The Collaborative Future

Thomas Marlowe
Seton Hall University
400 W. South Orange Ave.
South Orange NJ 07079
thomas.marlowe@shu.edu

Susu Nousala
Aalto University, Helsinki, Finland
University of Melbourne
Parkville, Melbourne
Parkville, 3052, Australia
s.nousala@gmail.com

Norbert Jastroch
MET Communications
Eschbacher Weg 10
61352 Bad Homburg, Germany
norbert.jastroch@metcommunications.de

Vassilka Kirova
Alcatel-Lucent
600-700 Mountain Ave.
Murray Hill, NJ 07974
vassilka.kirova@alcatel-lucent.com

Abstract

Collaboration has become an important goal in modern ventures, across the spectrum of commercial, social, and intellectual activities, sometimes as a mediating factor, and sometimes as a driving, foundational principle. Research, development, social programs, and ongoing ventures of all sorts benefit from interactions between teams, groups, and organizations, across intellectual disciplines and across facets and features of the inquiry, product, entity, or activity under consideration. We present a survey of the state of collaboration and collaborative enterprise, in the context of papers and presentations at the International Symposium on Collaborative Enterprises 2011 (CENT 2011), and the extended papers appearing in this special issue.

Keywords: Collaboration, interoperability, collaborative enterprise, knowledge management.

1 Introduction

Collaboration has become an important goal in modern ventures, across the spectrum of commercial, social, and intellectual activities, sometimes as a mediating factor, and often as an underlying philosophy, driving practices and mechanisms. Research, development, social programs, and ongoing ventures of every kind benefit from interactions between teams, groups, and organizations, across intellectual disciplines and across facets and features of the inquiry, product, entity, or activity under consideration.

Achieving successful, sustainable, repeatable collaboration, however, requires far more than simply a decision by the collaborating organizations or entities. Rather, it needs a milie and environment in which collaboration feels natural, in which collaborative ventures can easily be imagined, created, developed, and maintained. That environment will rely on a number of interrelated changes—to social and corporate culture; to business plans, policies, practices and processes; to our understanding of the nature and management of knowledge, risk, and intellectual property; and to the technology base itself.

Technology has in turn been an important mediating factor and enabler for collaboration, supporting realistic and fine-grained communication across nations and cultures, as well as organizations, and for the first time allowing large, often distributed communities to work easily together on a common effort. Successful collaboration will clearly involve use of common technology and tools, or at least of technology and tools with mutually comprehensible interfaces and supporting a common view of processes, projects and products—the most basic definition of interoperability. Shared data, product artifacts (typically code), or even process information, often stored and sometimes executed in the cloud, not only intensifies these needs but can also address many of them.

As discussed below, real interoperability will call for far more integration and for mutual intelligibility and controlled mutual transparency for selected business and technical processes, as well as other common elements. It must, however, also be complemented by integration of intellectual resources, while however safeguarding the privacy, security and intellectual property interests of the individual participants and groups.

Interdisciplinarity is a key component of collaboration and collaborative enterprise, providing a motivator through an availability of complementary and specialized expertise, a synergy through the interaction of resources, ideas and perspectives, and a challenge in the need to provide translations, common views, and compatible objectives. This will clearly thus require a higher level of transparency and interoperability than simply a well-functioning common platform.

(It is important to distinguish transparency and intelligibility, which are largely orthogonal. The former lies in determining what must be shared and creating mechanisms for sharing, and the latter in agreeing on and guaranteeing common context, notations, glossary, and structures to make what is revealed understandable and usable by all parties involved.)

In addition, consideration must be given to human factors, and the challenges, changes and incentives entailed in collaboration between established entities with their individual goals and their

own established practices and viewpoints. Resistance to collaboration and partial integration is (perhaps inherently) further compromised by differences in culture, the need to establish trust, the need to reward collaboration, the sense of membership in an individual group or organization, and resistance—often partially justified—from subgroups, such as the IT and legal departments and some upper-level managers in large corporations.

Finally, successful use of collaboration will entail understanding collaboration itself and its success factors. Again, there are several facets: the importance of cultural understanding, good communication, and trust (as documented in the organizational behavior and other literature [14, 18, 21]), and the establishment of good collaborative relationships. Collaborations will unsurprisingly also need a solid product vision and business plan, and will require support and advocacy from corporate leadership and from technical managers and staff. (For community development, this translates into support from government or foundations, staff and community.) Business processes will also have to be modified to value and reward collaborative activities, including support activities with no apparent business function within the organization, in order to establish good relationships and solid communication.

The remainder of this paper looks at a conceptual framework and environment for collaboration, including the knowledge base and knowledge management for collaboration; collaborative infrastructure and interoperability; and evaluation of collaboration, and places the papers in this issue, some of which also appeared in CENT 2011 [1], in the context of this overview.

2 Providing a framework for collaboration

2.1 The collaborative environment

The first conceptual step in establishing a framework for collaboration—if one that is difficult and often very much delayed—lies in creating a social, educational and business environment that encourages, values, and rewards cooperative behavior, rather than competition alone, while still striving for excellence and creativity. Since contrary attitudes are established early, at least part of the solution lies in restructuring education.

Rodriguez and Nuño [p. 48] present an approach currently in use in selected kindergartens in the Mexican state of Puebla, aimed at fostering and rewarding group formation, individual and group responsibility, cooperation, creativity and synthesis of ideas. Part of the effort lies, of course, in sensitizing the instructors, parents and administrators. The approach has been quite successful, appreciated by students, parents, and teachers, and will be replicated in more kindergartens and eventually up the educational scale.

At the other end, Ripley [p. 18] documents a successful academic collaboration, offering an interdisciplinary course integrating philosophy and marketing, aimed at both liberal arts and business students. The course was extremely rewarding if demanding for the faculty. It also made the problems of philosophy and business ethics more real for students, and encouraged them to think interdisciplinarily, and gave them a positive model for collaboration. However, Ripley also documents the costs and difficulties in creating and teaching such a course, from both the faculty and the administrative perspective, providing an excellent example of the changes and adjustments needed to realize the benefits of collaboration.

On the other side of the ledger, we [7, 12, 14] and others have discussed the changes needed in business practices and processes. First, the resistance from key personnel, mentioned above, will need to be addressed by education, training, positive examples, and customer/market demands. It will also most likely require selection of managerial personnel and demonstrated support, including top-level contacts for collaborative projects. Second, practices and processes will need to change to support and value work on collaborative projects and the development of good collaborative relationships. Third [9], the goals and strategies of individual partners, and to some extent their internal processes, practices, artifacts and conventions, need to be aligned. Finally, all involved need to recognize that some artifacts, processes and knowledge will be inherently collaborative, requiring development of policies for sharing, agreements and/or metrics for credit and use, and procedures for negotiation or arbitration and for risk management.

Nousala *et al* [p. 65] discuss in passing similar changes in perspective and approaches that need to occur for successful community efforts, both in the community and among the practitioners.

2.2 The knowledge base

Collaboration, whether in academia, business, or community action, entails sharing and integration of knowledge from many sources. Sharing of publicly available knowledge poses little difficulty, and sharing of information about component interfaces and constraints is obviously needed and will usually pose little difficulty. But sharing of component internals, or of internal processes, practices and approaches, and in particular of organizational memory, confidential information or intellectual property, will evoke more (and often justified) resistance, but may to some extent be necessary for interoperability, for process optimization and project efficiency, for product maintenance and evolution, for risk analysis and management, or for evaluation of global constraints and metrics [p. 41, 12, 13, 14].

It is a well-understood fact that knowledge is often not objective and often context-dependent. It is also clear that knowledge will be encoded in many ways, using languages, glossaries and notations reflecting local conditions and cultural understandings, both social and corporate, but also in many cases simply an accident of history or chance (such as the choice of a particular database design methodology and product).

Finally, it is known that while some knowledge is explicit—documented and available—and even managed—with tools or approaches for access, modification, cross-reference and access control—much knowledge is implicit—documentable but not yet captured or not available—or even tacit. We distinguish two sorts of tacit knowledge—on the one hand, processes and

practices "known to the senses but not to the mind", such as how to make fine adjustments to a machine; on the other, knowledge that affects individual, societal and corporate behavior without being fully understood or articulated, and certainly not communicable, such as "how do I decide which stock to invest in?" or even "who do people really listen to on this issue?". (See [Zouaghi, p. 77] for further discussion and references on tacit knowledge.)

Because intellectual property and the level of contribution is so important in collaboration, we have also distinguished the orthogonal category of "collaborative" or "community" knowledge from shared knowledge on the one hand, and individual or corporate knowledge on the other [13]. This is knowledge that results from integration of knowledge from multiple partners, or from the action or analysis of the products of collaboration or of the collaborative process. Almost all collaborative knowledge is emergent—that is, it is not known, and often cannot be known, by a single partner at the start of the project.

There are at least three dimensions to the role of knowledge covered in this issue: the nature, representation and relationships of knowledge, the identification and integration of knowledge for collaborative activities, and the role of knowledge in collaborative ventures, especially as connected to interoperability.

2.3 Nature, representation and relationships of knowledge

van Lier [p. 91] looks at the distinction between knowledge and information, in the context of general systems theory, and argues that a (conceptual) knowledge base must account for not only information about entities and objects, but the objects themselves, their environments, and the subjects who observe them, and that this need is made both more pressing and more valuable with increasing technology and possibilities for communication, resulting in an "Internet of Things". A theory of collaboration will need to consider and address this, since in this perception successful collaboration will entail integration of abstractions and translations of multiple views of this Internet of Things.

Karbe [p. 98] considers the representation of knowledge artifacts using Mahr's Model of Conception together with context. Considering this model and considering both the role of context and the uses of knowledge, he explores requirements for communication, abstraction and use of knowledge that apply in single-entity ventures, but will have an even more powerful impact on sharing and management of knowledge for collaboration.

Nousala et al [p. 65] also discusses in context issues of cultural differences, communication, notations and representations, and steps needed to ensure that meaningful communication occurs.

2.4 Identification and integration of knowledge for collaboration

Zouaghi [p. 77] addresses primarily the identification and encoding of tacit knowledge (of "the senses know" kind), and its capture as organizational knowledge, and eventually inter-organizational knowledge. As he suggests, tacit knowledge is often preserved by a succession of apprenticeships or hands-on workshops within a single organization, and by identification of key personnel within the organization for solving particular kinds of problems. One of the challenges in collaboration is how to share this knowledge among organizations, and for that matter in deciding the extent to which such knowledge must or should be shared for collaborative success.

Fortunato et al [p. 12] discuss an approach and initial results in identifying engineering competencies in the aerospace industry, focusing not just on explicit knowledge, but on "hands-on" tacit knowledge and on implicit or tacit behavioral knowledge. Each competency is structured as an Activity (goal, process or problem), a Competency (solution or approach) consisting of Method, Technology and Product, and an Output. This approach, extended to also apply to Business and other aspects, is likely to prove valuable in identifying both process and product knowledge to be shared, and obstacles in achieving interoperability.

2.5 The role of knowledge in collaborative ventures

Jastroch et al [p. 30] explore how the nature of the collaboration and in particular the nature of its product or goal affect the level and types of knowledge needed, difficulties arising due to intellectual property and confidentiality, and the likely consequences of catastrophic events affecting one partner. The kinds of goals they distinguish are resource sharing, creating a service, creating a material product, or creating an intellectual property artifact, such as a piece of software.

In another paper in this issue, Jastroch, Kirova, Marlowe and Mohtashami [p. 36] discuss the interaction of partner and collaborative knowledge across the phases of a collaborative venture aimed at developing a complex, long-lived, and evolvable software artifact or system. The demonstrated need for steady information and knowledge flows in and out of collaborative activities, and forward and especially backward between software development and knowledge management phases and/or iterations, imposes particular constraints on the sharing of product, process, and business knowledge which must be considered in entering and pursuing such projects.

Nousala et al [p. 65] discuss the required knowledge base and social and technical infrastructure needed for community action, governance and repositories of community knowledge. There are intriguing connections to the theoretical discussions mentioned above, and to issues of culture, trust and communication. It will be important to understand the similarities and differences between this kind of venture/project and collaborative business enterprises, especially for ventures, such as those based on virtual reality or social media, that will increasingly combine elements of both.

3 Creating collaborative infrastructure and collaborative ventures

Much of the discussion of collaboration elsewhere has focused on support services and tools, such as repositories, software and communication support for live meetings and group editing, and on the business aspects of collaboration. However, satisfactory collaboration will also entail interoperability, as well as use of collaborative structures and processes for arbitration or mediation of differences.

3.1 The technology base

3.1.1 Interoperability

In two papers from the symposium (but not appearing in this special issue), Koussouris *et al* [9, 10] explore the dimensions of interoperability. The first proposes an initial classification of the different facets of interoperability and the relationships between those facets, identifying directions for future research as well as providing a valuable checklist and roadmap for complex collaborative technology-based ventures. In its view, interoperability involves not only creating common (or at least mutually intelligible and inter-translatable) frameworks for the platform and the knowledge base, as well as its referents, but also requiring cross-cultural intelligibility and aligned and consistent technical and business processes and practices. The second outlines a research program for exploring the facets, with the eventual goal of developing an Enterprise Interoperability Science Base [EISB], in response to a research program proposed by the European Commission [2].

Popplewell [p. 6], likewise in the context of the EISB, and very much sharing notations with the two previous papers, considers a structure for interoperability, less in terms of the features and domains of investigation, and more from a semantic and knowledge-generation perspective. The two main contributions are consideration of the sources and use of knowledge, and structuring the knowledge base of results.

3.1.2 The collaborative platform

While the collaborative platform was not a major focus of the symposium, there were significant contributions in two areas: a cloud-based platform for collaboration, and interactions of collaboration and virtual reality.

Teichmann, Schwartz and Dittes [p. 57] propose a cloud-based platform and design methodology for collaborative creation of business applications, based on material flow diagrams. The structure allows quick design and deployment of systems with well-specified interfaces, more or less via plug-and-play with consistency checking. The paper also presents compatible approaches to a design methodology.

Lemus-Martinez *et al* [p. 86] propose a layered approach for video conference platforms with the specific goal of increasing communication and collaboration during disaster simulations (and eventually, during disaster management). The paper points to the need to specialize platforms if one wants to improve collaboration, particularly in situations in which communication is a priority, and in which some participants may be reluctant to fully collaborate.

Kopecki [p. 24] deals with an orthogonal, almost dual problem—how to smoothly integrate existing applications into virtual reality applications, or for that matter, meshing existing applications into any "meta-applications" that combine and extend application functionality. Thus, the approach can both be a collaborative tool, and a technique for developing collaborative applications.

3.2 Collaboration structures and resources

A common theme, both in our earlier papers [7, 12, 14] and in papers presented here [p.36, p.98, p.57], is the need for structures belonging not to the individual partners but to the collaboration, including knowledge bases, component repositories and configuration managers, risk management plans, and integration wrappers, although partners may retain certain rights to parts thereof.

There are a number of interesting questions involved, partially addressed, but open to a great deal of further research. What knowledge or artifacts does the resource own or have the right to use? What rights does each partner have, and are they global to the resource, or local to particular items? What credit does each partner receive, for providing knowledge, artifacts, hosting, financing, or analysis? And what charges, if relevant, does each partner accrue for the use of the resource and its contents?

Further, each of those questions, as well as conflicting interpretations of requirements and specifications, and other issues, will require clear and mutually agreed policies for resolution of differences, well-defined channels of business-level communication, and in extreme cases, even an provision for third-party arbitration or mediation.

4 Evaluating collaboration

One of the themes of modern business and technical processes is evaluation and quality control. It will prove important to evaluate the collaborative process, both qualitatively and quantitatively. There are three major goals: better understanding to promote further research (compare [9, 15]), optimizing the collaborative process, and evaluating a particular collaborative venture. If there are quality indicators and metrics for such evaluation, they can be used in deciding whether to pursue collaboration, in evaluating the current state of a collaborative venture, and in evaluating the success of the collaboration.

Focusing on one domain, [15] considers a number of attributes of collaboration for a complex software development project and product that would need to be measured, discussing a small number in detail. As with many of these papers, the focus is in creating a roadmap for future research. Several other papers [9, p.6, p.18, p.48] also touch on collaborative success as a measure in a specific context.

5   Conclusions

Collaboration is the future, in several dimensions. Collaborative, inter-organizational and often cross-national, cross-lingual and cross-cultural ventures are of increasing importance. Collaborative and interdisciplinary research allows synthesis of knowledge and models, and supports to economic and scientific activity. And interdisciplinary meetings focused on collaboration provide researchers and practitioners with context, information, and ideas, and opportunities for interactions.

Conferences such as CENT offer a setting for consideration of collaboration-written-large, complementing specialized conferences focused more narrowly on infrastructure, tools, and platform, on management and coordination of collaborative projects, or on analysis of collaboration from the perspective of management science.

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