

The Transdisciplinarity of Information Mapping in Practice: A Case Study of a Polar Data Hackathon

SASKIA M. VAN MANEN, PHD

KEYWORDS Data visualization, hackathon, information mapping, interdisciplinary design, polar, polar data, prototyping, real-time design

ABSTRACT This paper presents a reflexive case study of a two-day data hackathon and elucidates challenges and opportunities for transdisciplinary practice. The hackathon was sponsored by the United States National Science Foundation Polar Cyberinfrastructure Program and therefore specifically targeted information mapping of polar data. Its objective was to enhance end-to-end workflow through a focus on development of open-source cyberinfrastructure and tools for supporting analysis and

visualization of selected polar datasets. The large interest from early career researchers and high level of satisfaction from workshop participants, particularly related to the transdisciplinary nature of the event, suggests significant potential for the use of information mapping hackathons as a process of building community and advancing (polar) science. However, to realize this potential, observed social and technical barriers arising from communication, education, human factors, and the hackathon structure need to be considered.

INTRODUCTION

With increasingly complex problems facing society, there is a growing need for innovative approaches to data analysis, synthesis, and knowledge transfer. The traditional model of disciplinarity allows for specialization in the production, dissemination, and application of knowledge, and provides structured practices, authority, and professional identity.¹ Yet this is accompanied by institutionalized limitations on questions and methods. In response to the theoretical and practical requirement

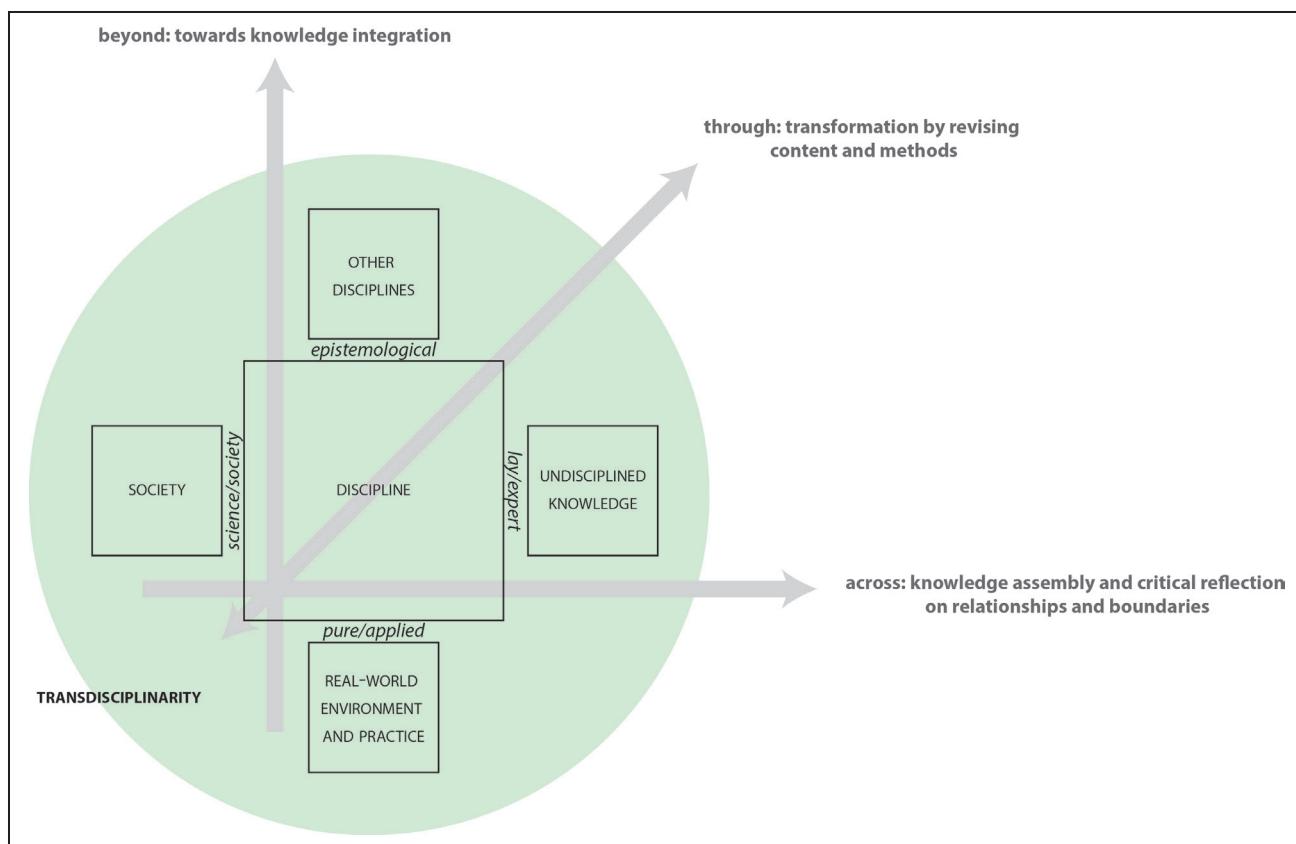


FIGURE 1: Transdisciplinarity (represented by the green circle and arrows) aims to cut through, across, and beyond existing discipline boundaries (*in italics*) to assemble, critically reflect on, integrate and revise content and methods to address challenges in a manner that transcends traditionally accepted borders.

to surpass these constraints, boundaries between the humanities, natural and social sciences, and the wider socio-political context they are situated in are continually re-configured through multidisciplinary, interdisciplinary and transdisciplinary (FIGURE 1) practices aimed at raising stakeholder engagement and broadening impacts.²

Despite the growing theoretical rhetoric developing around transdisciplinarity, little remains written on how it can be achieved in practice. A common language is required in order to connect and transcend discipline boundaries and cultures. Horn asserts that visual communication is the global language for the twenty-first century, yet more than ten years later, it appears that this needs to be re-assessed and replaced with the broader scope provided by information mapping.³ The goal of information mapping is to build “knowledge tools” that, depending on the objectives, help to (1) derive and/or (2) disseminate information and understanding from data, by allowing viewers to gauge complex information more effectively and efficiently.⁴ In doing so, it builds on a wide range of disciplines that include advertising, architecture, communication, engineering, environmental design, Geographical Information Systems (GIS), illustration, information architecture, knowledge management, pattern recognition, and semiotics amongst others.⁵ These “knowledge tools” enable users to analyze, structure and visualize data more effectively. This, in turn, allows for visual communication of (scientific) knowledge through well-planned and executed sophisticated graphics that tell a story through data and information regarding quantity, process, and spatial relations.⁶

This paper presents a reflexive case study of a two-day hackathon as a practical example of information mapping as it relates to the polar community, elucidating challenges and opportunities of transdisciplinarity in practice.⁷ It first outlines the hackathon format, followed by an overview of the outcomes and discussion of these results and their implications for the transdisciplinary nature of information mapping as a method. It concludes with a number of recommendations for those interested in hosting a similar event.

THE HACKATHON

MOTIVATION

The polar regions are increasingly recognized as an important environmentally sensitive area (NSF Division of Polar Programs 2013). Furthermore, sea level rise resulting from ice losses from glaciers, ice sheets and ice caps is acknowledged as an urgent challenge facing society (US Government 2013). A wealth of polar data encompass-

ing a wide range of disciplines (e.g., biology, astrophysics, astronomy, ecology, etc.) have been collected to date; although a range of infrastructures exist to acquire, process and distribute these data, a large number of challenges remain, particularly in light of the increasing complexity, size, and rate of acquisition of new data. During a 2013 National Science Foundation (NSF) Workshop on Cyberinfrastructure for Polar Sciences (wcpS), the following four areas were identified as key priorities (Pundsack et al. 2013): 1) Data as a service: the ability to provide on-demand data sharing through discovery, access, transportation, and delivery to the end user; 2) Education and training through a range of formal and informal methods; 3) Communication and networking of data: freely synching and moving information between data centers; and 4) Community building: polar cyberinfrastructure is an emerging community that encompasses a range of disciplines and therefore requires appropriate mechanisms to support its growth and sustainability. Furthermore, the workshop report noted that “scientific workflow components, notably modeling and data analysis (including visualization and algorithms and software)” should be explored further. In response to these findings, the Polar Cyberinfrastructure Program at the NSF funded the hackathon described here, whose aim was to demonstrate and enhance the end-to-end polar workflow through a focus on development of open-source cyberinfrastructure and tools to support data analysis and visualization.⁸

FORMAT

On November 3 and 4, 2014, the “NSF Polar Cyberinfrastructure/Datavis Hackathon” was organized at Parsons Institute for Information Mapping in New York.⁹ This hackathon was aimed at the cyberinfrastructure and the data visualization communities to work on problems within polar science. There were a number of objectives for the event, including: 1) evaluating and recommending open-source cyberinfrastructure technologies for automated data curation, processing, and dissemination and, 2) assessing the needs and challenges of visualizing polar datasets and identifying relevant techniques and tools.

The hackathon was advertised through a number of platforms specific to the cyberinfrastructure and polar communities, such as the CRYOLIST mailing list, NASA Earth Science Data System Working Group mailing lists, The Federation of Earth Science Information Partners (ESIP) lists, and specific Apache Software Foundation lists.¹⁰ Following expressions of interest, the organizing committee extended invitations to up to fifty individuals,

with the aim of creating a balance between various disciplines and ensuring appropriate representation of early career, minority, and female participants.

The hackathon was organized as an “unconference,” where participants were provided the opportunity to actively contribute to the development of the meeting’s goals and structure, primarily by suggesting sessions prior to the event rather than submit work to predefined sessions. Workshop organizers chose Github (www.GitHub.com), a web-based repository used mainly for code, as their main organization and communication portal, complemented by e-mail, a website, a Twitter hashtag (#NSFPolarDataViz), and a Google Group. The GitHub site provided participants with the ability to propose sessions and comment on various aspects of the hackathon throughout the organizing process.¹¹ Sessions, or issues, entered in GitHub all have unique identifying numbers, representing the order in which they were raised. These were used throughout the event to organize code, images, and other relevant information.

The event itself opened with a general introduction and objectives from the organizers, followed by a keynote and an overview of the NSF Polar Cyberinfrastructure program. Subsequently, session proposers were given time to provide a short overview and introduction of their sessions to generate interest. During the first coffee break, participants expressed their interest in sessions by adding their names on flip chart pages headed by the session title and the corresponding GitHub issue number. The five sessions with the most interest were designated as starting points during the “first hack,” and hacking continued throughout the remainder of the day. If session objectives were achieved, or participants felt it was time to move on, other issues of interest were worked on. Faculty from Parsons The New School for Design were invited to attend during the afternoon on the first day of the event in order to engage with the polar and computer scientists, and actively provide design feedback on overall ideas and designs as they emerged.

Day two was structured in a similar manner, opening with a keynote followed by more hacking sessions, which included *Parsons* faculty providing design feedback in the morning. The afternoon saw continued work on projects and was followed by closing remarks, prior to which a paper-based post-event questionnaire was administered to participants.

RESULTS

A total of forty-five participants representing twenty-eight institutions attended the workshop, although attendance

numbers fluctuated between the two days. A total of seventeen sessions covering a wide range of topics had been proposed prior to the event; fourteen of which were covered during the hackathon. These resulted in contribution of code to GitHub where it is freely accessible, and collaborative ideas regarding visualizations that may lead to proposals for future work.

QUESTIONNAIRE FEEDBACK

Post-event questionnaires were completed by thirty-two participants, 94% of whom achieved their ideal outcome fairly or very well, with the most important outcomes described as networking, learning about new tools, and developing ideas for further work. The importance of networking and being provided with sufficient time to do so was also reflected in participants’ responses when asked about the time available to interact with other people and develop contacts: 81% of participants responded “adequate,” with a further 9% stating “exceptional.” As a result of these positive outcomes, 91% of participants stated they’d be likely or very likely to attend a similar event.

As a result of providing participants the opportunity to develop the meeting agenda, 81% of participants were satisfied or very satisfied with the structure of the event. However, 31% stated they would have liked to see additional sessions. The most frequent comments related to the desire for additional sessions resulted from inability to attend co-incident sessions. Other frequent requests revolved around having more clearly defined session goals and actual data available, and more design/user experience focused sessions, as well as the desire to have a session that would involve all participants. Despite session objectives not being rated as very clear by several participants, 72% of participants rated the overall hackathon objectives as clear or very clear.

Although 78% of participants were satisfied or very satisfied with the duration of the hackathon, those who expanded on this answer suggested they would have liked it to be longer. This concurs with the findings that only 66% of participants were satisfied or very satisfied with what was achieved during their session. If participants elaborated on their responses, they mainly attributed their satisfaction/dissatisfaction to the fact that they got little done due to long discussions, although these did, in some instances, result in ideas. Others noted that they simply required more time to achieve their objectives: 21% of participants said it was unfeasible to achieve their session’s goals within the available time, 27% rated it as neither feasible nor unfeasible and 42% saw it as feasible. 59%

felt there was some or strong agreement on session goals among fellow participants in that specific session.

People's favorite aspect of the hackathon was by far the opportunity to network across different disciplines, as one participant phrased it: "4-way conversations between domain scientists, data scientists, programmers and designers—so rare, so good." With regard to improving future hackathons, the main responses were to have better defined objectives and goals for sessions, with more data to work on, and more pre-event development and interaction. In addition, participants would have liked more time and expertise present to take more ideas through from concept to realization.

DISCUSSION

From a theoretical perspective this hackathon, a combination of polar science based cyberinfrastructure and

visualization objectives involving a range of experts from a wide variety of disciplines, should have been a textbook example of information mapping: combining analysis, organization, and presentation of polar data. In practice, however, a number of challenges were experienced, predominantly related to communication, education, human factors, and the way the hackathon was structured. These challenges contemporaneously represent opportunities, highlighting areas of potential exploration and future growth for the communities involved.

COMMUNICATION CHALLENGES

It was apparent from the "clash of cultures," that, in general, participants with engineering and scientific backgrounds were coming from a data-centric viewpoint, whereas those from design and social science backgrounds took a user-centered approach.¹² This is unsurprising considering the

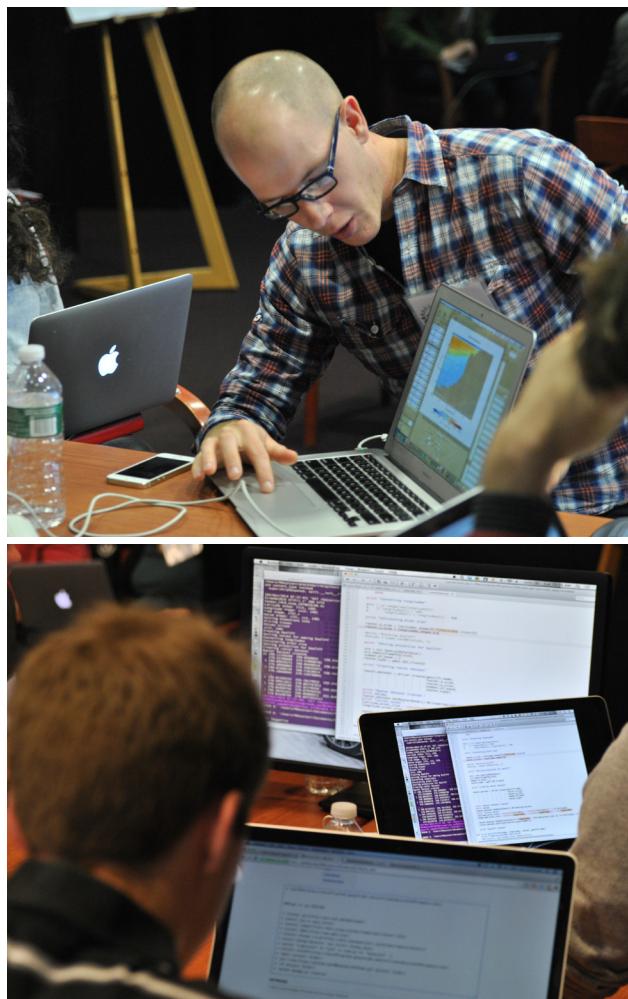


FIGURE 2: Photographs taken during the hackathon.
Images courtesy of Ashawnta Jackson, Parsons Institute of Information Mapping.

opposing problem-solving/solution-seeking nature these respective disciplines are rooted in, resulting from the historically different epistemologies, axiologies, and ontologies that are ingrained into the contemporary education systems.

Furthermore, the difficulties associated with the inherent uncertainties and complexity of the scientific data and processes contributed to challenges in visualization. Scientists felt it was difficult to translate their science from a peer-to-peer communication level to non-scientific audiences due to the potential loss of information and changing scales of interest (e.g., extrapolating from the processes occurring at a single glacier to making this relevant to a lay-audience by connecting it to climate change through carbon emissions and atmospheric and oceanic temperature rises). This is where the design feedback from Parsons faculty was particularly valued as their questions and comments provided different perspectives, leading to better defined objectives, narratives, and audiences for the proposed visualization. Despite indicating on the questionnaire that participants were not entirely satisfied with what they achieved in their session due to the long discussions, when questioned in person, they stated they found these discussions, particularly when the design experts were present, challenging but extremely useful.

EDUCATIONAL CHALLENGES

There was a distinct lack of familiarity with the design process among the majority of participants: rather than following a creative yet structured and iterative approach, which commences with understanding, observing and defining the problem to be addressed, many of the participants started with how they wanted their final visualization to look, rather than addressing the fundamental questions of why, who, what, where, and when.¹³ Those participants from engineering or scientific backgrounds also found it harder to work on exploratory rather than confirmatory projects that have more specific objectives, which at times resulted in the inability of groups to come to consensus and resulted in dispersion of participants. These challenges are again rooted in the different philosophies that underpin the respective disciplines of participants.

HUMAN FACTORS

There was a distinct lack of familiarity with the design process among the majority of participants: rather than following a creative yet structured and iterative approach, which commences with understanding, observing and defining the problem to be addressed, many of the par-

ticipants started with how they wanted their final visualization to look, rather than addressing the fundamental questions of why, who, what, where, and when.¹⁴ Those participants from engineering or scientific backgrounds also found it harder to work on exploratory rather than confirmatory projects that have more specific objectives, which at times resulted in the inability of groups to come to consensus and resulted in dispersion of participants. These challenges are again rooted in the different philosophies that underpin the respective disciplines of participants.

Firstly, it is important to note that workshop participants represent a self-selected subset of individuals interested in transdisciplinary approaches to cyberinfrastructure and visualization challenges in polar science. This means that results cannot be generalized across the cyberinfrastructure and polar communities. However, the high number of expressions of interest and representation from early career scientists reveals a growing awareness of the importance of events and approaches such as that provided by the hackathon.

Specific human-related factors that were identified as challenges during the event were the level of engagement and participation; due to perceived lack of personal ability to contribute, certain individuals excluded themselves from discussions. Furthermore, session proposers did not necessarily lead the discussion or focus within their identified group. At times conversation was dominated by participants with strong personalities and outspoken opinions rather than session proposers and more introvert, less experimentally-engaged, or less confident participants.

As sessions also divided into more cyberinfrastructure or visualization driven projects, the majority of participants naturally remained within their comfort zones. This resulted in some session groups feeling as though the necessary design and/or technological know-how was lacking to further develop concepts, when this expertise was likely present in the room.

HUMAN FACTORS

One of the difficulties of planning “unconferences” is that they lead to a high number of “pet projects” or personal challenges as sessions, with the “selfish” nature of their suggested projects acknowledged by some session proposers, rather than larger overarching challenges to be addressed. Such a hackathon structure is not conducive of cross-fertilization of ideas and expertise, as people prefer to stay in their comfort zones, as noted above. Furthermore, the presence of concurrent sessions with similar topics resulted in frustration for some participants as they

were forced to pick the session that at first glance appeared most relevant to them, rather than benefitting from the ability to compare and contrast workflows of sessions focused around similar subjects. In response a number of participants suggested that future hackathons should include a narrower focus or even consist of a single challenge to be collaboratively addressed by the entire group. Furthermore, the actual available time to realize ideas was considered insufficient by the majority of participants.

The lack of integration of design and Parsons-based design faculty in the event also resulted in complications. As a consequence of their consulting role, time was not utilized as efficiently as it could have been as participants had to re-demonstrate applications or problems they had previously explained to their session group once the designer joined. Furthermore, from the designer's point of view it would have been more helpful, when placed in this type situation, to, at a minimum, be provided with a one-page overview of the session's challenge, objectives, and potential audience. However, as mentioned earlier, many groups struggled to establish these without the design input.

CONCLUSIONS AND RECOMMENDATIONS

The ability to manage the complexity, uncertainty, and liminality associated with transdisciplinary research and its related methods and tools will have to be derived from sharing of experience, whether successful or ineffective. This is necessary in order to encourage collaborative learning and development towards best practice. In this case, the hackathon's goals were only partially achieved; although code was written, visualizations only reached prototype stage and were not fully realized. Yet, breaking down social barriers is at least as important and complex as the technological hurdles encountered in ideating and delivering solutions to today's global challenges, and in that respect the hackathon was successful. It is through the process rather than the physical outcomes that the various cultures and disciplines present at the hackathon were bridged and transcended, with this transformation of social relations and collective enabling of the potential to advance (polar) science also resulting in high levels of satisfaction in participants.

Based on our experience with this hackathon aimed at information mapping of polar data, we have a number of recommendations for those interested in hosting a similar event aimed at cyberinfrastructure and/or scientific communities. These include: 1) hosting an icebreaker prior to the event to facilitate interaction during subsequent trans-

disciplinary hacking challenges; 2) integrating design into the structure of the hackathon by (a) commencing with a general introduction to design and design methods, which will aid the development of a shared language that bridges the different underlining epistemologies, axiologies, and ontologies of the participating disciplines, and (b) integrating designers as regular participants rather than in consulting roles; and 3) Including at least one session that presents a challenge that requires the collaboration and integration of the various areas of expertise.

Micro-level initiatives such as the hackathon presented here are clearly situated within the overall context of the changing landscape of cyberinfrastructure, science, and the large-scale multi-faceted challenges facing society today. The ability of hackathons to function as an instrument of information mapping and putting transdisciplinarity in practice, places them at the intersection of research and the real-world. This endows them with enormous potential for innovation and transformation through real-time design. However, existing methods of assessing results from initiatives such as these are too constrained in their target of quantification and should therefore be revisited. It is up to the community to develop suitable indicators for the success of initiatives where process is practice and the most valuable outcomes such as the building of a transdisciplinary community can ever be only partly measured or not measured at all. However, to broaden and sustain the impacts of these small, innovative, and experimental transdisciplinary initiatives, policy, such as that enacted by major science funders such as NSF, is key. This should include increased democratic governance by responding to the communities' call for similar events and the funding of small projects and initiatives, particularly those resulting from collaborative events such as this hackathon and accepting quantitative and qualitative measures of success.

ACKNOWLEDGEMENTS

The hackathon was funded through NSF grant numbers PLR-144562 and PLR-1348450 and made possible through the efforts of the Organizing Committee, led by C. A. Mattman, and the participants. M. Tedesco and C. A. Mattman provided valuable input on this manuscript, which also benefitted from comments by R.P. van Manen. Careful editing by A. Jackson and W. Bevington of Parsons Institute for Information Mapping significantly improved the readability of this work. The author would also like to thank C. Chaihirunkarn, E. Trainer, J. D. Herbsleb and A. Kalyanasundaram at Carnegie Mellon University for allowing the organizing committee to contribute and utilize parts of their questionnaire. Van Manen is funded by Society in Science, The Branco Weiss Fellowship, administered by the ETH Zürich.

BIOGRAPHY

Saskia van Manen is a researcher whose core interest is deploying design as a strategy to mitigate the effects of natural hazards through disaster risk management. She is based at the *Open University* (UK) and is currently a Visiting Fellow at the *Parsons Institute for Information Mapping* (USA). Her current focus is on enhancing scientific communication related to natural hazards through information design. She holds a PHD in volcanology from the *Open University* (UK) an MA in Product Design and Innovation from the *University of Wales Trinity Saint David* (UK) and M.Sci. in Geophysics from *Imperial College London* (UK).

NOTES

- 1 Stenner, P. 2014. "Transdisciplinarity." In *Encyclopedia of Critical Psychology*, edited by T. Teo, 1987-1992. Springer.
- 2 Transdisciplinary is here defined as the development of new (intellectual) frameworks and innovative methods to (re-)solve complex real world problems through developing comprehensive questions and providing new perspectives (FIGURE 1). This stands in contrast to interdisciplinary, where knowledge and methods from various disciplines are synthesized into a coherent whole or multidisciplinary, where individuals from different disciplines come together but draw on their own respective bodies of knowledge.
- 3 Horn, R.E. 1998. *Visual Language: Global Communication for the 21st Century*. Bainbridge Island, WA: MacroVU Inc.
- 4 Bevington, W. 2007. "A visualization based taxonomy for informative representation: introduction and overview." Accessed November 1. <http://piim.newschool.edu/research/PIIM-PAPERS>.
- 5 Ibid
- 6 Lin, T.S. 2005. "Information Design for Learning: A Visual Communication Perspective." *International Journal of Technology, Knowledge and Society* 1:1-6.
- 7 A hackathon is a collaborative event where the various disciplines involved in software development come together to work on a specific project (e.g. Lapp et al., 2007; Wieczorek, et al., 2014)
- 8 For more information about the Polar Cyberinfrastructure Program, please contact Marco Tedesco, mtedesco@nsf.gov
- 9 Please see <http://nsf-polar-cyberinfrastructure.github.io/datavis-hackathon/>
- 10 Apache is a popular open-source community currently home to the Internet's flagship technologies including the Apache HTTPD web server that powers over 53% of the Internet (Netcraft 2014)
- 11 <https://github.com/NSF-Polar-Cyberinfrastructure>
- 12 Marco Tedesco, (NSF Polar DataVis Hackathon closing remarks, *The New School*, New York, NY, November 4, 2014)
- 13 Brown, T. 2009. *Change by design*. New York: Harper Collins.
- 14 Ibid

BIBLIOGRAPHY

- Bevington, W. 2007. "A visualization based taxonomy for informative representation: introduction and overview." Accessed November 1. <http://piim.newschool.edu/research/PIIM-PAPERS>.
- Lapp, Hilmar, Sendu Bala, James P Balhoff, Amy Bouck, Naohisa Goto, Mark Holder, Richard Holland, Alisha Holloway, Toshiaki Katayama, and Paul O Lewis. 2007. "The 2006 NESCent phyloinformatics hackathon: a field report." *Evolutionary Bioinformatics Online* 3:287.
- Meier, Mark F., Mark B. Dyurgerov, Ursula K. Rick, Shad O'Neil, W. Tad Pfeffer, Robert S. Anderson, Suzanne P. Anderson, and Andrey F. Glazovsky. 2007. "Glaciers Dominate Eustatic Sea-Level Rise in the 21st Century." *Science* 317 (5841):1064-1067. doi: 10.1126/science.1145200.
- Netcraft. 2014. "April 2014 Web Server Survey." Accessed November 5. <http://news.netcraft.com/archives/2014/04/02/april-2014-web-server-survey.html>.
- NSF Advisory Committee for Polar Programs. 2013. Recommendations for Polar Programs.
- NSF Division of Polar Programs*. 2013. "National Science Foundation Polar Vision 2012-2017." Accessed November 6. http://www.nsf.gov/geo/plr/opp_advisory/briefings/nov2012/oac_vision_doc.pdf.
- Pundsack, J., R. Bell, D. Broderson, G. C. Fox, J. Dozier, J. Helly, W. Li, P. Morin, M. Parsons, A. Roberts, C. Tweedie, and C. Yang. 2013. *Report on Workshop on Cyberinfrastructure for Polar Sciences*. St. Paul, Minnesota: University of Minnesota Polar Geospatial Center,
- U.S. Government. 2013. "National Strategy for the Arctic Region." Accessed November 5. http://www.whitehouse.gov/sites/default/files/docs/nat_arc