The Key Principles of Virtual Organizational Structures that Promote the Sustainable Development of Emerging Computational Tools

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Introduction

The exponential development of Big Data infrastructure and growing availablity of HPC resources has given reign to a new "Third Pillar" in science (Domain Scientist Physics, Illinois, 4/22/14). Computation is unique from both experimentation and theory therefore yielding new and formidable Administrative and Managerial challenges.

An understanding of the working environment specific to developing organizations is needed to effectively manage this distinct and emerging set of stakeholders.

Literature Review

While many managerial and organization communication studies are more focused on traditional groups this study acknowledges the specific and unique work place conditions that regularly affect the production of open source computational tools for e-Science. "We define success as delivering a code base that produces consistent, reproducible results, is usable and useful, can be easily maintained and updated, and has a reasonable shelf life"(Baxter, 2006, p. 2). In order to develop successful computational tools, developers must go to great lengths understand their end user and to have a long term mind set from before beginning development.

"Communications planning involves determining the information and communications needs of the stakeholders: who needs what information, when they will need it, how it will be given to them, and by whom. While all projects share the need to communicate project information, the informational needs and the methods of distribution vary widely. Identifying the informational needs of the stakeholders and determining a suitable means of meeting those needs is an important factor for project success" (PMBOK, 2000, p. 96). Baxter (2006) recommends the following best practices for how this can be achieved. "1) design the project upfront; 2) document programs and key processes; 3) apply quality control; 4) use data standards where possible; and 5) incorporate project management. "

This poster seeks to answer the research question, *"What are the principle of virtual organizational structures that promote effective & productive tool/technology development?"*

Methodology: This poster employed the grounded theory approach (Corbin & Strauss, 1990) and analyzed 30 interviews conducted with domain scientists (e.g. bioinformatics, computational chemistry, theoretical physics) and computational technologists. Participants were from across the US (States). Interviews were conducted either in person or by telephone. Guided by the stated research question, the co-authors performed multiple iterations of data analysis and literature integration, yielding preliminary findings presented in this poster.

Findings

- Throughout the coding process, three common themes were found within:

Establishing the 'Long Now' Mindset

Successful computational tools can emerge from a variety of different developing organizations. Some begin as simple code written by a domain scientist while other tools are developed by professional computer scientist for an external user. However the commonality between all successful tools is that in any regard they have been planned properly in a complete manner with the mindset that what they do and build now matters a long time from now (i.e., the long now).

- "It forced us to schedule things and do things a little more formally. So we had records of what was done and what was said and objectives and we knew [we] had weekly meetings. So we had weekly timelines. So it was critical to our process that we really structure and organized ourselves because we were at remote sites" (Domain Scientist Physics, IL, 4/22/14).
- "So, a lot of people focus on some core parts… They've got a new idea, a way to solve a problem, and they implement a tool to do that, but the reality is that almost all these tools have to be put into a bigger system, and if you don't connect that tool into what other people are trying to do, then they may not have very much patience for it" (Computational Developer, IL, 11/20/13).
- "And this is another thing that people don't put enough effort into: they don't learn the standards; they don't go to the effort, and it is effort to make sure it will work well in other places. So, there's a lot of blame-the-customer sometimes, and so we put a lot of energy into that. We did examples, so again" (Computational Developer, IL, 11/20/13)

Facilitating Synergy Among Diverse Developers & Users

In many cases, tools built for use in e-Science bring together stakeholders from diverse disciplines, whom at times have varying technology exposure or conflicting ideologies. It is important for developing organizations to understand the needs of domain scientists and when necessary mediate or mitigate between the multiple perspectives of all stakeholders.

- "The work that we are doing is to obviously develop a tool but also to make the interface accessible enough to researchers that don't necessarily have the technology chops" (Humanities Scholar, CA, 5/12/14).
- "So, my goal is to develop some of those tools. And the communication directly between developer and humanities researcher… genuine language translation and clearly a culture translation" (Interdisciplinary Liaison, IL, 7/15/14).
- "Well, we need to make an effort to understand each other's language, because usually we speak in jargon that is not very well understood by other communities. Or, we have the tendency to look at problems from particular point of view. It may be the same problem, but a computer scientists looks at the same problem in a different way than me"(Domain Scientist Chemistry, TX, 6/10/14)

Reconfiguring Motivational Structure with Funding Continuity

It is critical to reconfigure the funding and financial system and to align the way in which all members in the development process to carry out work in a coherent, constructive, and continuous manner. The emerging virtual organizational form is a juxtaposition of a new collaborative entity and traditional institutions, which resulted in a range of motivational conflicts and organizational tensions in the development of computational tools for e-science.

- "You are dependent on someone for a project, but he or she reports to someone else in another country, what do you do? And then there is a hierarchy, you have to deal with his or her manager, convince him or her that he or she should be doing this a bit more" (Division Director, CA, 7/17/14).
- "They have this concept of when you do something innovative, you're supposed to file an invention disclosure and then the campus goes through the processing, 'Well who contributed to this innovation?' Then you say 'Well I'm working with someone at this university,' and then their similar office gets involved and then all kinds of crazy chaos cannons. So there office is saying 'No, this is primarily ours,' and ours is saying 'No, this is primarily ours,' and the researchers are out of the loop even" (Interdisciplinary Liaison, IL, 7/15/14).
- "[T]his is true everywhere that I have worked, it has always been a problem with the funding cycles and the length of them. I have just seen a lot of projects die before they had a chance to go through a lot of iterations to be successfully used in a community… It happens so often." (Technologist, TX,4/24/14)

Conclusion

In answering the research question, "*What are the principle of virtual organizational structures that promote effective & productive tool/technology development?",* we concluded that it is critical to establish the 'Long Now' mindset, facilitate the synergy among diverse developers and users, and reconfigure the motivational structure with funding continuity. While these concepts may appear to be common sense, the practices and issues brought up in this study can greatly improve the potential success of tools developed for e-Science. Beyond the e-Scientific context, these findings are applicable to projects that involve the management of any project or team organizing virtually as well as in the development of open source tools in a commercial environment.

References

A Guide To The Project Management Body Of Knowledge (PMBOK Guide). Newtown Square, Pa. : Project Management Institute, Inc., 2000. Print.

Atkins, D. E. (2003). Transformation through cyberinfrastructure-based knowledge environments. In W.H. Dutton, B. Kahin, R. O'Callaghan, A. W. Wyckoff (Eds.), *Transforming Enterprise: The Economic and Social Implications of Information Technology* (155-175). MA: Massachusetts Institute of Technology.

Baxter SM, Day SW, Fetrow JS, Reisinger SJ (2006) Scientific Software Development Is Not an Oxymoron. PLoS Comput Biol 2(9): e87. doi:10.1371/journal.pcbi.0020087

Corbin, J., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology, 13*(1), 3-21.

Rogers, E. M. (2003). *Diffusion of innovations* (5th Ed.). NY: Free Press.

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