The Performance of Distributed Problem Solving Networks

Proposal to McKinsey & Company for an Initial Phase of a Collaborative Research Program on the Changing Nature of Work in a Network Society

Submitted by the

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Introduction

The rise of e-enabled forms of distributed problem solving, involved in the co-creation of products and services, has been one of the most potentially far-reaching developments for the future of work in the network society. Examples of distributed problem-solving networks include:

- voluntary peer-production of information-compendia (e.g. the collaborative free encyclopedia Wikipedia, emblematic in this area but unique only in its size and scope);
- the use of advanced e-infrastructures like the Grid for academic e-research or e-science collaborations;
- the production modes of large communities of free and open source software developers (and newer initiatives exploring the potentialities in areas like 'open source synthetic biology'); and
- 'open innovation' programs initiated by business firms (e.g. in the use of the Internet to announce prize competitions for the solution of specific technological design problems, which has induced in some areas the emergence of cooperative team-efforts to compete for the prizes).

The level of success achieved by some networks, such as the reputation for quality gained by Wikipedia, has generated interest in applying this approach to a growing array of problems. However, the apparent success of distributed networks has been a matter of contention and it has raised major questions about the relative merit of market-oriented 'proprietary' modes of problem solving versus more 'open' non-market approaches. Therefore, as the novelty of this approach diminishes, there will be increasing controversy and closer

[1] This proposal emerged from a meeting on 29 November 2006 between the OII's Director, Bill Dutton, with James Manyika, Kara Sprague and Markus Loeffler at McKinsey, and from a subsequent meeting which brought John Hagel and Brad Johnson into the discussion. At Oxford, it has benefited from discussions among colleagues at the OII and Balliol College, including Paul David, Andrew Currah, Andrew Graham, Wolf Richter, and Jonathan Zittrain.

scrutiny of their performance relative to alternative modes of production.

It is therefore timely and important to develop systematic approaches to measuring the performance of distributed problem-solving networks so that they might be assessed and managed. How can the performance outcomes of these activities be judged? What is the social organization of distributed problem-solving activities that achieve high-levels of performance?

This proposal outlines a six-month project focused on advancing approaches to measuring and explaining levels of performance of distributed problem solving activities, by examining cases within the areas of open source software, e-science, and film production. It is designed to provide new insights on a challenging topic surrounding the social organization of distributed problem solving and its consequences for organizations, ranging from business firms to communities formed online around the distributed co-creation of a particular product.

The project will be conducted by researchers at the Oxford Internet Institute (OII), and its associates, with the support of, and in collaboration with, McKinsey. The results, which will be widely disseminated, will provide a basis for discussion of a broader collaboration on the changing nature of work in a network society.

A work plan and budget for this six-month study are detailed below. Research could begin as soon as the proposal is accepted, but we are aiming for a sign-off on the proposal in May so that work could begin as early as June 2007. The launch would be followed by at least one workshop with OII and McKinsey staff that progresses to a concluding public forum aimed at making the lessons learned from this research accessible to a wide audience.

The proposal emerged from discussions among teams from the OII and McKinsey that explored areas of common interest between McKinsey's priority areas[2] and the OII's strategic areas of research. The changing nature of work in a society networked through digital IT and communication technologies was identified as a high-level and high-priority subject for McKinsey and one that crosscuts OII's research areas (see Appendix 1). However, both teams sought to target a more focused topic as a means to begin work in this broad area, leading to the focus on performance.

The Changing Nature of Work in a Network Society: Critical Issues

Changing conditions of access to digital information sources and connectivity among individual agents and teams are reshaping the nature and conduct of work in many areas, such as in scientific research and other distributed collaborations in knowledge work and in the design and production of creative information-goods more generally. Communication and information technologies like the Internet are being applied to the scheduling of work and

[2] As reflected, for instance, in McKinsey's Technology Initiatives, Global Institute and material on the changing nature of work (e.g. in *McKinsey Quarterly* and *Financial Times* articles).

allocation of tasks by firms[3] in a widening array of service industries[4]. Combined with the growth of ubiquitous communications for maintaining real-time contact with employees, this has far reaching (and potentially disruptive) effects on the organization of everyday life and work.

One of the most significant developments has been the rise of 'distributed problem solving' or what has been called 'distributed co-creation'. A great deal of work has tracked the rise of this new form of e-enabled work, particularly in the area of open source software development[5]. There has also been years of work on distributed scientific collaboration such as around 'collaboratories'[6].

Some work has explored the social and technical factors that contribute to the diffusion and sustainability of these activities. For the most part, participants and observers have been surprised with the success of some of the most notable projects, such as key open source projects, or compendia, such as Wikipedia -- a 'peer-produced encyclopedia, which seems to have defied conventional wisdom and challenged major commercial encyclopedias.

However, the surprising success of distributed problem solving has not as yet yielded a systematic approach for measuring their performance. What are reliable and valid indicators of the performance of distributed problem solving? Are there indicators that could travel across different kinds of activities, or must they be specific to an activity? If we can measure performance, how can we account for the relative levels of performance of different groups? These are the questions that drive the current proposal.

The Proposed Study of Performance

Initial focus of research: *Measuring and explaining the performance of 'distributed peer-based problem solving' initiatives that have been enabled by advances in information and communications technology*.

Although this is an emerging field, the excitement surrounding it has generated a significant level of research, primarily anchored in case studies of collaboration around joint work products, such as open source software.[7] The proposed study seeks to avoid the more researched topics and to focus on a major lacuna in the research literature: indicators, and determinants of, their performance outcomes. This includes examination of:

1. Indicators of Performance Outcomes: What are the relative strengths

[3] Digital networks are also altering the nature and capabilities of public service organizations and their relationships with citizens and businesses, with substantive implications for the managerial and skill qualifications of public sector employees.

[4] Such prospects are signalled by Wal-Mart's recent moves to introduce a 'hyper-flexible' system of work scheduling for employees in its retail stores.

[5] For example, see papers of the free and open source research community, at: http://opensource.mit.edu/

[6] For example, see: http://www.scienceofcollaboratories.org/

[7] See, for example, Steven Weber (2004), *The Success of Open Source* (Cambridge, Massachusetts: Harvard University Press).

and weaknesses of alternative approaches to creating indicators of the performance of distributed problem solving activities? How do these indicators relate to productivity measures at the firm, sector, and economy level? What are the impacts of distributed problem solving and decentralized co-creation initiatives on the culture, environment and performance of organizations? What empirical evidence can be used to assess whether these approaches create real competitive advantage? How best can relevant performance indicators be identified? Can we quantify the implications of such initiatives within particular case studies, organizations or sectors?

2. Factors Shaping Levels of Performance: Are there generic and specific characteristics of the class of networked information-creating initiatives to be studied that help to understand the boundaries of the public and private sector domains in which such work organizations are likely to be effective enough to perform well and be able to sustain competition with other organizational entities? This includes assessment of the social and psychological motivations behind participation in distributed co-creation, such as those concerned with the demography of participation. Is the social organization of such distributed problem solving a generational phenomenon? Through what processes are the information-products of these networked collectivities able to gain acceptance, trust, and even 'authority' among the using population at large?

In addressing these issues, the project will need to be rooted in a conceptually and empirically useful definition of the distributed and collaborative work phenomena to be explored. In some respects, all work outputs are the products of distributive collaboration if they involve more than one person. What, then, is genuinely new about the emerging Internet-based networks of distributed collaboration? For example, is the decentralized geography of production critical? Is the distributed co-production of information products and services distinctly different from more material activities, such as mining raw materials[8]? Is this approach constrained primarily to information products and services, such as software and film production, or does it extend in significant ways to manufacturing goods, from consumer electronics to motorcycles? Is there a typology of applications that would help understand where distributed problem solving is – and is not – a viable strategic approach to production?

And in understanding performance and its determinants, the study will inevitably raise related questions about the successful implementation of distributed activities. For example, what special abilities and skills are critical to distributed work and co-creation, and how is such work organized, conducted, assessed and rewarded in peer-based collective systems of knowledge production and distribution? What mixtures of social and technological mechanisms do organizations of this kind find to be effective in regulating participation and interactions among members of these

[8] See, for example: http://www.fastcompany.com/magazine/59/mcewen.html

‘communities of practice’? How diverse are these successful ‘governance mechanisms’ and to what degree are their key features generic and transferable, rather than having evolved in particular organizational contexts that fitted them to the specific problems with which the organization was characteristically engaged in solving?

We may also gain insights concerning the economic, social and technical contexts shaping the development, adoption and impacts of geographically distributed collaborative approaches to creating and disseminating new information goods and services? To what degree is the social organization of distributed problem solving dependent on particular policy contexts, such as a certain approach to intellectual property?

The study might also suggest issues concerning the longer-term societal implications of these new modes of work. What are the broader transformative implications for people’s lives and livelihoods in societies where a growing number of organizations undertake more of their work in distributed and co-creation modes, and a correspondingly greater proportion of goods available for consumption and investment are produced in this way?

The breath of this far-from-exhaustive set of questions underscores the value of our focus on performance. By focusing on indicators of performance and its determinants, it will be possible to construct a manageable six-month project, which may point towards a broader program of collaboration in the longer-term.

Approach: Case Studies in Three Areas of Application

The project research questions will be addressed through empirical studies of three areas of application. Taking into account the need to study a range of activities within the scope of our expertise, we have proposed, in collaboration with McKinsey, that the initial case studies build on:

1. open source software;
2. e-science collaboration; and
3. film production.

Each case study will develop an overview of developments around distributed problem solving in the respective area, but focus on our issues of indicators and determinants of performance outcomes. For example, identifying the underlying norms and modalities of networked collaboration will be a critical element in the analysis of performance. Does distributed, e-enabled problem-solving require agile teams with new communicative behaviors and organizational cultures?

In the specific case of film production, for example, the analysis will be anchored in an overview of distributed co-creation in global media and entertainment industries, with special reference to the Hollywood film industry. The case will seek to develop typologies of distributed co-creation activities, with a focus on how best practices and performance metrics might vary across

these types of activity. It will explore the factors shaping the success of distributed co-creation in this area, such as public policy, especially given intellectual property concerns in the entertainment sector, and explore the geography of distributed problem solving activities with reference to different territorial, legal and regulatory frameworks.

While empirically anchored in three areas, a key goal of the project will be to develop a synthesis of concepts and approaches to indicators that can travel beyond these areas of study, yielding more general as well as specific themes of measurement and the shaping of performance.

The OII Team and Associate Researchers

The project will involve a strong collection of academics at the University of Oxford. Appendix 2 identifies researchers we expect to involve, but others are likely to be identified as the research progresses.

The project will be conducted primarily by a core group of OII researchers and associates. They will undertake the initial effort of approximately six months, working in collaboration with McKinsey to draft relevant papers and conduct the planned meetings, workshop and forum.

They will seek to engage a larger set of advisors among Oxford academics, who will be informed of the project, asked to critically review our work, help us identify key experts, and potentially join project activities, such as our workshop and forum, as well as become involved in future work.

In addition, the research team will draw on their respective academic networks to identify international experts, who will be tapped for particular skills and contributions that would complement the study. Within six months, we expect to have identified a global network of key academic researchers involved in areas relevant to this project.

Finally, the team will engage with McKinsey colleagues, who will be in regular communication with the project and occasionally visit the team. At this early stage of collaboration, with its short time horizon, we are planning for short, informal visits. However, these visits could lead to longer visits in the future.[9]

Project Management

[9] Support for a sequence of Research Visitors at the OII from the McKinsey organization could contribute to the program's work while the Visitors are at the Institute and, possibly, through their subsequent research and writing. Such 'Visiting McKinsey Fellows' would provide McKinsey colleagues with the time and setting to advance their thinking, and facilitate the development of closer interactions between the University, Oxford Colleges and McKinsey's research efforts. Towards that end, it would be desirable for these visiting researchers to be 'in situ' at the OII for at least one of the three Oxford Terms, and for the OII to arrange for them to have an association with one of the Colleges with which it has strong relationships, such as Balliol, Mansfield and Keble.

Bill Dutton will direct the project, as the principal investigator, with Paul David, as co-principal investigator. Together they will set the general academic direction for the project. There will be a project manager, OII doctoral student Wolf Richter, who will be supported by the administrative and events teams of the OII, freeing project researchers to focus on the case studies and events. The principal investigator and project manager will manage collaboration with outside advisors and colleagues at McKinsey.

Work Plan: A Process for Collaborative Research

Given the distributed nature of this collaborative project, and its time constraints, the project will unfold through the following plan of activities:

1. OII-McKinsey Project Meeting
2. Ongoing Communication: Periodic Visits and Teleconferences
3. Drafting of Working Paper(s)
4. Workshop to Critically Discuss the Draft Working Papers
5. Final Report
6. Public Forum

Initial Project Meeting

As soon as the project is agreed, we propose to organize a joint OII-McKinsey workshop at the earliest possible date. This will inform OII investigators about work completed by McKinsey, and vice versa -- sharing insights that have been developed to-date; provide an opportunity to review the initial selection of case studies of distributed co-creation to assess which case studies are the most promising for more in-depth investigation both with respect to the analysis and quantification of performance outcomes, as well as the variables shaping these outcomes; discuss initial thoughts on potential frameworks and approaches to analyze and quantify performance outcomes (including productivity metrics) from distributed co-creation and the optimal set of associated motivations or incentives for distributed networks; and develop a research approach that will ensure that we arrive at distinctive and compelling perspectives on performance outcomes over the next six months and agree upon realistic end products that could be generated within this limited time frame. This discussion will help each team understand the range of expertise and skills covered by the combined team and ensure that the research questions and approach are well considered and not duplicative of others' work. A more detailed work plan will be developed at the conclusion of this meeting.

Ongoing Communication

Collaboration during this period will be supported by periodic videoconferences and regular e-mail communication between the OII and McKinsey, as well as short visits to Oxford by McKinsey principals. A project Website will enable broad exposure of the project to a wide global audience.

Drafting of Working Paper(s)

The OII will prepare a working paper on the performance of distributed problem-solving networks. This could be packaged as several papers, if it proves useful to treat each case separately, or as a single combined paper, with sections dealing with each case and an overall synthesis. The most useful delineation and form of project working papers will be one focus of discussion during the early phases of the project.

Workshop

A workshop will bring OII and McKinsey principals together in Oxford to critically discuss and improve draft working papers, plan the public forum, and discuss new directions for any further collaboration. It will be critical to the momentum of any follow on research that we continue to discuss the elements of a longer-term collaboration since this might involve the recruitment and appointment of a dedicated research fellow, and faculty from elsewhere in the University; and discussions with Colleges about the creation of associated memberships for the McKinsey Visiting Associates.

Report

The OII will revise the working paper(s) for a final project report for widespread dissemination, initially as one or more OII Research Reports, but subsequently in a variety of forms, from press releases to published articles. In addition to benefiting from the workshop, the OII will send working drafts to experts within the field for outside review and comments. (Many of these reviewers will be invited to the public forum.)

Public Forum

The report will provide one centerpiece for a public forum to be held in London or Oxford to discuss the study findings with a wide range of invited experts from academia, business and industry and government. The OII will use all of its facilities in collaboration with McKinsey to bring the world's leading experts together and to ensure that the study findings and the forum discussion and related reports and Webcasts are used effectively to inform discussion and stimulate debate among as wide an audience as possible. The OII has had considerable experience with the use of publications and forums as vehicles for informing the public and stimulating debate. McKinsey sponsorship of public events would, of course, be appropriately acknowledged.

The forum will also be a useful device for enabling the OII to engage directly with business leaders, and for McKinsey to get access to the best academic thinking in the area. It would also help to assess the state of related research projects, identify gaps, and elaborate a revised agenda for further research.

The Budget for the Scoping Study

The budget for this six-month study is attached as Appendix 3.

Conclusion

Our agreement on the general theme of the future of work in a network society and an initial project on the performance of distributed problem-solving networks will enable us to make a strong start on an important research question. The success of the initial study and forum could lead to a broader program of research, which is likely to require an expanded effort among a broader set of academic researchers.[10]

[10] For example, a longer-term program of research in this area would benefit greatly from a full-time, dedicated economist with the qualifications to assume a central role in the research. This appointment could be advertised as a named position, such as the 'McKinsey Research Fellow in the Economics of Internet Organizations'. Topics to be pursued by this Fellow could include aspects like the applied microeconomics of Internet enabled network for the production and distribution of information goods and services, including the evolving organization of distributed modes of work and skill formation. The occupant of this post would be recruited by the OII in collaboration with one of the Oxford Colleges, possibly as a joint fellowship appointment.

Appendix 1. Convergence between McKinsey and OII Research

The proposed research will be anchored in the University of Oxford, within the OII, from where researchers will be able to mobilize the expertise of researchers throughout the University and beyond. For example, the OII will draw on faculty partners from the Social Sciences Division (of which it is a member), particularly the Departments of Economics and Sociology, as well as the Saïd School of Business and the School of Geography (See Appendix 2). This forms the basis of harnessing the strengths of the OII, the University of Oxford and McKinsey's specialists to build an innovative, focused program of research on the chosen theme.

The program's focal area builds on and resonates strongly with research already underway in the several domains of disciplinary expertise within the OII and intersects with McKinsey research on the changing content and organization of work. This opens opportunities to focus and extend the OII's existing lines of research in directions that would afford mutual benefits by engaging with themes of central importance to work within the McKinsey Global Institute on the necessarily multi-faceted character of organizational initiatives that successfully utilize advances in digital networking. It is in such ways that the proposed integrative program can bring the trajectory of OII research to bear directly on themes of much relevance to McKinsey's work.

The OII has several strengths as a research organization of central relevance to the interests of McKinsey in topics around the Internet and work in a network society, both generally and in the more focused domain of the changing organizational contexts of creative distributed problem-solving and decentralized co-creation work in an increasingly information-intensive and networked society:

1. The OII is the leading centre for multidisciplinary research on the social shaping and societal implications of the Internet. The workplace is central to potential social transformations enabled by the Internet. Key members of our team have a strong track record over decades of research on the social dynamics of computers and telecommunications. This cannot be matched even by most leading disciplinary theorists, many of whom only recently discovered the Internet. The OII's commitment to multidisciplinary research means that we understand how to draw individuals from complementary disciplinary perspectives to address key problems, such as distributed work in e-science research. This is important given that no single discipline is well placed to explore the range of distinct but interrelated issues surrounding the Internet and the future of work, particularly in activities involving information and knowledge work.

2. The OII and Oxford are global in their focus and reach. Many US centres have a North American focus. In contrast, the OII addresses issues on a more global stage as a key strategic goal, while at the same time conducting strong empirical work in the UK. McKinsey's interests in exploring trends across European and Asian business and industry

would fit well with this global mission.

3. The OII has a wide ranging and strong research base. This includes a number of OII faculty and staff with a direct interest in the role of the Internet in the future of information and knowledge work within a variety organizations and sectors (see Appendix 2A below). In addition, there are key individuals and centres in Colleges across the University of Oxford we would wish to bring into the management and conduct of a collaborative research programme (see Appendix 2B below).

Appendix 2: Expertise within the OII and Oxford University relevant to a Programme on Information Work in a Network Society

A. Core Research Team: OII Faculty, Associates and Doctoral Students

- Robert Ackland is an economist at the Australian National University and a James Martin Visiting Fellow at the OII and the e-Horizons Institute, where he is associated with the Oxford e-Social Science Project. He has an expertise in index number theory and webmetrics. See: http://www.oii.ox.ac.uk/people/visitors.cfm?id=108

- Andrew Currah is an economist in the School of Geography, and a Research Associate with the OII. He is focusing on the economics of collaborative production and content distribution, anchored in studies of the Hollywood film industry. See: http://www.oii.ox.ac.uk/people/researchassociates.cfm?id=100

- Paul David is Senior Research Fellow at the OII and Emeritus Fellow of All Souls College, Oxford, and Professor of Economics (emeritus) at Stanford University. He has been engaged in studying the economic organization of open source software production, as a continuation of his work on resource allocation mechanisms in open science research communities. He has also done seminal work on IT diffusion and its implications for productivity growth. At the OII he has been pursuing quantitative studies of these matters with reference to the recent experiences of European government and health sector organizations. See: http://www.oii.ox.ac.uk/people/faculty.cfm?id=20

- Bill Dutton is Professor of Internet Studies and Director of the OII at the University of Oxford, where he is a Fellow at Balliol College. He was a co-principal investigator on a pioneering empirical assessment of the impact of computers in American local governments, supported by the NSF in the late-1970s, which developed a series of empirical indicators. His research has focused on the societal implications of the Internet and related ICTs, but extending to the workplace, such as with his work on virtual organizations, which has been widely acknowledged. See: http://www.oii.ox.ac.uk/people/faculty.cfm?id=1

- Karen Croxson is an applied game theorist based in the Department of Economics at Oxford. She is also an Economics Lecturer at Balliol. Her research interests include analysis of teamwork, leadership, and the workings of Internet markets. See: http://www.economics.ox.ac.uk/Faculty/EconDetails.asp?DetailNo=233

- Max Loubser, a Rhodes Scholar, is a computer scientist pursuing his doctoral degree at the OII in Information, Communication and the Social Sciences. His dissertation is focusing on the peer-production of software. See: http://www.oii.org.uk/people/students.cfm?id=105

- Wolf Richter is an doctoral student pursuing a DPhil in Information,

Communication and the Social Sciences. His doctoral studies are focused on IPR and its implications for new media production and distribution networks (see: http://people.oii.ox.ac.uk/richter/about/).

- Ralph Schroeder is a James Martin Research Fellow at the OII and a social scientist with a long-standing interest in virtual environments for distributed collaboration. His current work focuses on the organizational aspects of Grid-enabled e-Science research. (See: http://www.oii.ox.ac.uk/people/faculty.cfm?id=26).

B. Collaborative Partners from other Oxford Organizations

There is enormous strength across Oxford University to draw from in building on the themes of our proposed programme. Individuals we would invite to participate in this multidisciplinary programme include:

- Gavin Cameron, Reader in the Economics Department is engaged in quantitative empirical studies of economic growth, competitiveness, innovation and productivity, including applied econometric modelling of topics in industrial organization and labour economics.

- Professor Jay Gershuny, who recently joined the Department of Sociology, is a leading researcher on longitudinal time-use studies.

- Andrew Graham, an economist and Master of Balliol College, Chair of the OII's International Advisory Board, member of the OII Management Committee and key to the founding of the Oxford Internet Institute. He has strong research interests in the economics of the Internet and ties to individuals within industry, government and academia.

- Ken Mayhew, a Reader in Economics, directs the ESRC Research Centre on Skills, Knowledge and Organizational Performance (SKOPE) in Oxford. SKOPE's research focus complements the traditional emphasis of labour economics on the supply of skills, by focusing on the analysis of factors affecting the demand for skills and examining the conditions necessary for firms to maximize the benefit from higher levels of skill (e.g. through particular forms of work organization or investment in R & D) as these are affected by technological change.

- Helen Margetts, OII Professor of Society and the Internet, focuses on the role of the Internet and Web in government operations, including studies of Government on the Web in the UK for the National Audit Office, as well as leading cross-national comparative research in this area.

- Felix Reed-Tsochas, Co-director of the Centre for Complex Agent-based Dynamic Networks (CABDyN) at the Saïd Business School, and a Research Associate with the James Martin Institute. CABDyN brings together Oxford researchers from multiple disciplinary domains to develop tools and methods that will enable the identification and

transfer of desirable properties from networks that have emerged and evolved in competitive environments (e.g. in biological and socio-economic systems) to designed networks, such as computer networks, supply chains or distributed organizations. CABDyN's industrial collaborators and partners are participating in this search for solutions to complex network problems in the real world.

- Jonathan Zittrain, OII Professor of the Internet Governance and Regulation, has a legal background (e.g. in copyright and IPR issues) and has directed some of the most innovative global studies of the Internet, such as his work on national filtering of content and the development of distributed approaches to fighting malware.