

# Building Cyber-Infrastructure across Disciplinary and Institutional Boundaries: Stakeholder Emergence and Alignment

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## ABSTRACT

We discuss research-in-progress that conceptualizes cyberinfrastructure (CI) as boundary objects, and focus on the translation work of actors who span organizational and disciplinary boundaries. Those engaged in translation work are able to communicate the value of the CI and align the CI's diverse constituencies to a common vision of the system. Understanding what motivates individuals to engage in translation activities can help inform the design of CIs with respect to the emergent nature of their stakeholder constituencies.

## Author Keywords

## ACM Classification Keywords

## INTRODUCTION

### CI Systems as Boundary Objects

Boundary objects are objects that are “both plastic enough to adapt to local needs and the constraints of the several

parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use” ([17], [4], [3]). The concept of boundary objects can be a useful tool to think with regarding the design of CI systems: CI systems need to balance local customization and other user needs with global system reliability, interoperability with heterogeneous components (eg, middleware and software). To derive design suggestions for CIs, we can think of CI systems as a boundary objects. CI systems can be conceptualized as boundary objects in that:

- They serve or “inhabit” multiple interpretive worlds (e.g., [6]) such as the disciplinary worlds of the engineering communities, those of the IT specialists, those of the industry experts and sponsoring agencies.
- In their design to support multiple domains, CI systems evoke and surface the underlying cultural/interpretive differences among their subcommunities ([3]), and as such pose potentially divisive challenges to the institutional requirements of each subcommunity. That is, CI system design occurs at the intersection of not

only different interpretive worlds/cultures but also of institutional /organizational arrangements and policies that make the CI's design problematic.

- Their design is loosely defined or weakly “structured” to preserve consistency of global specifications while allowing flexible local instantiations.
- Their design is strongly “structured” in their local customization and use; that is, CIs, like boundary objects, can have a well-defined structure at the global level but a less specified structure at the local level that permits customization without compromising global specifications (e.g., regarding security, reliability, and interoperability).

Conceptualizing CIs as boundary objects foregrounds the social dynamics surrounding the CI's development and use without losing sight of their technical nature. In contrast to stand-alone information systems, CIs include multiple, complementary and integrated resources (equipment, data, software). Integration and complementarity create tight coupling (socio-technical dependencies) among the CI users and the IS resources. Users rely on a limited set of interconnected resources (technical coupling) and on each others' willingness to share data, reports and other research-related contributions (social coupling). The tightly coupled CI resources might create technical, but not necessarily social, incentives and structures for cooperation among the various user groups; in fact, the tight coupling of users-resources might create occasions that surface the their underlying differences in goals and values, and might thus impede the collaboration that they were designed to support.

### Stakeholder Alignment

The coordination of the development of large CI projects involves complex decisions and tasks that require the input of individuals with different backgrounds (or knowledge domains, such as engineering, information technology, systems design, usability) that represent distinct “thought worlds” ([6]).

In a prior study ([16]), we examined the composition and centrality of the various subgroups involved in the development of a CI, and traced the evolution of their network (changes in its composition and structure) adopting the perspective of faultlines. Faultlines are a metaphor for potentially divisive characteristics (such as expertise diversity in a group) that can cause conflict ([9]). We found a strong presence of faultlines in the early networks; however, over time as the network of actors became more inclusive.

What might account for that effect? Divisions among subgroups might have dissipated as a result of changes in the project's leadership, changes in the incentives originating from the funding agency that might have increased the responsibilities and rewards for different

institutions, or changes in behavior of individual actors (eg., individuals' taking greater initiative to communicate the value of the CI to diverse subgroups/sub-communities. To further pursue that question, we focus on key actors (individuals that were central in the network analysis) and examine the ways in which they communicated the value of the CI system to various constituencies (sub-communities of which they were not a member, the funding agency, other key decision-makers).

Building on studies on boundary-spanning behavior, we bring the “translation work” of those actors to the foreground, and attempt to describe it against the background of other interventions that also aimed to bring the various NEES sub-communities together (e.g., interventions by the funding agency and the board of directors that aimed to promote project coordination and accountability).

To that end, we pose the following research questions:

What leads individuals that have a stake in the development of a CI to assume greater initiative and engage in translation work? How are the faultlines or divisions among the sub-communities bridged or mitigated by individuals' actions?

That question involves examining how individuals perceive their role and relation to the various sub-communities associated with NEES, how they identify with their profession vs. their employing organizations (which often raises institutional barriers to collaboration), how that shapes their professional identity, and how those different modes of identification affect their involvement in the cyberinfrastructure project.

Below we provide more background on this line of research.

Recent reports on various CI projects have noted the challenge and need for alignment of the divergent goals, values and cultures of CI stakeholders, (e.g., [1]). Stakeholders need to be aligned in ways that promote both effective development and long-term adoption and use of the CI resources in ways that lead to transformational outcomes (e.g., augment or transform current research practices). How such alignment among stakeholders is to be achieved is unclear. Funding and sponsoring organizations (e.g., NSF) play a role by promoting workshops and other activities that bring together key actors, and by working closely with CI project leaders throughout the development and maintenance of the CI system. Nevertheless, effective alignment of the various sub-communities, among key players and among end-users that do not necessarily have influence over the development process, depends on individuals' actions, the ways in which they perceive and enact their roles and/or professional identities with respect to the CI. For example, the decisions individuals make about exploring and forming new research/work practices with the use of CI resources, and the extent to which they leverage not only the technical but also the social resources

afforded by the CI, such as opportunities to collaborate with other researchers and institutions beyond sharing data.

Research on technology adoption (e.g., [19]), innovation (e.g., [7]), user participation (e.g., [2]), and information systems development (e.g., [18]) has tended to conceptualize users as a given, predictable group of entities, operating within the physical or cultural boundaries of an organization or a community with a common value system (e.g., open-source community). CI systems differ in that their users and stakeholders are not always specified or known ahead of time. Even though CIs are funded and designed with the explicit goal of promoting research practices such as interdisciplinary collaboration, their users and stakeholders often extend beyond the immediate group of researchers and might include industry specialists, IT developers and subcontractors, equipment sites and their staff that host parts of the CI system, students and other prospective researchers, and oftentimes the general public that stands to benefit (or be adversely affected) from the outcomes of the CI researchers. Even when CI sponsoring agencies and designers plan and design the CI system with the diversity of those constituencies in mind, it is not always the case that those individuals and institutions readily assume the role and responsibility of a stakeholder (or a constituency in the case of research groups, departments and institutions).

We take the position that stakeholders and/or users of a CI system are not given, static entities that are necessarily invested in the success of the CI system, but, rather, are 'developed' through the ways they perceive their professional role and identity in the context of the communities, and through processes of actual participation in the development of the system, such as contributing to decision-making (e.g. task forces formed around the CI development, policy-making groups, governing boards and technical specialist groups).

### **Translation Work and Professional Identity**

We focus on the translational activities of CI actors which we define as actions they undertake to frame and communicate the value of the CI system to audiences of the various subgroups and sub-communities that are involved in the cyberinfrastructure project. The term 'translation' points to the fact that the value of any CI system is not necessarily obvious to its intended users; different individuals and groups might have disparate understanding and visions of what the CI system should be like or what it should do; those disparate understandings are a function of disciplinary, institutional and professional identities that individuals and the participating institutions hold, and that individuals can help create a synergistic (but not necessarily single) vision of the system through framing or reframing and translating its value, usefulness and the value of interdisciplinary research it can promote in ways that are

persuasive to those having different disciplinary backgrounds and work cultures.

The role that professional identity plays into individuals' participation in any large-scale collective endeavors has been noted in CI-related studies and outside the CI literature, in the communities-of-practice research stream. CI studies, such as Ribes and Finholt ([15]) note that "It is the identity of those groups, and what kinds of resources to provide, that are *at stake* in defining [a] community". The communities of practice literature highlights the mutual shaping of professional identity and a given community of practice through processes of learning and legitimate peripheral participation ([20]). Social movement studies note that collective action occurs through the mobilization of the identity (or multiple identities) which the actors/participants of the movement share or are presumed to share (e.g., [5], [13]).

Moreover, studies on boundary-spanning behavior have noted that boundary-spanners tend to engage in 'translation' activities ([4]) that involve "relating practices in one field to practices in another by negotiating the meaning and terms of the relationship ([11]). Levina and Vaast ([11]) draw a distinction between nominal boundary-spanners (individuals who span organizational or community boundaries by virtue of their formal role, such as project managers, CEOs, those occupying higher places in the organizational hierarchy, etc) and boundary-spanners-in-practice (individuals who engage in boundary-spanning practices without being forced or mandated to do so by their formal roles and responsibilities). They also point out that whereas studies on boundary-spanners have focused on their characteristics and their impact on project groups and organizations (e.g. innovation), what motivates individuals to engage in boundary spanning practices is less well understood.

While those studies focus on the overall role of boundary-spanners in helping to create organizational value such as innovative products, in our research we slightly shift the focus towards individuals and ask what contributes to their initiative to engage in translation activities across sub-communities of research and practice of which they are not necessarily a member. While not everybody who is designated as a boundary-spanner may engage in translation activities, those will likely be effective boundary-spanners. We draw attention to the translation work of boundary-spanners rather than on the designated role itself as a way of maintaining a tighter focus on the activities and initiatives of stakeholders that helped create common ground among the various sub-communities. We propose that translation work (and by extension, boundary-spanning) are shaped by the way individuals perceive and enact their professional identities. Drawing on studies of professional identity and organizational identification ([14]) we consider professional identity as the set of enacted beliefs that individuals hold about their being part of a field of inquiry or a professional field. Those with a strong sense of professional identity tend to personalize the successes and failures of their field and

define themselves in terms of their membership in that field ([12]). Strong identification with one's disciplinary field (and/or institution) can motivate individuals to take greater initiative and risks towards promoting the development of the CI system since they and their discipline would stand to benefit from implementing the system and ensuring that others also see the value of the system. However, strong identification with a field and/or an organization can have the opposite effect and exacerbate the divisions among the various CI constituencies if individuals are not engaged in translation work, that is, are not creating common ground but enhance the divisions between themselves/their organizations and those holding different professional and organizational identities and perspectives. Taking these perspectives together, we propose that individuals' involvement in the development of a CI is shaped and mobilized by the way they perceive and enact their professional identity, for instance, by the boundaries (narrower or wider) they choose to draw, figuratively, around their professional identity.

### Research Site

NEES is the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES), a project created by the National Science Foundation (NSF) to better understand earthquakes, their causes and effects. The goal of NEES is "to promote collaborative research, shared understanding, and shared equipment (including engineering equipment sites, computational resources, and digital libraries) among the earthquake engineering community". The NEES project involved the creation of NEESgrid, a large-scale network designed to connect researchers and experimental equipment sites comprised of advanced earthquake testing capabilities. The NEESgrid project involved multiple stakeholder (or constituencies) with different user needs and work cultures. The immediate user groups and governing committees associated with NEES (including NEESgrid) are comprised of academics and professionals with different expertise backgrounds and different institutional affiliations (academia, private sector, and NSF). This study is based on interview- and archival data.

### REFERENCES

- Atkins, D. (2007). "Social Networks, CI, and Meta-CI". Presentation available at: <http://www.ncsa.uiuc.edu/Conferences/SNAC/presentations/Atkins-CIandSocialNetworks.pdf>
- Barki, H. and J. Hartwick. "User Participation, Conflict, and Conflict Resolution: The Mediating Roles of Influence," *Information Systems Research* (5:4), December 1994, pp. 422-438
- Bechky, B. A. (2003). Sharing Meaning across Occupational Communities: the Transformation of Understanding on a Production Floor. *Organization Science*, 14(3), 312-330
- Carlile, P. R. "A Pragmatic View of Knowledge and Boundaries: Boundary Objects in New Product Development," *Organization Science* (13:4), July-August, 2002, pp. 442-455.
- Cook, E. , 2004-08-14 "The Dual Stage of Social Movements: Internal Collective Identity and External Strategy Structure" *Paper presented at the annual meeting of the American Sociological Association San Francisco, CA*
- Dougherty, D. Interpretive barriers to successful product innovation in large firms. *Organization Science*, 1992, 3(2): 179-202.
- Fichman, R.G, (2000) "The Diffusion and Assimilation of Information Technology Innovations" in *Framing the Domains of IT Management: Projecting the Future Through the Past*. In Robert Zmud (editor), Pinnaflex Publishing.
- Finholt, T., Birnholtz, J. (2006). If we build it, will they come? The cultural challenges of cyberinfrastructure. In Bainbridge, W. & Roco, M. (eds) *Managing nano-bio-info-cogno innovations*. Berlin: Springer.
- Lau, D. C. and J. K. Murnighan. "Demographic Diversity and Faultlines: The Compositional Dynamics of Organizational Groups," *Academy of Management Review* (23:2), 1998, pp. 325-340.
- Lee, Charlotte P., Paul Dourish, Gloria Mark. 2006. The Human Infrastructure of Cyberinfrastructure. Computer Supported Cooperative Work Conference (CSCW), Banff, Canada.
- Levina, N., Vaast, E. (2005). Understanding Boundary-Spanning in Knowledge Work: Implications for IT Use.
- Mael, F., & Ashforth, B. E. (1992). Alumni and their alma mater: a partial test of the reformulated model of organizational identification. *Journal of Organizational Behavior*, 13, 103-123.
- Polletta, F., Jasper M. (2001). Collective Identity and Social Movements. *Annual Review of Sociology*, 27, 283, 305.
- Pratt, M. G., K. W. Rockmann, J. B. Kaufmann. (2006). Constructing professional identity: The role of work and identity learning cycles in the customization of identity among medical residents. *Acad. Management J.* 49 235-262.
- Ribes, D., Finholt, T. (2008). Representing community: Knowing users in the face of changing constituencies. Computer Supported Cooperative Work Conference (CSCW) 2008.
- Slaughter, S., Kirsch, L.J., Ma, L., Diamant, E.I., Haney, M. (2007). The Formation and Evolution of Faultlines in Large Scale, Multi-Party Information Systems Development," *International Conference on Information Systems*, 9, December 2007.

17. Star, S., & Griesemer, J. (1989). Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science* (Sage), 19(3), 387-420.
18. Stewart, K. J. and S. Gosain. "The Impact of Ideology on Effectiveness in Open Source Software Development Teams," *MIS Quarterly* (30:2), June 2006, pp. 291-314.
19. Venkatesh, V., Morris, M.G., Davis, G.B., and Davis, F.D. "User acceptance of information technology: toward a unified view," *MIS Quarterly* (27:3), 2003, pp. 425--478.
20. Wenger, E. (1998), *Communities of Practice: Learning, Meaning, and Identity*, Cambridge: Cambridge University Press