



# Understanding the Human Factor as a Dimension of Cyberinfrastructure

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## Introduction

For over a decade, the National Science Foundation has been funding the development of cyberinfrastructure (CI) to accelerate and promote breakthrough research. CI represents a new generation of innovation that is multidimensional, involving material objects, behavioral practices, and philosophical ideologies. The material objects of CI consist of networks, hardware, software, and big data. In addition, the behavioral practices are composed of project-specific computational tool production and collaboration of dispersed multidisciplinary experts. Another dimension of CI are the philosophical ideologies. These are represented through developing computational tools as fundamental to science and open-source data sharing. Limited research has been conducted to describe other possible dimensions of CI, such as the human factor.

## Literature Review

The human infrastructure of CI brings to light the importance and role of humans within the e-science community. The human infrastructure is defined as the alignment of organizations and individuals who work together to successfully execute work (Lee et al., 2006). Additionally, the infrastructure is continually changed as the human infrastructure plays out through negotiations and interactions. Specifically, this investigation focuses on the components of CI in relation to the human factor.

In a study conducted by Ribes and Finholt (2009), they formed a tension of infrastructure, *aligning end goals* across three scales: institutionalizing, organizing work, and enacting technology. Multiple end goals of scientists exist due to varying interests and competition. Furthermore, the sustainability of CI is also influenced by funding infrastructure. These are the communication arrangements, salient motivations, and financial of institutions, individuals, and ideologies compensations which is needed for a dynamic stability of CI (Kee & Browning, 2010). Tensions within CI and funding infrastructure are driven by the human factor.

Past research has demonstrated the tensions of CI. However, there is limited research on *how* the human factor is a necessary key to resolving tensions such as misalignment of mission and developing CI for the future (Kee & Browning, 2010). This current study seeks to understand the human factor influence on the sustainability of CI. We ask the question: How does the human factor enable the successful function of CI?

## Methodology

- This study employed the Grounded Theory Approach (Corbin & Strauss, 1990) and analyzed 60 interviews conducted with members in the e-science community, such as directors, domain scientists, and principal investigators. Participants were from a diverse range of institutions across the United States. Following a semi-structured protocol, interviews were conducted by telephone. The co-authors performed multiple iterations of data analysis and literature integration, yielding preliminary findings presented in this poster.

## Findings

### Training and Support

Users must have the knowledge and expertise to utilize and carry out their research using CI. After obtaining the skills needed for CI use, they have the ability to train other users. This allows for the opportunity to generate interest among potential users.

- “Having a good staff – a staff that can help people and has a lot of knowledge that they can use to facilitate the whole thing from beginning, where people are showing up with their data, through ‘how do you log in?’, ‘how do you change your password?’, ‘how do you use a particular kind of system?’ – all of that requires staff who can train users and help them kind of navigate the whole thing” (Technologist, AZ, 5/11/2016)
- “Without the people, our staff facilitating other people to use the infrastructure, it’s not as powerful. So we help onboard people – we train people on how to use the next level of interface for the cyberinfrastructure. There’s lots of entry points and we try to fit the best entry point to the user’s ability” (Administrator/Facilitator, AZ, 5/5/2016)

### Community of Practice

Within the e-science community, there are two components that drive community relations: staying current and common goals. The ability to stay up to date on other organizations’ research projects and technologies allows the community to advance CI. Additionally, within an organization there must be a cohesive understanding of the organization’s mission.

- “So in Oklahoma, we have what’s called the OneOCIL group and it’s a one net Oklahoma cyberinfrastructure group and we literally have teleconference calls every week and discuss what’s going on with all of our high-performance computing and cyberinfrastructure stuff... That’s kind of the one good thing about all of us in Oklahoma is we’re all kept apprised of who is doing what and possible funding sources and opportunities and conferences and workshops” (Co-Producing User, OK, 5/17/2016)
- “The biggest challenges in cyberinfrastructure in the last 15 years have not been technological, but it’s people, customs, organization and getting a structure on which everybody can agree. Once you have that, then you can start agreeing on standards, protocols. And then all the pieces that you’re building have a framework in which they fit together and complement an infrastructure” (Co-Producing User/Administrator, AZ, 5/10/2016)

### Advocates and Champions

An e-science project cannot exist without the necessary funding and resources. To obtain these financial resources, liaisons advocate for researchers to administrators and important stakeholders to understand the importance of a research project.

- “I try to predict what researchers will need tomorrow or try to get input from them, and then I’m basically the cyber infrastructure advocate for the people with money, and so I go to then the people with money and say, ‘I have all these wonderful researchers that need this resource,’ and then something that, you know, well, lately it’s worked pretty well. They believe me and give me some money so I can make that happen.” (Administrator/Facilitator, OK, 5/25/2016)
- “There’s administrators and campus, you know, we have an advisory committee and so there’s various folks involved also at making sure that things actually match with the mission of the institution and not simply take off some boxes of capabilities, but these capabilities have to result in things that enhance the mission of the university.” (Administrator/Scientist-Developer, NE, 5/6/2016)

## Conclusion

A participant of the study perfectly captures the importance of human’s involvement in CI by saying, “I think that an essential component of making anything work in cyberinfrastructure is the people who build it, the people who operate it, the people who make people aware. There is a large number of different types of human intelligence, intellect, capability required in order to make the lifeless objects function as a system that actually gets the job done” (Administrator, CA, 4/19/2016). In answering the research question, “how does the human factor enable the successful function of CI?”, we can conclude that three elements of human involvement are essential to CI: training and support, community of practice, and advocates and champions. This poster sets forth that training and support allow the knowledgeable users of CI to educate other users and potential users about basic and up-and-coming CI technologies. Additionally, a community of practice exists for the e-science community to share research projects and developing technologies with one another. Furthermore, CI needs advocates and champions to obtain the funding and resources necessary to operating and sustaining CI. In order to more fully understand the relationship between humans and cyberinfrastructure, further research should consider the infrastructure that exists within humans and their interactions. Such future investigations will lend to identifying the key roles humans hold within that infrastructure and how those roles effect CI.

## References

- Kee, K. F., & Browning, L. D (2010). The dialectical tensions in the funding infrastructure of cyberinfrastructure. *Computer Supported Cooperative Work*, 19, 283-308.
- Lee, C. P., Dourish, P., & Mark, G. (2006, January). The Human Infrastructure of Cyberinfrastructure. Retrieved November 30, 2016, from [file:///C:/Users/Owner/Downloads/The\\_human\\_infrastructure\\_of\\_cyberinfrastructure.pdf](file:///C:/Users/Owner/Downloads/The_human_infrastructure_of_cyberinfrastructure.pdf)
- Ribes, D., & Finholt, T. A. (2009, May). The Long Now of Technology Infrastructure: Articulating Tensions in Development. Retrieved November 30, 2016, from [http://interoperability.ucsd.edu/docs/ribesFinholt09\\_jais.pdf](http://interoperability.ucsd.edu/docs/ribesFinholt09_jais.pdf)