Communication of the ACM*, 46(1), 24-27.

Miseldine, P. and A. Taleb-Bendiab (2005a). An Empirical Study into Governance Requirements for Autonomic E-Health Clinical Care Path Systems, in *Proceeding of 1st International Workshop on Requirements Engineering for Information Systems in Digital Economy (REISDE 2005)*, Reading, UK.

Miseldine, P., A. Taleb-Bendiab, M. Randles and D. England (2006). Addressing the Need for Adaptable Decision Processes within Healthcare Software. To appear in *Procceding of HC2006*. March 20-22, 2006, Harrogate, UK.

Ntiro, S. (2000). eGovernment in Eastern Africa. KPMG.

OFSI (2005). Office of Public Sector Information, Directgov.

Peirce, C. (1931-1935). Collected papers, Hartshonrne, C. and Weiss, P. eds, (Harvard U.P) Cambridge

Ombudsman, P. (2004). Annual Report of the Parliamentary Ombudsman 2003-2004. The Stationery Office.

Prime Minister's Strategy Unit (2005). Connecting the UK: the Digital Strategy, DTI. Cabinet Office.

RAE and BCS (2004). Royal Academy of Engineering and British Computer Society, The Challenges of Complex IT Projects. London.

Randles, M., A. Taleb-Bendiab, P. Miseldine and A. Laws (2005a). Adjustable Deliberation of Self-Managing Systems, in *Proceeding of 12th Annual IEEE International Conference and Workshop on the Engineering of Computer Based Systems*, April 3-8, 2005, Greenbelt, MD, USA, pp. 449-456.

Randles, M., A. Taleb-Bendiab and P. Miseldine, (2005b). Using Stochastic Situation Calculus to Formalise Danger Signals for Autonomic Computing, In *Proceeding of 6th Annual PostGraduate Symposium on the Convergence of Telecommunications, Networking and Broadcasting*. June 27-28, 2005, Liverpool, UK.

Stamper, R. (1993). Social Norms in Requirements Analysis - an outline of MEASUR. In Jirotka, M., Goguen, J. and Bickerton, M. (eds.), Requirements Engineering, Technical and social aspects. *Academic Press*, New York.

Stamper, R.K. (2000). Information Systems as a Social Science: an alternative to the FRISCO formalism, in E. Falkenberg *et al.* (eds.), *Information Systems Concepts: An Integrated Discipline Emerging*, Kluwer Academic Publishers, Boston, 1-51.

Taleb-Bendiab A., D. Bustard, R. Sterritt, A. Laws, M. Randles, F. Keenan and P. Miseldine (2005). Model-Based Self-Managing Systems Engineering, in *Proceedings of the 16th International Workshop on Database and Expert Systems Applications (DEXA'05)*.

The Economist Reportage (2000). No Pain Without Gain, Government and the Internet Survey, *The Economist*. London. p. 7-10.

UNESA (2003). *World Public Sector Report 2003: E-Government at the Crossroads, Department of Economic and Social Affairs*, United Nations, New York, ST/ESA/PAD/SER.E/49.

Wagner, C, K. Cheung, R. Ip, S. Bottcher (2006), Building Semantic Webs for e-government with Wiki technology, *Electronic Government, an International Journal 2006*, 3(1)**,** 36-55.

(WITSA, 2006). JMU_WITSA Project (2005). Project Web site (http://WITSA.cms.livjm.ac.uk), Last accessed: 26-Mar-06.