OPEN ACCESS

KING'S College LONDON

King's Research Portal

Document Version
Peer reviewed version

Link to publication record in King's Research Portal

Citation for published version (APA):
Xing, Y., Borgo, R., & Abdul-Rahman, A. (in press). Bridging Disciplines with Visualization: Fostering Interdisciplinary Collaboration in Computer Science and Beyond with Design Studies. In 10th ACM Celebration of Women in Computing: womENcourage™ 2023

Citing this paper
Please note that where the full-text provided on King's Research Portal is the Author Accepted Manuscript or Post-Print version this may differ from the final Published version. If citing, it is advised that you check and use the publisher's definitive version for pagination, volume/issue, and date of publication details. And where the final published version is provided on the Research Portal, if citing you are again advised to check the publisher's website for any subsequent corrections.

General rights
Copyright and moral rights for the publications made accessible in the Research Portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognize and abide by the legal requirements associated with these rights.

•Users may download and print one copy of any publication from the Research Portal for the purpose of private study or research.
•You may not further distribute the material or use it for any profit-making activity or commercial gain
•You may freely distribute the URL identifying the publication in the Research Portal

Take down policy
If you believe that this document breaches copyright please contact librarypure@kcl.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.

Download date: 05. Jan. 2026

Bridging Disciplines with Visualization: Fostering Interdisciplinary Collaboration in Computer Science and Beyond with Design Studies

Yiwen Xing
King's College London
London, United Kingdom

Alfie Abdul-Rahman
King's College London
London, United Kingdom

Rita Borgo
King's College London
London, United Kingdom

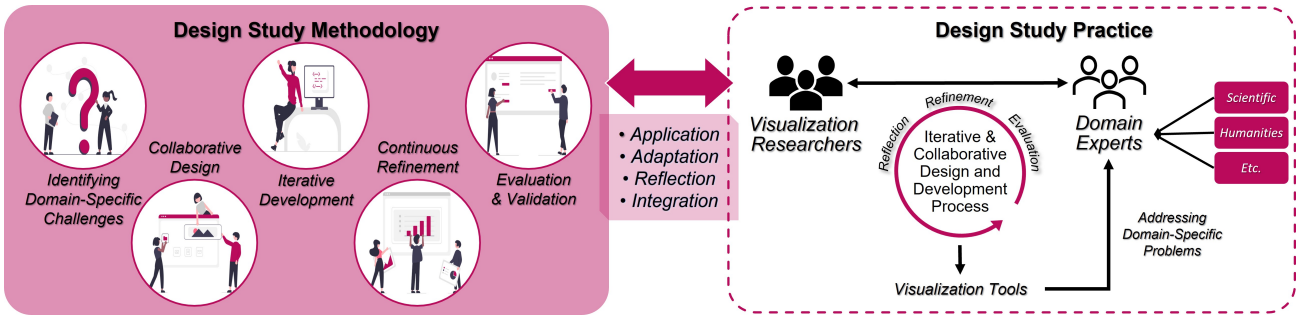

Figure 1: Key components of design study (left) and the illustration of how it bridges disciplines with visualization (right).

ABSTRACT

This paper highlights the role of design studies in promoting interdisciplinary collaboration and innovation in visualization research. As demand for visualization and analysis of large data volumes across various disciplines and domains grows, design study has gained attention for its iterative approach to addressing real-world challenges in specific domains. We share our experience in applying and adapting existing design study methodologies to conduct collaborative visualization projects with diverse domain experts, with valuable visualization tools as the output. We also summarize commonalities and differences encountered during collaborations with experts in various domains. By integrating our findings into design study frameworks, we hope to contribute to the development of a more comprehensive methodology system. Our work underscores the importance of using computer science and visualization technologies to address real-world challenges across multiple disciplines. The insights and lessons learned from our practice can serve as guidelines to facilitate the execution of visualization projects in collaboration with experts from different backgrounds and domains.

CCS CONCEPTS

• **Human-centered computing** → **Visualization application domains**; **Visualization design and evaluation methods**.

KEYWORDS

design study, visualization, application

ACM Reference Format:
Yiwen Xing, Alfie Abdul-Rahman, and Rita Borgo. 2018. Bridging Disciplines with Visualization: Fostering Interdisciplinary Collaboration in Computer Science and Beyond with Design Studies. In *Proceedings of Make sure to enter the correct conference title from your rights confirmation emai (Conference acronym 'XX)*. ACM, New York, NY, USA, 2 pages. https://doi.org/XXXXXXX.XXXXXXX

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.
Conference acronym 'XX, June 03–05, 2018, Woodstock, NY
© 2018 Association for Computing Machinery.
ACM ISBN 978-1-4503-XXXX-X/18/06…$15.00
https://doi.org/XXXXXXX.XXXXXXX

1 INTRODUCTION

As data become increasingly integral to our daily lives, visualization has captured the attention of various fields, including academia and industry, leading to an increased demand for effective methods to visualize, understand, and analyze data. Consequently, the application of visualization tools has emerged as a central theme within the visualization (VIS) domain. Design studies have become vital in this context, providing guidance on conducting VIS projects in collaboration with domain experts and creating tools to tackle domain-specific challenges. Developing effective and practical VIS tools is based on a systematic, iterative, and collaborative process. Design study methodologies provide structured approaches to guide the design, development, and evaluation of VIS tools, which guide VIS researchers in collecting and refining domain requirements, defining VIS tasks, collaborating efficiently with domain experts, and evaluating both the development process and the final output. Adhering to design study methodologies enables researchers from different backgrounds to co-design customized VIS tools that address domain-specific challenges, ensuring that the tools are functional and user-friendly. Therefore, design studies, encompassing both methodologies and practices, play a pivotal role not only in advancing the visualization domain but also in fostering interdisciplinary collaboration across multiple disciplines. As visualization

design studies are application-oriented and built on the foundation of in-depth communication with domain experts, the increasing number of such projects contributes to the continuous improvement and development of design study methodologies. Simultaneously, they facilitate the exchange of knowledge and expertise between different domains, ultimately contributing to the growth and development of each discipline involved.

2 BACKGROUND AND RELATED WORK

Design studies within the VIS domain involve collaboration between visualization researchers and domain experts to address real-world challenges using visualization techniques (Figure 1 right). This process encompasses the development and retrospective evaluation of problem-solving solutions. The design study literature can be broadly categorized into two groups: works that summarize methodologies for guiding design study execution [3, 6] and works that document design study practices, featuring iterative design processes with domain experts and visualization solutions addressing domain-specific issues [1, 4]. An extensive body of literature exists on the methodologies side, offering general and structured approaches to conduct design studies, e.g., the Nine-Stage Framework [6] and the Nested Model [3]. In addition, significant efforts have been made to develop methodologies tailored to specific contexts, such as collaborations with artists [2], and design studies in educational settings [7].

By applying and adapting existing methodologies, we have undertaken design studies in collaboration with experts from various domain backgrounds. Drawing on our own experiences, we believe these methodologies can be further refined and adjusted to better suit design studies under different domains and disciplines.

3 DESIGN STUDIES IN DIFFERENT DOMAINS

We have broadly classified the application domain into two large groups: humanities-focused and science-based. In the humanities, we have collaborated with researchers in humanities and history, concentrating on visualizing constitutional convention data and historical book trade data [8]. It should be noted that we have developed the *BookTracker* platform [9] with three novel and practical visualization toolsets for the book trade project to address different challenges in the domain. Some toolsets are already in use, and collaboration is ongoing. In scientific domains, we have collaborated with experts on the visual analysis and prediction of COVID-19 data [5]. Drawing from existing methodologies and our own practices, we identified commonalities and differences during different stages of design studies across various domain collaborations. We present five key components for conducting a design study in Figure 1 (left). All of these components are highly dependent on intensive close collaboration between VIS researchers and domain experts.

Similarities in conducting successful design studies include: ***Problem identification***: It is crucial to understand and identify domain experts' specific problems and challenges to create effective visualization tools. ***Two-way communication***: To ensure successful outcomes in the iterative design, development, and validation process, it is essential to establish cooperative communication between visualization researchers and domain experts. This will enable the identification of problems and establish a common language and an understanding of domain-specific terminology. ***Visualization principles***: Fundamental principles, such as clarity, simplicity, and user-centered design, apply to all projects.

We also reflected on the ***differences*** encountered in design studies with collaborators from different domains: ***Nature of data***: Scientific projects often handle quantitative data, while humanities projects involve more qualitative data or a mix of both, influencing visualization techniques and design. ***Research objectives***: Scientific projects focus more on identifying patterns and correlations, while humanities projects prioritize storytelling and interpretation. ***Evaluation criteria***: Criteria for evaluating effectiveness may differ, with scientific projects emphasizing accuracy, efficiency, and reproducibility, and humanities projects prioritizing user engagement, interpretability, and contextual understanding. ***Domain-specific constraints***: The constraints and requirements of each domain can vary, necessitating different design considerations.

By recognizing and addressing these similarities and differences, we intend to contribute to the refinement of design study methodologies, which in turn can aid in conducting effective visualization design studies with collaborators from diverse backgrounds.

4 CONCLUSION

In this paper, we highlight the importance of design studies in promoting interdisciplinary collaboration and fostering innovation in visualization research. Our work underscores the vital role design studies play in tackling real-world challenges across various disciplines. We share our findings on the similarities and differences encountered while conducting design studies with collaborators from diverse domain backgrounds and seek to tailor methodologies to better fit each project. It is essential to note that these conclusions regarding humanities and scientific visualization projects should not be generalized or stereotyped, as they can vary depending on individual participants and specific projects undertaken.

REFERENCES

[1] Joscha Eirich, Jakob Bonart, Dominik Jackle, Michael Sedlmair, Ute Schmid, Kai Fischbach, Tobias Schreck, and Jurgen Bernard. 2021. IRVINE: A Design Study on Analyzing Correlation Patterns of Electrical Engines. *IEEE Trans. Visualization & Computer Graphics* 28, 01 (2021), 11–21.
[2] Sean McKenna, Dominika Mazur, James Agutter, and Miriah Meyer. 2014. Design activity framework for visualization design. *IEEE Trans. Visualization & Computer Graphics* 20, 12 (2014), 2191–2200.
[3] Tamara Munzner. 2009. A nested model for visualization design and validation. *IEEE Trans. Visualization & Computer Graphics* 15, 6 (2009), 921–928.
[4] Carolina Nobre, Nils Gehlenborg, Hilary Coon, and Alexander Lex. 2018. Lineage: Visualizing multivariate clinical data in genealogy graphs. *IEEE Trans. Visualization & Computer Graphics* 25, 3 (2018), 1543–1558.
[5] RAMPVIS. [n. d.]. RAMPVIS. Retrieved April 30, 2023 from https://sites.google.com/view/rampvis?pli=1
[6] Michael Sedlmair, Miriah Meyer, and Tamara Munzner. 2012. Design study methodology: Reflections from the trenches and the stacks. *IEEE Trans. Visualization & Computer Graphics* 18, 12 (2012), 2431–2440.
[7] Uzma Haque Syeda, Prasanth Murali, Lisa Roe, Becca Berkey, and Michelle A Borkin. 2020. Design study "lite" methodology: Expediting design studies and enabling the synergy of visualization pedagogy and social good. In *CHI*. 1–13.
[8] Yiwen Xing, Cristina Dondi, Rita Borgo, and Alfie Abdul-Rahman. 2022. A Design Study of Visualizing Historical Book Movement. In *EuroVis 2022 - Short Papers*.
[9] Yiwen Xing, Dengyi Yan, Cristina Dondi, and Alfie Abdul-Rahman. 2021. BookTracker. Retrieved April 30, 2023 from https://booktracker.nms.kcl.ac.uk/

Received 20 February 2007; revised 12 March 2009; accepted 5 June 2009