

# The Journal of Information Technology in Social Change

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*Introduction to:*

**Coordinated ICTs for Effective Use in Humanitarian Assistance**

There are many themes that are emerging from the new world of networks in civil society. One of the most important of these is collaboration and coordination between organizations. What are the goals of such coordination? What are the barriers?

In this paper, Carleen Maitland, and Andrea Hoplight Tapia approach these questions with secondary research into the literature of the field, for the purposes of developing a series of cogent research questions. They touch on the topics of decision processes, organizational patterns, folksonomies, and complex adaptive systems theory, in order to lay the groundwork for discovering the success factors in coordination and collaboration.

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## Coordinated ICTs for Effective Use in Humanitarian Assistance

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### Abstract

Effective use of information and communication technologies (ICTs) for non-profits requires coordination among agencies. This is particularly true of international humanitarian assistance agencies, which face limited IT budgets, must deploy in difficult circumstances, and often depend on one another to provide relief and development services. In this paper we discuss the challenges of coordinated design and deployment of field-oriented, integrated and sustainable systems. This is followed by presentation of a series of research questions that draw on advancements in organization, information and computer sciences. If addressed, the findings from research stemming from the questions may help the humanitarian assistance community overcome some of the challenges presented by coordinate ICTs.

### Introduction

Recent events such as Hurricane Katrina and the genocide in Darfur, Sudan have brought increased attention to the humanitarian assistance domain of the non-profit sector. Particularly in the case of Hurricane Katrina, this attention has highlighted the need for better inter-agency coordination in all areas of operations, including the use of information and communication technologies (ICTs). The result has been increased emphasis on both the role that ICTs can play in facilitating coordination as well as improved coordination in deployments of ICTs themselves.

Calls for improved coordination have led humanitarian assistance organizations to more carefully consider when coordinated or stand-alone systems or processes are called for. Clearly for those functions in which coordination is required, the organizational issues that are inherent in any coordination effort will play a role. Further, as ICT-specific coordination projects, they will face their own unique challenges. These challenges are likely to vary depending on whether or the emphasis is on communication technologies or information technologies. Here we consider communication technologies to include the physical infrastructure to support communications — for example, telecommunications infrastructure, computer hardware, and email applications and by information technologies we refer to software applications and computing technologies that are used to perform specific tasks.

Due the relatively new emphasis being placed on coordination and ICTs in the non-profit sector, there is comparatively little academic research on the subject as compared

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to the corporate sector. This paper summarizes some of the key issues that coordination and ICTs raise for humanitarian relief agencies, as indicated by extant literature as well as conversations with humanitarian assistance ICT professionals during the past year. Based on this summary, we then lay out a research agenda that if implemented will help resolve some of these issues.

The paper begins with a discussion of the goals for and hurdles to ICT coordination and in particular highlights the challenges created by the highly distributed organizational structure of international humanitarian assistance agencies. This is followed by a discussion of research topics that could help address some of these problems as well as an explicit discussion of sustainability.

## Goals and Hurdles

**Goals.** The calls for increased coordination on ICT deployments and use of ICTs for improved coordination come amidst increasing ICT use by non-profits in general. Increased use is the result of both declining costs and improved skills among new employees. However, this increased use of ICTs is typically targeted to organizational and client needs, with consideration of cross-organizational coordination receiving relatively little attention. The plethora of ‘family finder’ systems that emerged during Hurricane Katrina is exemplary of the problems that some stand-alone system implementations can create.

Hence, calls for greater coordination in ICT deployments have created the opportunity to develop goals for coordinated ICT systems as well as to look afresh at the goals for ICT systems deployed within single organizations. While specific groups of organizations will have more targeted goals (see for example (Currion 2006), in our discussions with humanitarian assistance organizations three general goals appear to play a dominant role: 1. the importance of ICT systems that meet the needs of clients or field personnel directly serving these clients 2. the importance of developing coordinated ICT systems that are integrated with both the current systems and business processes of all organizations involved and 3. the importance of system sustainability. Each of these goals and their associated challenges are discussed below.

**Field-oriented systems.** Ensuring that the benefits of ICT investments accrue to clients rather than simply the organization itself is a common goal among non-profit organizations. In the corporate sector similar goals are articulated as ‘aligning’ information systems with strategic goals or emphasizing the ‘business value’ of ICT investments. In humanitarian assistance organizations the client-centered focus of ICT investments takes on greater importance due to donor restrictions. Donors demand that a significant portion of donations be spent directly on victims and that overhead expenses, including IT, be kept to a minimum. One consequence of this is that agencies use volunteer staff which in general are less skilled and more transient or face staff shortages, both of which present challenges of ICT systems development and information gathering (Bui, Cho et al. 2000; Corder 2001).

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In addition to the donor-related factors that both support and complicate the field-oriented goal, this initiative must contend with both contextual and organizational challenges. Contextual challenges of field-oriented systems in humanitarian assistance are those related to both the physical and political context. Humanitarian assistance typically occurs in areas lacking resources in general and in some cases is geared to victims of natural and, more commonly, man-made disasters (Leaning, Briggs et al. 1999). These contexts create physical challenges for ICT deployment through a lack of fixed infrastructure, poor or non-existent transportation, lack of power, and exposure to weather (lack of structures). Furthermore, it is impossible to ignore the political context of humanitarian assistance, where politics may limit access to victims (Munslow and Brown 1999; Taylor-Robinson 2002), and increased information flows resulting from ICT use may represent a threat to the government (Knuth 1999).

The organizational challenges that field-oriented systems face are related to first the distributed organizational structure of many international humanitarian assistance organizations and second to headquarters/field role conflicts. Many of the largest humanitarian assistance organizations actually consist of many individual national organizations united under an umbrella organization. In such an organization uniform ICT deployments are challenging, particularly with developing country offices. It is frequently the need for coordination between headquarters and field that drives the provision of communication technologies. However, even the most sophisticated technology cannot solve the conflict of knowledge and authority, where field staff understand the local conditions and constraints and frequently know what needs to be done, but infrequently have the authority to do so. Conversely, staff at headquarters are given the power to act but lack an understanding of what is happening on the ground (Suparamaniam and Dekker 2003).

***Systems and business process integration.*** The second goal for coordinated ICT systems is to ensure these systems are integrated with both business processes and legacy systems. Clearly, problems associated with both forms of systems integration are not unique to either humanitarian assistance or the non-profit sector in general. The focus on systems integration is driven in part by the need to extract the greatest value from ICT deployments and lessons learned from information systems failures during the past 2 decades. In coordinated ICT deployments systems integration will be an issue for each individual organization as well as collectively for all the members, and the two will be related and will face challenges of coordination in general.

The reasons coordination presents a challenge to organizations in general and non-profits in particular include differences in funding bases and organizational goals, professional and organizational status hierarchies, and the tendency of each organization to try to maximize its own autonomy (Tierney 1985). These issues have been exacerbated by the growing numbers of international humanitarian assistance organizations, making coordination even more complex and in some cases delaying or decreasing the efficiency of services (Kreps and Bosworth 1994; Middleton and O'Keefe 1997; Paton, Johnston et al. 1998). Increasing numbers of agencies also increases the complexity of humanitarian assistance networks, and research has found that network structure and composition have implications for relief results (Benini 1998; Moore, Eng et al. 2003; Trainor 2004).

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While increasing numbers of agencies can pose challenges to coordination, the inherent interdependencies can also facilitate coordination. Empirical studies on inter-organizational coordination have found that informal contacts, good historical relations with other organizations, common commitment, existence of common language, accessibility to other organizations, professionalism, standardization, structural similarities, scarce resources and frequent external communications all serve to enhance coordination efforts (Alexander 1995; Bui, Cho et al. 2000). Our own research on inter-organizational coordination in the area of ICTs for relief reflects these more general findings, and in particular found that NGOs' top three motivations for working with another agency were 1. mission 2. to fulfill a resource need and 3. prior experience in cooperation (Maitland 2005).

Systems integration must also take into account the special IT-related circumstances of non-profit organizations. Namely, these include a high degree of commercial-off-the-shelf (COTS) technologies use, limited IT staff, and limited uses of formal or well-specified system development approaches (Mallach 2006). Also, integration will be an important component of the joint design effort. Communal design processes are challenging and research has found that an impartial atmosphere, in which no one agency dominates, is important to including all important features (Sotirovski 2001). Furthermore, if the number of agencies involved becomes large it is important to ensure that the intended users remain aware of the system development project and committed to it, both of which are important for adoption and effective use (Malhotra and Galletta 2004).

In addition to these coordination-related issues, systems integration will also require, to some degree, business process standardization as well as integration with legacy systems. The challenges of inter-organizational systems integration can be reduced to some degree through the data format standardization inherent in the use of technologies such as web services, XML and SOAP, however these technologies generate new requirements such as explicit workflow models (Aalst and Kumar 2003) and service descriptions that define semantics, APIs and other non-formal requirements (Umar 2005). Additionally, when these technologies are used between organizations, similar vocabularies, protocols and business processes must be explicitly defined (Bruijn, Fensel et al. 2005).

An important component of defining vocabularies is the specification of ontologies. While to philosophers an ontology is the study of being, existence and reality, the concept of ontology has been appropriated by information and computer scientists as "an explicit specification of a conceptualization" (Gruber 1993). Ontology has come to mean one of two things: a representation vocabulary or a body of knowledge describing some domain (Chandrasekaran, Josephson et al. 1999). As a representation vocabulary, ontology is the conceptualizations underlying the vocabulary, not the vocabulary itself. As a body of knowledge describing a domain, ontology attempts to specify the relationships of the concepts. For IS researchers the tendency has been to treat ontologies as rigid (or semi-rigid) taxonomies that serve to structure knowledge for a particular domain. The construction of ontologies by information scientists is an attempt to overcome the Tower of Babel problem (Fonseca and Martin 2005) by providing a

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common dictionary of terms and definitions within a relationship (i.e., taxonomical) framework for knowledge representation that can be shared by different information-systems communities (Smith 2003).

The final challenge that systems integration in an inter-organizational system will face is the need to integrate with legacy systems, which for small or non-profit organizations are typically COTS software. COTS technologies create several integration challenges for organizations both large and small, including the 1. complexity of integrating large numbers of COTS (Lemahieu, Snoeck et al. 2005), 2. the emergent nature of customizable COTS (Warboys, Snowdon et al. 2005; Rampoldi-Hnilo 2006) and 3. the lack of methods or best-practices for the task (Egyed, Müller et al. 2005). Also, by constraining the set of possible functionalities, they change the system requirements gathering process (Boehm 2000). Furthermore, in addition to considering the integration of COTS, the inter-organizational information system may itself be constructed with COTS, making COTS coordination an important issue (Lemahieu, Snoeck et al. 2005).

**Sustainability.** Similar to integration, sustainable projects insure the greatest value is derived from ICT investments. Furthermore, particularly in field-oriented systems, sustainability provides clients with consistent levels of service. Sustainability of coordinated humanitarian assistance ICT projects requires that the system is maintained and upgraded beyond the initial design, development and implementation stages and that in some cases the system is flexible enough to serve the needs of clients as their needs change over time. Sustainability is challenging in ICT projects because simply getting a system up and running is a large undertaking. Furthermore, the skills required to develop a system may be different from those for maintaining a system. Thus, inter-organizational systems development projects must consider system maintenance from the outset, realizing that if no partner is willing to take long-term responsibility for the system that it might not be worth building in the first place. Finally, sustainability of coordinated projects may require extension of use of the final system to a broader community. The ability to establish a system as a defacto industry standard provides incentives for continued use and maintenance.

In addition to the responsibility factor, in humanitarian assistance sustainability should be defined from a field or client-oriented perspective. This means that as clients move from one status to another (e.g. from crisis to recovery mode) the system continues to offer benefits. This is particularly the case for humanitarian assistance agencies that offer both relief and development services. For coordinated systems to be transferred from relief to development projects the needs of both projects need to be assessed at the outset. Furthermore, the challenges of transferring information versus communications technologies are likely to differ (Maitland, Pogrebnyakov et al. 2006).

Thus, to maximize the value of coordinated ICT deployments for humanitarian assistance these systems should strive to support field operations, integrate both business processes as well as legacy ICT systems, and plan for sustainability. Admittedly this is an ambitious agenda and is one that may apply to variety of sectors. However, what is unique to the humanitarian assistance is the challenges they will face in undertaking these activities. For this reason it is likely that findings from studies of corporate

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inter-organizational information systems development projects will be of only limited value in this context. For this reason we believe that research on coordinated ICTs in humanitarian relief that may apply to other non-profit contexts is needed. Given the goals of the humanitarian assistance community and the current state of knowledge in academia, below we identify a series of research questions that can be investigated to help these agencies meet their goals.

## A Research Agenda in Support of Coordinated ICTs

The research agenda described below is broken into two categories, namely the organizational designs and decision making of coordination bodies and the ICT system design processes. It is our belief that the decisions made about coordination prior to the system design process itself will have significant implications first for the extent to which coordination is undertaken at all and, if so, the success of the effort. Once decisions concerning on what and with whom to coordinate have been made, the design process is likely to play an important role in determining coordination outcomes.

**Organizational design and decision making.** The decisions concerning ICT coordination in the humanitarian relief community are being undertaken through a variety of organizational forms, including bi- and multi-lateral agreements, informal coordination communities and formal organizations, which we refer to as coordination bodies. These ICT coordination bodies may be temporary, special initiatives, undertaken independently with donor funds or through the auspices of larger, general inter-agency bodies such as InterAction, or they may be permanent incorporated non-profit organizations that undertake ICT coordination as their exclusive mission, such as NetHope. The actions taken by these organizations are likely to have a significant impact on the attainment of the goals of developing field-oriented, integrated and sustainable systems as research has found that organizational characteristics such as centralization, organizational culture, strategy, and size, all influence IT project success (Meyer and Gardner 1992; Chengalur-Smith and Duchessi 1999).

Some coordination bodies attempt to coordinate intensely among a small subset of NGOs, while others target larger memberships and less complex interactions. Given these differing goals, it is unclear which decision processes and organizational designs work best for a given mission. While improved decision making is important for improving coordination outcomes, the extent of improvements will be constrained by organizational designs that define, in part, decision rights and processes. Thus, synchronized improvements in decision making and organizational design are required to truly enhance performance.

We define organizational design as the structures and processes that organizations use to achieve desired organizational outcomes. The organization must choose from a set of structural alternatives, organizational arrangements, and organizational role relationships

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with the intention of facilitating strategic accommodation to the environment and the implementation of the organization's strategy (Tushman and Nader 1978; Huber and McDaniel 1986; Tosi, Mero et al. 2000). Thus,

**R1 : Which decision processes result in field-oriented, integrated and sustainable systems?**

**R2 : Which organizational designs are associated with these superior decisions processes?**

To address these questions organizational analyses of coordination bodies are required. While comparative case studies are clearly one approach, the growing number of these bodies may enable broader scope through survey research. However, in either case the results will be limited to examining the efficacy of existing organizational designs. Excluded from such an analysis are potentially new organizational forms that are as yet untested. Given the context of the humanitarian assistance industry and the existence of isomorphism it is likely that only a limited range of organizational forms have been tried. To consider the potential of alternate forms different methods are required.

Through the use of organizational simulations with artificial intelligence a broader range of organizational designs may be considered and their implications for decision making and subsequently ICT design outcomes can be assessed.

**R3 : Are there alternate designs not observed in the field that might improve decision making and in turn design outcomes ?**

**Design processes.** The successful design of a field-oriented, integrated and sustainable system in the field of humanitarian assistance will require an innovative and flexible design method. It is expected that the extent to which the coordinated system is field-oriented will occur in the decision making in the coordination body and that the design process will have a greater impact on integration and sustainability.

Integration of business processes between organizations is a significant problem in all industries and systems developers have been tackling the problem for many years. One important aspect of the problem for humanitarian assistance is that of establishing shared vocabularies that can be used to establish data structures. This problem is typically approached as an ontological one. However, traditional domain ontologies have been criticized for being overspecified and decontextualized. When created as top-down taxonomic structures, ontologies impose a rigid constraint on the relational structure of the data contained in the information system. At the same time, these hierarchies tend to decontextualize the information by abstracting it from contexts that contribute to

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its semantic content and transforming it into primarily syntactic units. The reasons for creating ontologies in this way rest with the limitations of machine-based information systems.

A possible alternative to these top-down taxonomic structures is in the development of folksonomies, “people’s classification management” (Smith citing Thomas Vander Wal, 2004). Similar to a folk taxonomy, a vernacular naming system, folk taxonomies are generated by users from social knowledge. The term folksonomy is often used to describe an Internet-based information retrieval methodology consisting of collaboratively generated, open-ended labels that categorize content (Wikipedia, <http://en.wikipedia.org/wiki/Folksonomy>). Folksonomies are most notably contrasted from taxonomies in that the authors of the labeling system are often the main users (and sometimes originators) of the content to which the labels are applied.

For information systems researchers, in contrast to professionally developed taxonomies with controlled vocabularies, folksonomies are unsystematic and undependable and inconsistent. Ambiguity of the tags can emerge as users apply the same tag in different ways. At the opposite end of the spectrum, the lack of synonym control can lead to different tags being used for the same concept, precluding collocation. For their users and supporters, folksonomies dramatically lower content categorization costs because there is no, hierarchically organized nomenclature to learn. In addition, participating is far easier in terms of time, effort and cognitive costs. A folksonomy lowers the barriers to cooperation. Also a tight feedback loop leads to a form of asymmetrical communication between users through metadata (Mathes 2004). The users of a system are negotiating the meaning of the terms in the folksonomy, whether purposefully or not, through their individual choices of tags to describe documents for themselves (Udell 2004).

Other terms have been used to describe similar user-created categorization and classification systems. Merholz does not use the term folksonomy due to its derivation from “taxonomy,” which he argues tend towards hierarchy and control (Merholz 2004) (See also Taylor, 2004, for discussions of problems and disputes with the term “taxonomy.”) Merholz prefers the term “ethnolocation,” Peter Merholz argues that a folksonomy can be quite useful in that it reveals the digital equivalent of “desire lines” (Merholz 2004). Desire lines are the foot-worn paths that sometimes appear in a landscape over time. Merholz notes, “A smart landscape designer will let wanderers create paths through use, and then pave the emerging walkways, ensuring optimal utility. Ethnolocation systems can similarly ‘emerge.’ Once you have a preliminary system in place, you can use the most common tags to develop a controlled vocabulary that truly speaks the users’ language.” (Mathes 2004).

Thus, folksonomies may represent an innovative approach to fostering both business process as well as systems integration in the development of coordinated humanitarian assistance ICTs. Additional benefits might include that the user-oriented nature of folksonomies may help foster the development of field-oriented systems. Also the lower costs of classification that may result from folksonomies will help meet the financial constraints of non-profit organizations. Thus,

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## **R5: Design processes that make use of folksonomies will generate more integrated coordinated systems.**

Enhancement of the sustainability of coordinated humanitarian assistance ICT systems may be achieved through the application of recent advancements in information systems design theory. In particular, the application of complex adaptive systems theory (CAS) (Anderson 1999; Morel and Ramanujam 1999) to the information systems domain (Hanseth 2004; Horan and Schooley 2005; Benbya and McKelvey 2006; Jacucci, Hanseth et al. 2006; Kim and Kaplan 2006) and the articulation of colonial systems theory (Porra 1999), provide the basis for enhanced approaches to the development of inter-organizational systems.

Employing a CAS lens, through which goal conflicts (as indicated by divergent system requirements) are viewed as adaptive tensions, thereby suggests that these differences, instead of being a purely negative circumstance, be viewed as helpful in fostering long term evolution (Benbya and McKelvey 2006). Thus, a design approach that considers convergent goals of the various humanitarian relief agencies as a tool for fostering sustainability may result in coordinated systems having higher degrees of sustainability than stand alone organizational systems.

## **R6: Design processes based on CAS theory will use goal conflicts to generate more sustainable systems.**

The sustainability of coordinated field-oriented ICT systems will be enhanced by being able to transition along with the goals of their users (e.g. from relief to development) as well as by being usable by agencies in the broader humanitarian assistance community. To achieve this flexibility the system design process must include a requirements gathering procedure that recognizes interdependencies and attempts to align the system to the needs of interdependent users, given that the needs of any one may change. From CAS the concept of causal intricacy emphasizes that the causal mechanisms of information system alignment are multidirectional, that change in one variable has multilevel effects on other variables, and that forces of change are non-linear (Benbya and McKelvey 2006). Explicitly accounting for causal intricacy in the design process may enhance the system's sustainability both by making it more flexible to role changes and differing needs of a broader set of users.

## **R7: Design processes based on CAS theory will use causal intricacy to generate more sustainable systems.**

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## Conclusions

Humanitarian assistance can be enhanced through coordinated ICT deployments. In particular, the important characteristics of such systems include being field-oriented, integrated and sustainable. While possibly providing many benefits, the development of such systems will face many challenges. In the above we identify several research questions that if addressed may help the humanitarian assistance community overcome these challenges. The questions apply theories of organizations, decision making and complex adaptive systems to promote better understanding of the organizations and processes involved in the design of these systems.

## References

- Aalst, W. M. P. v. d. and A. Kumar (2003). "XML-based schema definition for support of interorganizational workflow." *Information Systems Research* 14(1): 23-46.
- Alexander, E. R. (1995). *How Organizations Act Together: Interorganizational Coordination in Theory and Practice*. Luxembourg, Gordon and Breach Publishers.
- Anderson, P. (1999). "Complexity Theory and Organization Science." *Organization Science* 10(3): 216-232.
- Benbya, H. and B. McKelvey (2006). "Toward a complexity theory of information systems development." *Information Technology & People* 19(1): 12-34.
- Benini, A. A. (1998). *Network Without a Center? A Case Study of an Organizational Network Responding to an Earthquake*, Natural Hazards Research and Applications Information Center, Institute of Behavioral Science, University of Colorado.
- Boehm, B. (2000). "Requirements that handle IKIWISI, COTS, and rapid change." *Computer* 33(7): 99-102.
- Bruijn, J. d., D. Fensel, et al. (2005). "Using the web service modeling ontology to enable semantic e-business." *Association for Computing Machinery. Communications of the ACM* 48(12): 43-47.
- Bui, T., S. Cho, et al. (2000). "A Framework for Designing a Global Information Network for Multinational Humanitarian Assistance/Disaster Relief." *Information Systems Frontiers* 1(4): 427-442.
- Chandrasekaran, B., J. R. Josephson, et al. (1999). "What Are Ontologies, and Why Do We Need Them?" *IEEE Intelligent Systems* January/February.

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Coordinated ICTs for Effective Use in Humanitarian Assistance

Chengalur-Smith, I. and P. Duchessi (1999). "The initiation and adoption of client-server technology in organizations." *Information & Management* 35(2): 77.

Corder, K. (2001). "Acquiring new technology: Comparing nonprofit and public sector agencies." *Administration & Society* 33(2): 194.

Curron, P. (2006). *Information and Technology Requirements Initiative Assessment Report: Findings and Recommendations*. London, Emergency Capacity Building Project: 15 pages.

Egyed, A., H. A. Müller, et al. (2005). "Guest Editors' Introduction: Integrating COTS into the Development Process." *IEEE software* 22(4): 16-18.

Fonseca, F. and J. Martin (2005). *Play as the Way Out of the Newspeak-Tower of Babel Dilemma in Data Modeling*. Proceedings of the Twenty-Sixth International Conference on Information Systems: Philosophy and Research Methods in Information Systems.

Gruber, T. R. (1993). *Toward Principles for the Design of Ontologies Used for Knowledge Sharing*. Formal Ontology Conceptual Analysis and Knowledge Representation. N. G. a. R. Poli, Kluwer Academic Publishers, in press.

Hanseth, O. a. L., K. (2004). "Theorizing about the Design of Information Infrastructures: Design Kernel Theories and Principles." *Sprouts: Working Papers on Information Environments, Systems and Organizations* 4(4): 207-241.

Horan, T. A. and B. Schooley (2005). "Inter-organizational Emergency Medical Services: Case Study of Rural Wireless Deployment and Management." *Information Systems Frontiers* 7(2): 155-173.

Huber, G. P. and R. R. McDaniel (1986). "The Decision-Making Paradigm of Organizational Design." *Management Science* 32(5): 572.

Jacucci, E., O. Hanseth, et al. (2006). "Introduction: Taking complexity seriously in IS research." *Information Technology & People* 19(1): 5-11.

Kim, R. M. and S. M. Kaplan (2006). "Interpreting socio-technical co-evolution: Applying complex adaptive systems to IS engagement." *Information Technology & People* 19(1): 35-54.

Knuth, R. (1999). "Sovereignty, Globalism, and Information Flow in Complex Emergencies." *The Information Society* 15: 11-19.

Kreps, G. A. and S. L. Bosworth (1994). *Organizing, Role Enactment and Disaster - A Structural Theory*. Newark, University of Delaware Press.

Leaning, J., S. M. Briggs, et al. (1999). *Humanitarian Crises: The Medical and Public Health Response*. Cambridge (MA), Harvard University Press.

# The Journal of Information Technology in Social Change

Coordinated ICTs for Effective Use in Humanitarian Assistance

- Lemahieu, W., M. Snoeck, et al. (2005). "Coordinating COTS Applications via a Business Event Layer." *IEEE Software* 22(4): 28-35.
- Maitland, C. F. (2005). "Report: Coordination in the use of ICTs for humanitarian relief - A preliminary assessment." Working Paper, Penn State College of Information Sciences and Technology (5 pages).
- Maitland, C. F., N. Pogrebnyakov, et al. (2006). A fragile link: Disaster relief, ICTs and development. International Conference on Information and Communication Technologies and Development, May 25-26, Berkeley, CA.
- Malhotra, Y. and D. F. Galletta (2004). "Building Systems That Users Want to Use." *Communications of the ACM* 47(12): 88.
- Mallach, E. (2006). "A Database Project in a Small Company (or How the Real World Doesn't Always Follow the Book)." *Journal of Cases on Information Technology* 8(3): 24-40.
- Mathes, A. (2004). "Folksonomies - Cooperative Classification and Communication Through Shared Metadata".
- Merholz, P. (2004). *Metadata for the Masses*.
- Meyer, N. D. and D. P. Gardner (1992). "Political Planning for Innovation." *Information Strategy* 9(1): 5.
- Middleton, N. and P. O'Keefe (1997). *Disaster and Development - The Politics of Humanitarian Aid*. London, Pluto Press.
- Moore, S., E. Eng, et al. (2003). "International NGOs and the Role of Network Centrality in Humanitarian Aid Operations: A Case Study of Coordination During the 2000 Mozambique Floods." *Disasters* 27(4): 305-315.
- Morel, B. and R. Ramanujam (1999). "Through the Looking Glass of Complexity: The Dynamics of Organizations as Adaptive and Evolving Systems." *Organization Science* 10(3): 278-293.
- Munslow, B. and C. Brown (1999). "Complex Emergencies: The Institutional Impasse." *Third World Quarterly* 20(1): 207-221.
- Paton, D., D. Johnston, et al. (1998). "Organisational response to a volcanic eruption." *Disaster Prevention and Management* 7(1): 5.
- Porra, J. (1999). "Colonial systems." *Information Systems Research* 10(1): 38-69.
- Rampoldi-Hnilo, L. (2006). *The changing face of enterprise applications*, Oracle Corporation.

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Coordinated ICTs for Effective Use in Humanitarian Assistance

Smith, B. (2003). *Ontology*. Blackwell's Guide to Philosophy of Computing and Information. L. Floridi. Oxford, Blackwell: 155-166.

Sotirovski, D. (2001). *Towards Fault-tolerant Software Architectures*. Working IEEE/IFIP Conference on Software Architecture.

Suparamaniam, N. and S. Dekker (2003). "Paradoxes of power: the separation of knowledge and authority in international disaster relief work." *Disaster Prevention and Management* 12(4): 312-318.

Taylor-Robinson, S. D. (2002). "Operation Lifeline Sudan." *Journal of Medical Ethics* 28: 49-51.

Tierney, K. J. (1985). "Emergency Medical Preparedness and Response in Disasters: The Need for Interorganizational Coordination." *Public Administration Review* 45: 77.

Tosi, H. L., N. P. Mero, et al. (2000). *Managing organizational behavior*. Malden, MA, Blackwell.

Trainor, J. E. (2004). *Search for a system: Multi-organizational coordination in the September 11th World Trade Center search and rescue response.*, University of Delaware.

Tushman, M. L. and D. A. Nader (1978). "Information Processing as an Integrating Concept in Organizational Design." *The Academy of Management Review* 3(3): 613.

Udell, J. (2004). *Collaborative knowledge gardening*. InfoWorld.

Umar, A. (2005). "IT Infrastructure to Enable Next Generation Enterprises." *Information Systems Frontiers* 7(3): 217-256.

Warboys, B., B. Snowdon, et al. (2005). "An Active-Architecture Approach to COTS Integration." *IEEE Software* 22(4): 20-27.