Information Systems Research
Vol. 20, No. 3, September 2009, pp. 317–328
ISSN 1047-7047 | EISSN 1526-5536 | 09 | 2003 | 0317

informs

DOI 10.1287/isre.1090.0244

Introduction to the Special Issue

Flexible and Distributed Information Systems Development: State of the Art and Research Challenges

Pär J. Ågerfalk
Department of Informatics and Media, Uppsala University, Uppsala, Sweden, par.agerfalk@im.uu.se

Brian Fitzgerald
University of Limerick, Limerick, Ireland, bf@ul.ie

Sandra A. Slaughter
College of Management, Georgia Institute of Technology, Atlanta, Georgia 30308, sandra.slaughter@mgt.gatech.edu

Key words: agile information systems; flexible information systems development; distributed information systems development; global software development; software development; special issue

Introduction

Process flexibility and globally distributed development are two major current trends in software and information systems development (ISD). The quest for flexibility is very much evident in the recent development and increasing acceptance of various agile methods, such as eXtreme Programming (Beck and Andres 2005) and Scrum (Schwaber and Beedle 2002). Agile development methods are examples of apparently major success stories that seem to have run counter to the prevailing wisdom in information systems (IS) and software engineering. However, rather than being antimethod, agile approaches operate on the principle of "just enough method." The quest for flexibility is also apparent in the currently increasing interest in striking a balance between the rigor of traditional approaches and the need for adaptation of those approaches to suit particular development situations. Although suitable methods may exist, developers struggle in practice when selecting methods and tailoring them to suit their needs. Certainly, agile methods are not exempt from this problem as they too need to be flexibly tailored to the development context at hand (Fitzgerald et al. 2006a). Distributed development recognizes that, more and more, ISD takes place in globally distributed settings. This is perhaps most evident in the many cases of offshoring and outsourcing of software development to low-cost countries (King and Torkzadeh 2008). Distributed development places new demands on the development process through the increased complexity related to communication, coordination, cooperation, control, and culture, as well as to technology and tools. Interestingly, many of the difficulties faced in globally distributed ISD are the same issues surfaced by agile methods and development flexibility in general.

It is something of an irony that the special issue before us appears on the bicentenary of Darwin's birth. Evolutionary theory suggests that success and survival are not the preserve of the strongest nor the most intelligent. Rather, the ability to adapt to changing circumstances is the key trait. Flexibility, one of the twin primary points of focus for this special issue, addresses this trait directly. A further parallel is that Darwin's theory of evolution was best exemplified by differences across different spatial locations. This is also inherent in the second focal point for the special issue dual focus—distributed development.

Setting the Scene

In a September 2006 call for papers (Fitzgerald et al. 2006b), scholars from a broad range of disciplines were invited to submit papers to a special issue of *Information Systems Research* on the topic of flexible and distributed ISD. The special issue is intended to build on the success of a previous special section of *Communications of the ACM* (Ågerfalk and Fitzgerald 2006a) and minitrack at the 39th Hawaii International Conference on System Sciences (Ågerfalk and Fitzgerald 2006b). It became clear from these efforts that as a very active emerging area of research, there was an imminent need for a forum that allowed for the development and dissemination of full-research papers of the highest quality. This special issue is the manifestation and result of that endeavor.

The Review Process

The deadline for the submission of papers to be considered for the special issue was June 1, 2007. By that date, we had received twenty four submissions. After the first round of reviews, the authors of the ten papers that remained in the process were invited to a workshop at the University of Limerick in Ireland. During the workshop, which was held on March 7 and 8, 2008, developmental discussions resulted in many valuable suggestions for improvement, and authors were asked to consider them along with reviewer comments when developing a revised version for the second round of review. The reviewers of the selected papers were invited to participate in the workshop, and each session had dedicated scribes to capture the discussions. The seven final papers selected for inclusion in the special issue were those that, after the second round of review, were deemed suitable for publication after only minor further revision.

The Contents of the Special Issue

The papers in the special issue are organized in a logical sequence. The first paper, by Conboy, explores and defines the central concept of *agility* in ISD. Agility in ISD is a central theme of the special issue, and its definition is at the core of many other papers in the issue. The subsequent paper, by Vidgen and Wang, builds upon the notion of agility defined by Conboy and explores the enablers and inhibitors of agility. The paper written by Maruping et al. continues in the stream of understanding when agile methods are most effective. The authors consider the interplay among project control, agile methodology use, and requirements change, and they relate the use of agile methods to performance implications. The paper of Harris et al. then builds on the study of Maruping et al. by considering when flexibility is needed in software development and how to balance flexibility with control. The study by Harris et al. provides a complementary view to that of Maruping et al. and embellishes the notion of control in flexible ISD.

The study of Cummings et al. reveals the difficulties in coordinating distributed ISD. The study of distributed teams by these authors suggests that temporal boundaries are more difficult to overcome than spatial boundaries. This paper foreshadows the next paper by Sarker and Sarker, which echoes the themes of the difficulty of crossing temporal boundaries, especially in agile projects. The final piece in the special issue is a research commentary by Austin and Devin. The Commentary provides a historical perspective of development process choices and points to the future, suggesting the need for a more nuanced (contingent) view of ISD process choice.

A summary of each paper in the special issue follows.

1. "Agility from First Principles: Reconstructing the Concept of Agility in Information Systems Development" (Kieran Conboy, National University of Ireland, Galway, Ireland). Although agility has been defined and used in manufacturing and other contexts, there has been little development of the concept of agility in the IS field. In fact, as Conboy notes in his paper, "agile methods" in IS have been primarily advanced by practitioners, not by IS researchers. Conboy, argues that the lack of a definition of agility in ISD has contributed to a number of problems, including a lack of clarity as to what is meant by "agile ISD," a lack of a nomological network connecting other concepts to agility in ISD, a lack of a cumulative tradition of research on agile ISD, a lack of parsimony, and limited applicability. The goal of this paper is thus to provide a rich definition and conceptualization of agility in an ISD context, based on a literature review of agility across other disciplines,

including manufacturing and management, where the concept originated, matured, and has been applied and tested. Conboy defines agile ISD as

> the continual readiness of an ISD method to rapidly or inherently create change, proactively or reactively embrace change, and learn from change while contributing to perceived customer value (economy, quality, and simplicity), through its collective components and relationships with its environment.

He then translates this definition into a taxonomy of ISD agility. As a final step, he evaluates the taxonomy by conducting thought trials using two completed ISD projects (TaxSys and AccountSys) in ABC Consulting, a large multinational consulting firm.

2. "Coevolving Systems Approach to the Organization of Agile Software Development" (Richard Vidgen, University of Bath, UK; Xiaofeng Wang, Lero, Ireland). This paper strives to understand what enables or inhibits agility in software development teams from the perspective of complex adaptive systems (CAS). Vidgen and Wang identify three principles of coevolving systems—match coevolutionary change rate, maximize self-organizing, and synchronize exploitation and exploration—that they use to study the processes of two software development teams. One team uses eXtreme programming (XP) practices for software development, and the other a team uses a more traditional, waterfall-based development cycle. From the cases, Vidgen and Wang identify the key agile enablers of time pacing, self-management with discipline, and routinization of exploration. Agile enablers appear to help ISD teams operate in a region of emergent complexity or at the "edge of chaos." In contrast, event pacing, centralized control, and lack of resources allocated to exploration are agile inhibitors. The inhibitors appear to make it difficult for ISD teams to operate in the region of emergent complexity, because of problems such as overcommunication between developers or overresponding to unplanned disturbances. The authors suggest that traditional development methods, far from having too much structure, often lack structure in key areas, leading to the use of local organizing practices. Whereas agile ISD teams accommodate change and uncertainty, using constant planning to achieve stability, traditional teams are more plan-driven, viewing unforeseen events as disturbances to be managed on an exceptional basis. Finally, based on the case studies, Vidgen and Wang identify the emergent capabilities of agile teams to include the coevolution of business value, sustainable working with rhythm, sharing and team learning, and collective mindfulness.

3. "A Control Theory Perspective on Agile Methodology Use and Changing User Requirements" (Likoebe Maruping, University of Arkansas; Viswanath Venkatesh, University of Arkansas; Ritu Agarwal, University of Maryland). In this study, Maruping et al. advance the premise that the use of agile methods is not equally effective for all projects. Instead, the authors draw upon theories of control to identify the contingencies that enhance the value of agile methodology use in influencing software project outcomes (especially, quality). The authors argue that requirements change and project governance modes are two significant contextual conditions that moderate the relationship between agile methodology use and software quality performance, and they propose hypotheses related to the interaction among control modes, agile methodology use, and requirements change. The authors test the model in a field study of 862 software developers in 110 teams, considering four objective measures of project quality—bug severity, component complexity, coordinative complexity, and dynamic complexity. Findings provide support for their hypotheses and indicate that agile methodology use and the exercise of outcome control mutually reinforce higher project quality, particularly when requirements change is high. In contrast, the use of self-control appears to undermine the benefits of agile methodology use in software development teams, especially for projects with volatile requirements. The authors' findings contribute to extant literature by integrating control theory into the growing literature on agile methodology use and by identifying specific contingencies affecting the efficacy of different control modes. The study highlights the value of matching the use of agile methods to the contingencies of particular projects.

4. "Control of Flexible Software Development Under Uncertainty" (Michael Harris, Indiana University Southeast; Rosann Collins, University of South Florida; Alan Hevner, University of South Florida). This study poses a central dynamic in software development as the trade-off between control

and flexibility—that is, how to balance flexibility with controls essential to produce acceptable outcomes. Drawing comparisons between the arts and software development to motivate the dilemma, the study uses dynamic capabilities theory and an extension of control theory to formulate a research model with three main hypotheses. This research model is then tested in a field study involving structured interviews across four organizations and seven software projects. The results demonstrate that flexibility may be needed when the starting conditions are uncertain and that effective control in these situations requires the use of traditional controls plus a new type of control—emergent outcome control. Theoretical implications of the research derive from the concept of emergent outcome controls, which extends control theory in a way that is important to the study of today's dynamic work environments. The study suggests that a portfolio approach is necessary when individual controls are not sufficient. In addition, the study identifies two key boundary conditions (time pressure and project size) that influence the relationships between uncertain environments and flexible work methods in the dynamic capabilities extension of the resource-based view of the firm. The practical implications of the study are that project managers can use this understanding of how and why flexible approaches are used in practice to guide their selection of software development methods and of a control portfolio. This is particularly important in today's complex development environment, in which the exercise of control cannot easily be done through direct, face-to-face observation or interaction with team members who may be distributed in different countries and/or companies. Many project managers face the challenge of managing projects in uncertain environments that require increased flexibility, while operating in a distributed, virtual-control setting.

5. "Crossing Spatial and Temporal Boundaries in Globally Distributed Projects: A Relational Model of Coordination Delay" (Jonathon N. Cummings, Duke University; J. Alberto Espinosa, American University; Cynthia K. Pickering, Intel Corporation). Temporal boundaries, conceptualized as nonoverlapping work hours, have the potential to be as disruptive as spatial boundaries (different geographic locations). For members of geographically dispersed projects, spatial, and temporal boundaries often arise as a function of increased coordination costs. In contemporary software development projects, the use of agile methodologies encourages project members to communicate informally, without the need for plans and fixed requirements. Coordination delay is viewed as a major hindrance to the effective application of these kinds of methodologies in that coordination delay decreases the ability of project members to be flexible and agile in their work. The authors develop a relational model of coordination delay and test this model empirically using survey data from 675 project members (representing 5,674 pairs of members) across 108 projects in a multinational semiconductor firm. Hierarchical linear modeling (HLM) is used to analyze pairs of project members. As expected, greater use of synchronous Web conferencing reduces coordination delay for pairs of members located in different cities with overlapping work hours, relative to pairs of members with nonoverlapping work hours. Unexpectedly, greater use of asynchronous e-mail does not reduce coordination delay for pairs of members located in different cities with nonoverlapping work hours but, rather, reduces coordination delay for those with overlapping work hours. The study also found that temporal boundaries are more difficult to cross with communication technologies than spatial boundaries, and the study also discusses the implications of this finding.

6. "Exploring Agility in Distributed Information Systems Development Teams: An Interpretive Study in an Offshoring Context" (Saonee Sarker, Washington State University; Suprateek Sarker, Washington State University). This paper alludes to the lack of rigor and cohesion in the manner in which the agility concept is used in ISD and suggests that the confusion surrounding agility is arguably even greater in the globally distributed team arena. Using an interpretive approach based on a series of in-depth interviews in a global company, the authors inductively develop an empirically grounded framework of agility in distributed ISD settings and identify three broad categories of agility in such contexts: (1) resource-related (composed of both people and technology-based resources); (2) process-related (composed of methodology-based, environmental awareness-based, and temporal bridge-based); and (3) linkage-related

(composed of communicative relationship-based and cultural mutuality-based). Overall, the study indicates that agility in a distributed ISD setting is the capability of a distributed team to speedily accomplish ISD tasks and to adapt and reconfigure itself to changing conditions in a rapid manner by (a) drawing upon appropriate IS personnel and technological resources; (b) utilizing appropriate ISD methodologies, mechanisms for bridging temporal distances, and routines to anticipate, sense, and react to changes in the distributed team's project environment; and (c) forging and maintaining linkages across communicative and cultural barriers existing among the distributed teammembers. The study also identifies some of the contingencies that may influence the importance of the agility facets. Specifically, it highlights that factors such as the complexity of the ISD project, clarity and stability of the client's requirements, and the nature of the distribution of the team as important factors that determine the relevance and importance of the different agility dimensions. This latter focus on contingencies is consistent with the work of Harris et al. in an earlier paper that identifies boundary conditions for the model they propose.

7. "Research Commentary: Weighing the Benefits and Costs of Flexibility in Making Software: *Toward a Contingency Theory of the Determinants of Development Process Design*" (Robert D. Austin, Copenhagen Business School and Harvard Business School; Lee Devin, Swarthmore College). In this commentary, Austin and Devin focus on the design of ISD process, specifically, the extent to which a development process relies on planning before doing and sequential progression through distinct stages, as opposed to frequent iterations that blur distinctions between stages. The authors compare and contrast plan-based versus agile methods as the primary process design choices and argue that a contingency perspective is necessary to understand when one design will be more effective than the other. Developing a contingency-based framework to guide the choice of process designs, the authors note that each process design choice has benefits as well as costs and that decisions about process designs should therefore maximize the difference between benefits and costs in a given set of conditions. Austin and Devin then take a historical perspective of development process design choices, describing the transition from craft to industrial production of physical products and considering software as a special case. They argue that craft processes are flexible and provide novel products but at a high cost, whereas industrial processes are more cost effective in producing products with some novelty but are less flexible. In contrast, postindustrial processes, such as agile methods, offer the potential to generate highly novel products in a cost-effective way, but only under certain conditions. Based on this discussion, Austin and Devin identify the specific novelty benefits and costs that influence the choice of appropriate ISD processes and suggest directions for future research of ISD process selection.

A Delphi Study on Flexible and Distributed IS Development Topics

Inspired by King and Torkzadeh (2008) a Delphi-informed study was conducted as part of the special issue production process. The aim of this study was to elicit trends and especially future research topics within the area of flexible and distributed ISD. The results should be useful in shaping a research agenda of the area and to individual researchers when framing future studies. The sixteen authors of accepted papers were invited to participate. Three rounds were used in which the first round ($n = 14$) aimed at eliciting topics, the second ($n = 14$) and third ($n = 12$) at prioritizing these topics and achieving consensus. The response rate was extremely high, but this is likely a result of all the authors already being very involved in the production of the special issue.

In the first round, respondents were asked to supply five future research topics, defined as "an open question or assertion that deserves immediate research attention." In total, fifty six such topics were suggested which, after elimination of redundancies and generation of common phraseology, resulted in a total number of 16 topics. In the second round the respondents were asked to rank these topics in order of importance and suggest up to three additional topics believed to belong among the top ten. Again, after elimination of redundancies and generation of common phraseology, this resulted in an ordered list of sixteen topics and one additional topic. In the third

Table 1 Top-Ten Future Research Topics in Flexible and Distributed IS Development

Number	Topic
1	Appropriateness of agile methods for emerging contexts (software as utility, open source, etc.)
2	Organizational selection, adoption, and adaptation of agile methods
3	Limits of and differences between different forms of distributed work
3	Agility at the organizational level
5	Appropriateness of agile methods in different situations (specifically, those not typically associated with agile)
6	Role of tools and social technologies for flexible and distributed ISD
7	Agile methods and the individual developer
8	Use of IT for innovation
9	Understanding fundamental concepts (agility, distributed, flexibility, high-speed, etc.)
10	Agile methods' and individual practices' links to project success

round, respondents were asked to rank this additional topic with respect to the current ranking resulting from the second round.

Future Research Topics

Table 1 presents the top ten future research topics in flexible and distributed IS development, from most to least highly ranked.

In the remainder of this section we will expand upon these topics and conclude with a discussion of the contribution of this special issue in the light of these.

Appropriateness of Agile Methods for Emerging Contexts. Perhaps not surprisingly, the most imminent research topic, as judged by our expert panel, is the question of where agile methods will be used. Two specific emerging contexts were brought to the fore: software as service and open-source software (OSS) in the context of enterprise systems such as ERP and CRM. When software is procured as if it were a utility (e.g., in a manner that of similar to buying electricity) where a company buys iterations and velocity from an agile team or teams, what processes, controls, and changes to organizational structure are needed? How can robust support services (fixes, enhancements, customization training, consulting, etc.) work where development is distributed in agile OSS networks?

Organizational Selection, Adoption, and Adaptation of Agile Methods. How to select, adopt, and tailor development methods has always been at the core of the IS field and is clearly important also in the context of agile methods and flexible distributed development. A number of specific research questions were suggested, including tailoring to specific projects, the influence of application domain, and the influence of project goals (see Appendix B for the complete list.) One respondent specifically called for longitudinal studies of how agile methods are adopted, adapted, and used in organizations.

Limits of and Differences Between Different Forms of Distributed Work. What does work at a distance make impossible or less possible? How can mediating technologies be deployed in a targeted way to address some of the limitations? A deeper understanding of the differences between cooperative, collaborative, and ensemble work, each of which implies a different level of communication and creative possibilities, could help distributed teams become more flexible, effective, and efficient.

Agility at the Organizational Level. As agile teams have to interact with many organizational functions, including legal departments, accounting, etc., the question arises as to how best to grow agile beyond the system development team to accommodate the required interactions. At a more general level, respondents called for studies addressing transition to agile practices at the organizational level, rather than at the team level.

Appropriateness of Agile Methods in Different Situations. What is the applicability of agile methods in the domains that were previously seen as nonagile, such as large systems, legacy systems, mission-critical systems, distributed environments? For example, what are the geographic boundary conditions for effective agile development? What are the conditions under which certain types of tasks and certain project management techniques are better or worse for flexible and distributed IS development? Agile methods have proven successful in custom ISD projects with an explicit customer in mind. However, different forms of standard systems and software products are becoming increasingly important.

This idea challenges some of the assumptions of agile methods. While adaptation and tailoring of products to a specific organization can be done using current agile methods, how to develop standard software products in an agile manner is not well understood. For example, while agile methods focus on customer involvement, a single customer may not be representative of the market. How effective, then, is it to use a customer surrogate, such as a product manager, instead of a real customer? One possible strategy suggested is to develop hybrid agile and plan-based development methods, with criteria for deciding when (in what conditions) each should be used.

Role of Tools and Social Technologies for Flexible and Distributed ISD. What roles can social technologies play for software development agility in distributed environments? How can Web 2.0 technologies affect the dynamics of software development in distributed environment? Also, the role of more traditional technology, such as CASE tools, in supporting agile methods needs further attention, perhaps especially in a global context.

Agile Methods and the Individual Developer. How important are individual characteristics for agile method use? What are the multilevel/cross-level effects of agile method use on individual outcomes? A related question is: How does one best educate current and future developers in agile and hybrid agile, as well as plan-based, development methods?

Use of IT for Innovation. Another central theme in IS research is the leveraging of information technology to intensify innovation. What are the lessons from agile and flexible methods in this context? Perhaps these methods and novel IT can be used not to standardize processes or systematize a routine approach but as a means of creating novelty more rapidly and cheaply. There is, for example, more work to be done in areas such as automated prototyping and testing, simulation, etc. On a more general level, what are the consequences of applying agility perspectives to open innovation processes and co-evolution of IT vendors or service providers with customer organizations?

Understanding Fundamental Concepts. Although this special issue clearly contributes to our understanding of fundamental concepts in the area, there are still many such concepts to be addressed. What do we, for example, mean by "distributed"? Should we focus research on atomic concepts such as culture, language, coordination, configuration, etc., or do we need to develop simpler composite variables to measure the overall global boundary complexity? Agility is often referred to as high-speed development, but what is meant by "high-speed"? Is "fast-paced" the same as "fast time to completion?" Is it possible that the cost in time of agility (through multiple iterations and rework) is such that a plan-driven approach will actually give a shorter time to completion? Overall, conceptual studies are required to develop much-needed instruments to assess the agility of ISD processes and teams, whether co-located or distributed.

Agile Methods' and Individual Practices' Links to Project Success. The role and impact of individual practices that make up agile methods are likely to have an important impact on various project outcomes, including success. Particularly, empirical studies are sought that assess existing agile methodologies with respect to their impact on agility of distributed IS development teams. What are the business benefits to an organization of adopting flexible and agile practices, and how can they be measured? How can we monitor and record the performance of distributed and/or outsourced teams?

Additional Topics. In addition to the top-ten topics described above, a number of further topics were suggested but deemed less important (median rankings of these topics were 10 or above). These include: agile implications for human resources and work-life balance; multiparadigm research; assessment of distributed team compositions, configurations, and practices; understanding and exploiting cultural differences in agile ISD; transition of use of agile methods from development to maintenance; methods for agile ISD; and management and control of flexibility. For completeness, Appendix B lists all suggested items and topics suggested by the respondents.

Conclusion

Although the topics identified in this study partly mirror the content of the special issue, they also advance the state of the art by providing a fresh view of an emerging research area. Many of the topics reflect research areas that have been on the IS research agenda for a long time. Yet, the current IS landscape clearly involves new modes of working and new challenges induced by globalization and steadily increasing demands on flexibility and speed. We hope that these topics, provided by some of the most knowledgeable people in the field, together with the insights brought out by the individual papers in the special issue will help to guide further research into this important area. Although we believe that this special issue has indeed advanced the field considerably, there is clearly a lot more that needs to be done.

Appendix A

Editorial Board and Reviewers for the Special Issue

Thomas Acton, NUI Galway, Ireland
Pekka Abrahamsson, University of Helsinki, Finland
Liam Bannon, University of Limerick, Ireland
Richard Baskerville, Georgia State University, USA
Erran Carmel, American University, USA
Kieran Conboy, NUI Galway, Ireland
Kevin Crowston, Syracuse University, USA
Kevin DeSouza, University of Washington, USA
J. Alberto Espinosa, American University, USA
Robert Fichman, Boston College, USA
William C. Hardgrave, University of Arkansas, USA
Brian Henderson-Sellers, University of Technology, Sydney, Australia
Ola Henfridsson, Viktoria Institute, Sweden
James Herbsleb, Carnegie Mellon University, USA
Alan Hevner, University of Southern Florida, USA
Helena Holmström, IT University of Gothenburg, Sweden
Hemant Jain, University of Wisconsin, USA
Matthew Jones, Cambridge, UK
Rajiv Kishore, SUNY Buffalo, USA
Akhil Kumar, Pennsylvania State University, USA
Björn Lundell, University of Skövde, Sweden
Likoebe Maruping, University of Arkansas, USA
Lars Mathiassen, Georgia State University, USA
Peter Meso, Georgia State University, USA
Balasubramaniam Ramesh, Georgia State University, USA
T. Ravichandran, Rensselaer Polytechnic Institute, USA
Matti Rossi, Helsinki School of Economics, Finland
Marcus Rothenberger, University of Nevada, USA
Steve Sawyer, Pennsylvania State University, USA
Olivia Sheng, University of Utah, USA
Keng Siau, University of Nebraska, USA
Katherine Stewart, University of Maryland, USA

Attendees at the Special Issue Workshop

Pär J. Ågerfalk, Uppsala University, Sweden, *Workshop Leader*
Brian Fitzgerald, University of Limerick, *Workshop Leader*
Sandra A. Slaughter, Georgia Institute of Technology, *Workshop Leader*
Lorraine Morgan, University of Limerick, Ireland, *Workshop Coordinator*
Helena Holstrom, IT University Gothenburg, Sweden, *Workshop Scribe*
Eoin O'Conchuir, University of Limerick, Ireland, *Workshop Scribe*
Maha Shaikh, LSE, UK, *Workshop Scribe*
Jason Sharp, Tarleton State University, USA, *Workshop Scribe*
Robert D. Austin, Copenhagen Business School and Harvard Business School, *Participant*
Liam Bannon, University of Limerick, Ireland, *Participant*
Kieran Conboy, NUI Galway, Ireland, *Participant*
Jonathan Cummings, Duke University, USA, *Participant*
J. Alberto Espinosa, American University, USA, *Participant*
Michael Harris, Indiana University Southeast, USA, *Participant*
Likoebe Maruping, University of Arkansas, USA, *Participant*
Kannan Mohan, City University of New York-Baruch, USA, *Participant*
Bala, Rajagopalan, Oakland University, USA, *Participant*
Balasubramaniam Ramesh, Georgia State University, USA, *Participant*
Saonee Sarker, Washington State University, USA, *Participant*
Suprateek Sarker, Washington State University, USA, *Participant*
Pankaj Setia, University of Arkansas, USA, *Participant*
Ramanath Subramanyam, University of Illinois at Urbana–Champaign, USA, *Participant*
Richard Vidgen, University of Bath, UK, *Participant*
Xiaofeng Wang, Lero, Ireland, *Participant*

Appendix B

Table B.1 provides the full list of items and refined topics in the Delphi study and also indicates in which round they were elicited. The individual items are reproduced here as they were provided by the respondents. The refined topics were those used in Rounds 2 and 3.

Table B.2 provides the complete ranking from Round 2. Round 3 consisted of ranking the one new topic (agile methods and the individual developer) in relation to the top-ten topics from Round 2 (median ranking 7.0, std. dev 2.45).

Table B.1 Full List of Items and Topics in the Delphi Study

Refined topics	Individual items (topics suggested by respondents)	Round suggested
Understanding fundamental concepts (agility, distributed, flexibility, high-speed, etc.)	What do we mean by distributed? Michael O'Leary and colleagues have suggested different characterizations of geographic dispersion. For example, some teams may be widely dispersed, others more concentrated or with uneven distributions across locations. Some may work across time zones; some may not. Some teams may have other global variables, confounding the results (e.g., culture, language, organizational membership—i.e., outsourcing, etc.). How to make flexibility and agility work in distributed environments may vary, depending on the specific geographic configuration of the team. One related research question is: Do we study the effect of each geography or global component (distance, time zone, etc.), or do we need to develop simpler composite variables to measure the overall global boundary complexity that summarizes all boundaries?	1
	Agility is often referred to as high-speed development, but what is meant by high-speed? It is clearly fast-paced. There are many techniques to ensure the team keeps up the pace. However, is fast-paced the same as fast time to completion? Agile development encourages experimentation and relies on multiple iterations. If we assume an uncertain future, then an adaptable (agile) approach may lead to the shortest and only possibility of completion. However, if we assume that uncertainty is low and that our biggest need is a fast finish, is an agile approach really a high-speed approach? Or is the cost in time of agility (through multiple iterations and rework) such that a plan-driven approach will give us a shorter time to completion?	1
	Developing instrument to assess agility of ISD process or IS teams, whether co-located or distributed	2
Appropriateness of agile methods in different situations (specifically, those not typically associated with agile)	Increasingly, software development is product-orientated development. Software product houses develop shrink-wrapped packages, software toolkits, components, and Web services. Development within organizations is often customization of existing components or tool kits. How does agile development need to be adjusted to apply to software products? For example, one of the key features of agile development is customer involvement. However, a single customer may not be representative of the market. How effective is it if we use a customer surrogate, such as a product manager, instead of a real customer? What about frequent product releases? Are these the betas we see from Google or Microsoft?	1
	The applicability of agile methods in the domains that were seen as nonagile home ground, e.g., large systems, legacy systems, mission-critical systems, distributed environments.	1
	Developing hybrid agile and plan-based development methodologies, with criteria for deciding when (in what conditions) each should be used	1
	What are the geographic boundary conditions for effective agile development. It has been debated whether or not agile development is suitable for (1) distributed development; (2) large-scale projects; and (3) mission-critical development. We do not have knowledge as to when and where agile approach can be best used. Furthermore, what interventions could be made to make the agile approach effective for the conditions mentioned above?	1
	Conditions under which certain types of tasks are better/worse for flexible and distributed IS development	1
	Conditions under which certain project management techniques are better/worse for flexible and distributed IS development	1
	Agile methods for software product development	2
	Link various forms of agile practices to the production of agile software	2
Appropriateness of agile methods for emerging contexts (software as utility, OSS, etc.)	Moving from procuring software as a product (requirements specified upfront, contract-based) to procuring software as though it were a utility (e.g., like buying electricity) where a company buys iterations and velocity from a team or teams. What processes, controls, changes to org structure would be needed?	1
	If OSS solutions are to be adopted for enterprise use (e.g., ERP, CRM), there must be robust support service (fixes, enhancements, customization training, consulting, etc.). For proprietary software this is supplied by the company producing the software. How would this work where development is distributed?	1
	Where do agile methods go from where they stand now?	1

Table B.1 (Cont'd.)

Refined topics	Individual items (topics suggested by respondents)	Round suggested
Transition of use of agile methods from development to maintenance	Development versus maintenance	1
	What is the transition from agile development to ongoing maintenance? In an agile development, relatively more of the knowledge is in the heads and experiences of the developers, and less is contained in a formal plan. How then do we transfer that knowledge from the development team to the maintenance team especially in the case of distributed development where this transfer may require consolidation of distributed knowledge across time zones and geographies?	1
Assessing distributed team compositions, configurations, and practices for flexibility and agility	Instruments/approaches for assessing the agility of distributed IS development teams	1
	Assessing different configurations of distributed teams (based on the number of locations, the size of workforce in the different locations, task specializations at different locations, etc.) regarding their agility/flexibility.	1
	What kinds of structural arrangements/configurations of distributed ISD teams lead to greater flexibility?	1
	What kinds of trust (e.g., cognitive, institutional, calculative) contribute to distributed team flexibility?	1
	Distributed Teams. Collaboration in distributed teams puts major difficulties in the way of collaboration. What are the effects, for instance, of collaboration using different first languages? What are the benefits of that difference? the difficulties? How can we exploit and increase the one and limit the other?	1
	Working Together. Study that discriminates among the various ways of working together. My experience in the theatre suggests four: following orders; compromise; cooperation; and collaboration. Collaboration needs practical, hands-on study that will distinguish it from the others and consideration of how it's done when done well. We need language and analysis that will change it from the buzz word du jour to a usefully technical term of art.	1
	Histrionic Sensibility. The heart of collaboration is the action of mirror neurons as a result of proximity. Are there ways we can train this fundamental human reflex (in the theatre it's called "histrionic sensibility") to respond to aural proximity in the absence of actual bodies? There have been cultures as focused on hearing as ours is on seeing: pre-Golden Age of Greece, Aztec Mexico, and others. Could study of them help us here? Actors, dancers, and musicians cultivate and grow their histrionic sensibilities, their skills of response to each other at the level of reflex, before thought, accessing their deepest creativity. Can agile teams do something similar?	1
	Developing a more refined taxonomy of modes and quality of distance collaboration; not all distributed IS development involves the same kinds of social activities, and we need better frameworks for distinguishing between them	1
	Effective use of agile methodologies in distributed teams	1
	Identifying and operationalizing programming practices for distributed teams	1
	When development is shared between in-house and outsourced/offshore developers, do the differences in the education and training of developers impact their acceptance of flexible development methods?	1
Limits of and differences between different forms of distributed work	*The Limits of Ensemble*. What does work at a distance make impossible or less possible? How can mediating technologies be deployed in a targeted way against some of the limitations of ensemble.	1
	Understanding the differences between cooperative, collaborative, and ensemble work, each of which implies a different level of communication and creative possibilities.	1
Role of tools and social technologies for flexible and distributed IS development	What roles can social technologies play for software development agility in distributed environments? Will Web 2.0 technologies affect the dynamics of software development in distributed environment? If so, how?	1
	Role of CASE tools in supporting agile methodology use/execution	1
Methods for agile ISD	Developing an IS development methodology that would promote flexibility in distributed IS development (a design-science undertaking)	1
	Developing hybrid agile and plan-based development methodologies	1
	Use of agile methods in offshore IS development	2

Table B.1 (Cont'd.)

Refined topics	Individual items (topics suggested by respondents)	Round suggested
	Systems documentation challenges with agile methods	2
	System reliability and agile methods	2
Organizational selection, adoption, and adaptation of agile methods	How are flexible methods adapted to specific projects? What are the influences of different application domains?	1
	What are the key emergent controls needed for effective flexibility in software development?	1
	How do project goals, such as time-to-market, product-market match, quality requirements, etc., influence the selection of flexible development methods?	1
	Longitudinal study of how agile methods are adopted, adapted, and used in organizations	1
	What are the determinants of software development flexibility (e.g., agility, adaptability, etc.), and how can this be balanced with rigor (e.g., CMM Level 5).	1
	How are organizations managing the adoption of agile methods? What are the success factors and barriers to adoption?	1
	Appropriation of agile techniques to achieve different development goals—market match, time, budget, product qualities, etc.	1
Management and control of flexibility	New ways to manage/control distributed IS development projects that would enhance flexibility	1
Agility at the organizational level	*The Agile Organization*. Growing agile beyond the ISD team to incorporate the other functions that the team has to interact with (legal dept, accounting function, etc)	1
	Agile transition at the organizational level rather than team level	1
Agile methods' and individual practices' links to project success	The role and impact of individual practices that make up agile methodologies on various project outcomes	1
	Linkage between agile practices in use and success of software development projects.	1
	Empirical assessment of existing agile methodologies with respect to their impact on agility of distributed IS development teams.	1
	What are the business benefits to an organization of having flexible/agile IT, and how can they be measured?	1
	Effectiveness of agile methodology use in offshore IS projects	1
	Success in offshored projects	1
	How can we monitor and record the performance of distributed/outsourced software teams? Standard measures of performance, e.g., ability to deliver on time, productivity, quality would help in deciding which teams to employ and how much to pay.	1
	IS benefits in agile projects—identification, measurement, and management	2
Agile implications for HR and work-life balance	Historically, there have been peaks and valleys in demand for ICT professionals, and so organizations have experienced periods of high and low turnover. What is the impact of high turnover in a development group on the use of flexible development?	1
	Agile skills and implications for HR	1
	What are the work-life balance implications of the use of agile methodologies in distributed ISD?	1
Understanding and exploiting cultural differences in agile ISD	Cultural issues	1
	The impact of cultural values on the effective use of agile methodologies	1
Agile and the individual developer	Educating current and future developers in agile methods	2
	Individual characteristics for agile method use	2
	Multilevel/cross-level effects of agile method use on individual outcomes	2
Multiparadigm research	Integrating knowledge from multiple paradigms of research	1
Use of IT for innovation	Leveraging information technology to intensify innovation; using IT not to standardize process or systematize a routine approach but as a means of creating novelty more cheaply; much more work to be done in areas of automated prototyping and testing, simulation, etc.	1
	Applying agility perspectives to open innovation processes	2
	Co-evolution of IT vendors or service providers with customer organizations	2

Table B.2 Round 2 Median Ranking

Refined topics	Median rank	Std. dev
Appropriateness of agile methods for emerging contexts (software as utility, OSS, etc.)	3.5	4.38
Organizational selection, adoption, and adaptation of agile methods	4.0	3.81
Limits of and differences between different forms of distributed work	6.0	3.08
Agility at the organizational level	6.0	3.40
Appropriateness of agile methods in different situations (specifically, those not typically associated with agile)	7.0	5.12
Role of tools and social technologies for flexible and distributed ISD	7.5	3.80
Use of IT for innovation	8.0	4.12
Understanding fundamental concepts (agility, distributed, flexibility, high-speed, etc.)	8.5	4.66
Agile methods' and individual practices' links to project success	9.5	4.82
Agile implications for HR and work-life balance	10.0	3.76
Assessing distributed team compositions, configurations, and practices for flexibility and agility	10.5	4.37
Multiparadigm research	10.5	4.78
Understanding and exploiting cultural differences in agile ISD	10.5	6.02
Transition of use of agile methods from development to maintenance	11.0	3.15
Methods for agile ISD	11.5	4.75
Management and control of flexibility	14.5	3.59

References

Ågerfalk, P. J., B. Fitzgerald. 2006a. Flexible and distributed software processes: Old petunias in new bowls? *Comm. ACM* **49**(10) 26–34.

Ågerfalk, P. J., B. Fitzgerald. 2006b. Understanding flexible and distributed software development processes. *Proc. Thirty-Ninth Hawaii Internat. Conf. System Sciences*, IEEE Computer Society Press, Washington, DC, 1.

Beck, K., C. Andres. 2005. *Extreme Programming Explained: Embrace Change*. Addison-Wesley, Boston.

Fitzgerald, B., G. Hartnett, K. Conboy. 2006a. Customising agile methods to software practices at Intel Shannon. *Eur. J. Inform. Systems* **15**(2) 200–213.

Fitzgerald, B., S. A. Slaughter, P. J. Ågerfalk. 2006b. Call for papers—*Information Systems Research* special issue: Flexible and distributed information systems development. *Inform. Systems Res.* **17**(3) 323–325.

King, W. R., G. Torkzadeh. 2008. Information systems offshoring: Research status and issues. *MIS Quart.* **32**(2) 205–225.

Schwaber, K., M. Beedle. 2002. *Agile Software Development with Scrum*. Prentice Hall, Upper Saddle River, NJ.