Meta Organizational Influences on Scientific IT Infrastructure Development

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ABSTRACT
By taking an organizational communication approach to examine the meta influences on scientific IT infrastructure development, a preliminary analysis reveals that existing practices in a field with the Internet and computer technologies, the agenda of the funding agency, and the competing theories and methodologies held by participating scientists and groups are three such meta organizational influences. Instead of presenting key findings in the form of statements, the student author instead raises meta questions to be asked as we develop and design large-scale scientific IT infrastructure in the early 21st century.

Categories and Subject Descriptors
J.4 [**Social and Behavioral Sciences**]: *Sociology*

General Terms
Management

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Cyberinfrastructure, IT infrastructure development, IT design, organizational communication, and meta influences

1. INTRODUCTION
Cyberinfrastructure (CI) refers to scientific IT infrastructure based on a collection of information, communication, computer technologies [1]. According to Stewart, "Cyberinfrastructure consists of computing systems, data storage systems, advanced instruments and data repositories, visualization environments, and people, all linked together by software and high performance networks to improve research productivity and enable breakthroughs not otherwise possible" [10]. In the influential *Atkins Report*, Atkins and colleagues [1] further state that CI is "an effective and efficient platform for the empowerment of specific communities of researchers to innovate and eventually revolutionize what they do, how they do it, and who participates". Therefore, cyberinfrastructure represents a collection of machines and humans, as well as the social interactions and organizational practices surrounding the meshing of the two. CI development is inherently social and organizational. A conversation about IT infrastructure can include an examination of the meta organizational influences related to CI development.

2. LITERATURE REVIEW
One approach to examine the meta organizational influences around CI development is to employ the lens of organizational communication. An organizational communication approach treats communication as a way to explain the production of "social structures, psychological states, member categories, knowledge and so forth rather than … simply one phenomenon among these others in organizations" [3]. An organizational communication approach emphasizes the process of organizing through symbolic interaction [4]. In this paper, I attempt to identify a few sources of organizational influences on CI development by taking an organizational communication approach. In so doing, I highlight three organizational issues that communicate influences to CI development. This poster is based on three representative excerpts drawn from a data set of 65 interviews with domain scientists, computational technologists, supercomputer center administrators, social scientist and policy experts across 17 US states. I present the preliminary findings in terms of questions to be asked as we develop scientific IT infrastructure. I will present these questions in the following paragraphs.

3. FINDINGS
3.1 Existing Practices
The first question asks, "*What is a field's existing practices with the Internet and computer technologies?*" The Internet, computers, and a wide range of emerging information technologies shape today's organizational life [5, 7, 8]. Every scientific field has an existing set of practices with the Internet and computer technologies at work. This set of practices will affect how scientists in a field approach CI, and how CI development will impact their work. The more integrated the Internet and computer technologies are within the field, the more receptive the scientists will be to using CI. As an interview participant shares,

> [L]et's take bioinformatics [as an example]… The use of the Internet to do the science is dominant… [B]ioinformatics was born 10 years ago. So it grew up as the Internet was growing up. So biology almost started doing cyberinfrastructure without thinking… That field is richly cyber-enabled…. Science is evolutionary... If the previous step was on the Internet, the next step probably has to be on the Internet, by definition. So you're not able to not do cyberinfrastructure." (Professor of Informatics, Indiana).

As we examine scientific IT infrastructure development, we need to distinguish the different disciplines of science, and take into consideration a field's existing set of practices with the Internet and computer technologies. Scientific practices within a field are shaped by its history, and these practices can only change by slowly evolving over a long period of time. The design of CI should closely match existing practices, if CI is to be adopted to support a particular branch of science. Compatibility [6] with existing practices is key.

Furthermore, an effective design for one field may not be equally useful for another. Different fields developed their unique ways of doing science, and these organizational practices rooted in past successes are difficult to change. The CI development has to acknowledge the complexity and diversity in a wide range of disciplines and fields in science. If we need to build more CI to support different branches of science, funding is a key organizational issue to consider next

3.2 Funder's Agenda

The second question to consider asks, "*Who is funding the CI project, and which agenda is the project advancing?"* Although science is often assumed to be a neutral endeavor simply to improve human conditions in the society, the meta organizational influence associated with funding agencies behind the scene is not neutral nor value free. Funding agencies only fund projects that promote and advance their missions and agendas. If an agency is to fund a particular project, the money is given only to conduct science relevant to the agenda of the funding agency, and not the agenda of another. Below is what a policy expert reveals,

> "In some cases, in larger institutions, the problems are really magnified by the fact that faculty receives grants from NIH and other places, which did not encourage collaboration and joint usage of technology, but rather, waived them off and said – If you go out and get a Sun workstation on your desk, put a couple of Condors together, and then when the funding runs out, you're left with this big bill to run these machines… if it's [the funding is] going to be used for anything other than the research you did initially." (Policy Expert, Washington DC)

Funding is perhaps the most powerful driving force behind large-scale science in the US. A scientific IT infrastructure project is very expensive, and without funding from agencies such as NSF and NIH, no CI can be built. These funding agencies allocate resources to CI projects on a limited term basis. Once the allocated funding is used up, and if the project cannot secure continuing support, the operation comes to an end, including CI development for the project. In addition, the agenda of the funding agency influences CI development to prioritize activities in scientific research. What does not serve the agenda does not get built into the design.

Furthermore, funding is not neutral. By receiving funding from a particular agency, acceptance of the agency's agenda is implied. Therefore, while discussing scientific IT infrastructure development, it is important to keep in mind the political priorities communicated through funding to a particular project. If a CI project is to continue, the project has to continue advancing the agenda. CI development is not only closely aligned with the funding agency's agenda, it is also closely tied to the theoretical and methodological competitions within a field. This observation turns us to the third question.

3.3 Competing Theories or Methods

The third question asks, "*For which theory or method is the CI built?*" There are competing theories and methodologies within any disciplines and fields in science. A vibrant scientific community engages in a healthy debate about the different ideologies and approaches to doing science. However, when it comes to scientific IT infrastructure design and development, we inevitably encounter the competition among these different groups of scientists who hold different philosophies of science. As the last informant in this position paper points out,

> "We've been in disputes with people essentially having two different – not quite theories, but two methodologies to approach a problem. They would come to the cyberinfrastructure folks and say – We're glad to be on the project and of course you're going to include my methodology in the way the software works and exclude my competitor over there." (Supercomputer Center Administrator, Illinois)

The decisions made before and during the process in which CI is being developed to support science involve persuasions, arguments, or even conflicts between groups. The theory or methodology selected to guide CI design determines which theoretical and methodological camp gains ground in advancing its approach to science. Scientists compete to influence CI development in favor of their own orientation, and persuade computational technologists to write codes and build applications that will support their method. This is a process to indirectly weed out competing theories and methodologies in the field. CI design and development become a contested terrain among competing groups of scientists.

4. CONCLUSIONS

In this paper, I attempted to employ an organizational communication approach to highlight three sources of meta organizational influence that could affect scientific IT infrastructure design and development. Through preliminary analysis of selected excerpts from a larger interview data set, I presented three questions to consider while designing and developing CI: "*What is a field's existing practices with the Internet and computer technologies?*"; "*Who is funding the CI project, and which agenda is the project advancing?";* and "*For which theory or method is the CI built?*" These questions reveal that the existing practices of a field, funder's agenda, and

theoretical/methodological commitment of scientists can influence decisions that go behind CI design and development. In other words, the development of an infrastructure for organizing information, knowledge, and people cannot be free of influence by the cultural norms of a community, the agenda of the agencies funding the projects, and the sometimes incompatible ontologies/taxanomies within a knowledge domain.

This paper extends Star and Bowker's argument of infrastructure as an "installed base" [9] to consider a recursive relationship between organizational forces and infrastructure design. Star and Bowker contend a new technology "wrestles with the inertia of the installed base and inherits strengths and limitations from the base". This paper highlights the meta organizational influences that get built into the 'installed base' for future science and IT infrastructure development.

Moreover, this paper shows that scientific IT infrastructure design is political and complex. Bijker calls scholars to pursue "political questions" [2]. By employing an organizational communication lens and presenting the findings in a form of questions, this poster reveals the political-cultural relevance of meta organizational influences in IT infrastructure development.

A few implications can be drawn from the analysis. First, given the limited resources to build CI, the design is best to be flexible in order to adapt to a wide range of scientific fields. When there are discipline specific requirements, parts of CI can be built as extensions to cater to these needs. Second, CI projects may benefit from staying with one primary funding agency, or closely allying agencies, as trying to satisfy different agendas simultaneously or subsequently is difficult, especially when (re)building CI can be extremely costly. Third, CI design may best be neutral by creating a platform through which competing theories and methodologies can be tested on equal ground.

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