Quantum Computing as Creative Material

Opportunities and Challenges for Crafting Physical Representations of Abstract Futures

Marije Kanis

Amsterdam University of Applied Sciences, m.kanis@hva.nl

Marten Teitsma

Amsterdam University of Applied Sciences, m.teitsma@hva.nl

Julia Cramer

Leiden University, Quantum & Society, cramer@physics.leidenuniv.nl

Emerging technologies such as quantum technology introduce futures that are abstract and difficult to engage with through conventional representational means. Although quantum technology is expected to have a wide-ranging societal impact, communicating its concepts and potential in effective and meaningful ways remains challenging, often leaving limited space for uncertainty and critical reflection. Within Human–Computer Interaction (HCI), creative, visual, and physical approaches —namely data physicalization and craft-based practices— offer alternative ways to engage with abstract and complex data topics. This position paper explores the opportunities and challenges of representing quantum technology and its data outputs through physical and craft-based data physicalization. Drawing on experiences from data physicalization workshops and creative practice, crafting is approached as a slow and collaborative activity that foregrounds material engagement, discussion, and reflection over time. The paper reflects on practical considerations such as mixed media, material affordances, time constraints, and the tension between accuracy, slow making practices and 'rapidly' developing technologies, using quantum computing as a motivating case for engaging with uncertain data futures.

CCS CONCEPTS • Human Computer Interaction (HCI) • Visualization • Interaction design • Collaborative and social computing • Art and humanities • Physical sciences and engineering

Additional Keywords and Phrases: Quantum technology, Data physicalization, Craft, Tangible interaction, Slow design, Public engagement, Science communication, Workshop, Critical thinking, Reflection

ACM Reference Format:

Kanis, M, Teitsma, M, Cramer, J. 2026. Quantum Computing as Creative Material: Opportunities and Challenges for Crafting Physical Representations of Abstract Futures. In Proceedings of CHI'26 Workshop on Craft-base Data Physicalization: Opportunities and Challenges, Barcelona.

1 INTRODUCTION

Nowadays society is shaped by complex challenges, uncertain futures, and rapidly transforming technologies. Quantum technology —with emerging and potentially disruptive applications in quantum computing, communication and sensing— is believed to have an impact on various levels, yet, for many people, it remains abstract, difficult to imagine, and hard to

meaningfully discuss [4]. Studies of popular communication about quantum science and technology show that public-facing explanations increasingly address core concepts, while still focusing primarily on future applications and benefits [16,21]. As a result, there is limited space for uncertainty, ambiguity, and critical reflection on how quantum technologies might function in practice or shape desired futures.

A central challenge lies in the nature of quantum-related data and phenomena. Unlike classical computing, in which information is represented as bits (0s and 1s), quantum technologies operate on quantum bits (qubits) whose states can exist in 'superposition', meaning that these can occupy multiple states simultaneously. These states cannot be directly inspected. Instead, information about a quantum system becomes accessible only through repeated measurement and observation. What can be engaged with are probabilistic patterns rather than single outcomes [17,18]. In systems with multiple quantum components, relevant information often lies in the relationships between parts rather than in the parts themselves, i.e., entanglement. This refers to the unique property that quantum systems cannot necessarily be described independently of one another, even when separated by large distances. These characteristics complicate how quantum-related phenomena can be represented, visualized, and interpreted —especially for non-expert audiences. This raises questions about how such phenomena might be made tangible, discussable, and open to reflection in broader societal contexts. This work explores how craft-based data physicalization can support collaborative engagement with abstract technological futures. Using quantum technology as a motivating case, it highlights how materials, making processes, and workshop dynamics shape the possibilities and challenges of physically representing uncertain and relational phenomena.

Within HCI and visualization research, different interactive representations, participatory and creative approaches — ranging from live-drawing to interactive dollhouses demonstrating 'smart' technology— have shown potential in supporting the communication and discussion of abstract, technological and complex concepts for public engagement [2,6,8,9,10,12,13,14,15].

Figure 1: Live-drawing report of data physicalization workshop during the Society 5.0 festival, Amsterdam, by Danibal

From this perspective, craft-based data physicalization can support critical thinking and collective engagement by externalizing uncertainty and ambiguity into tangible material forms that invite comparison, negotiation, and dialogue. Crafting physical representations also raises questions about accuracy and constraint, as materials, techniques, and time shape which aspects of abstract phenomena are emphasized, simplified, or foregrounded.

Figure 2: Data physicalization by children in primary school on the topic of Friendship, Amsterdam. The pupils crafted with all kinds of materials and techniques (including the 3D doodler and Makey Makey) and collected their own data with questions such as: How many friends do you have?

Physical representations are increasingly understood as shared reference points that support public engagement, interpretation, questioning, and discussion [1,3,4,7,10]. Creative and visually attractive forms play an important role in supporting engagement with abstract technological themes by inviting curiosity, participation, and discussion. While further evaluation is needed to understand how such approaches function in quantum-related contexts, existing practices illustrate how experiential formats —such as workshops (Fig. 2, 5), playful participatory approaches (Fig. 3), and installations (Fig. 4) — can create accessible entry points for engagement.

This work builds on insights from a series of workshops and educational activities with a diverse public —from children, students, professionals to older adults— (N>130) in The Netherlands, which explored data physicalization and critical making through practice-based formats focused on co-crafting tangible representations of data (Fig. 2, 5). These workshops were evaluated using learner reports [11,20] indicating increased self-reported critical thinking, creativity, communication and collaboration among participants [9]. The observations and results suggest that craft-based data physicalization can support collaborative engagement with complex and abstract topics. Specifically, the results from these workshops indicate that craft-based approaches can support data and technical literacy by making data tangible, discussable, and open to interpretation. Importantly, these approaches often shift attention from end results to the process of making, highlighting

decisions, assumptions, and uncertainties involved in data representation. Whether similar forms of engagement emerge in the context of quantum technology remains an open question and requires further exploration and evaluation. The workshop context provides an opportunity to further explore which craft techniques, materials, and collaborative making formats are most suitable for physically expressing quantum-related data and concepts.

Figure 3: Collaborative discussion on the desired future applications and impact of quantum technology, as supported by physical play, Quantum game night workshop, Waag=Open, Amsterdam, 2026. Photographs by Marije Kanis.

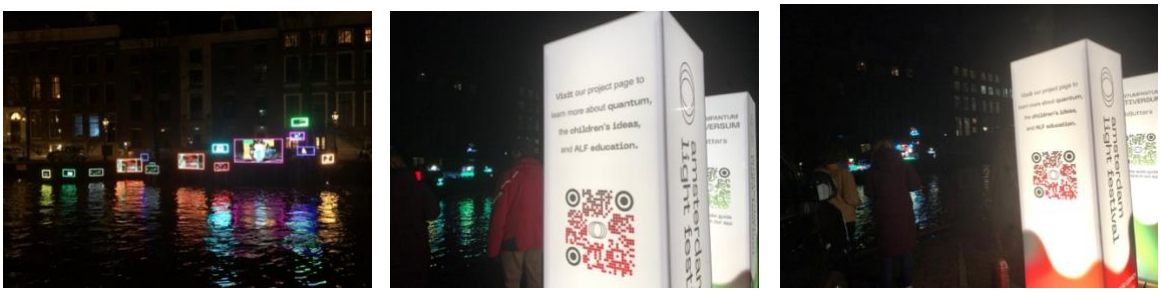

Figure 4: Quantumfantum multiversum, an interactive installation created for the Amsterdam Light Festival. It visualizes quantum futures imagined by 1600 participating children in co-creation with Beeldjutters art collective. The work unfolds a multiverse of futures on sixteen LED screens. Each screen shows children's future imaginations moving through 3D worlds (left). Visitors engaged from the shore -documenting, discussing, and watching the interactive light sculpture (middle, right), 2026. Photographs by Marije Kanis.

Workshop observations further highlight the importance of materials, skills, and time. Participants rarely showed a preference for a single craft medium, instead gravitating towards mixed-media approaches. Certain craft practices appeared compatible with quantum-related characteristics, such as working with repetition, accumulation, enactment, moving conditions and light-based elements. At the same time, material constraints and required skills shaped what could be made within limited workshop timeframes; for example, working with paint introduced delays due to drying time, affecting possibilities for iteration during short sessions.

Quantum technology is frequently framed through narratives of acceleration, optimization, and future disruption. Craft-based data physicalization introduces a different temporal logic: materials resist, processes take time, and outcomes emerge iteratively rather than instantaneously. In workshop settings, this slowness creates space for critical thinking, co-crafting, conversation, and reflection [5,10,19], allowing participants to collectively engage with uncertainty rather than seeking immediate fixed answers.

Figure 5: Crafting and discussing various data physicalisations on the data topic of loneliness in Amsterdam (and some combining this with data on the topic of Domestic waste and recycling in Amsterdam), using mixed media craft techniques and performance art, Waag = Open, Dataphysicalisation workshop

The emphasis on slow practices is particularly relevant. Crafting involves time, labor, and iterative engagement, standing in contrast to the speed and automation often associated with data processing or technology. This temporal dimension can be valuable when working with complex or emerging technologies, as it creates space for reflection, co-creation, and discussion. At the same time, it raises questions about accuracy, visual and physical translation, scalability, and the kind of knowledge, systems, formats, and collaborative thinking needed to support craft practitioners in engaging with quantum technology, its concepts, and its data over time.

This work contributes to the discussion about how data physicalization through craft can be understood not only as an aesthetic individual practice, but as a collaborative, communicative and reflective one. In a time of 'accelerating technologies and uncertain futures', crafting physical representations of data and abstract concepts offers not answers, but something equally necessary: the time, space, and material conditions to critically think together about what these technologies might become.

ACKNOWLEDGMENTS

We would like to thank all parties, participants, colleagues, creative crafters, partners and researchers that contributed to this work, in particular Ilse Geurts from Amsterdam's Quantum Talent & Learning Centre, Monique Pijls, and the 'Creative with Quantum' consortium. This work has been supported by the Dutch NWO through the Divide and Quantum project, ORC -NWA grant. This project was also made possible with the support of the Centre of Expertise Creative Innovation (www.coeci.nl).

REFERENCES

[1] Sandra Bae, Clement Zheng, Mary Etta West, Ellen Yi Luen Do, Samuel Huron, and Danielle Albers Szafir. 2022. Making data tangible: A cross-disciplinary design space for data physicalization. *Proceedings of CHI'22*.

[2] Marije ten Brink, Marije Kanis, Bert Bredeweg, Tamara Witschge, and Ben Schouten. 2023. PhotoReflexivity: supporting reflexivity for students in design education. *IASDR '23*.

[3] Pierre Dragicevic, Yvonne Jansen, and Andrew Vande Moere. 2021. Data Physicalization. In J. Vanderdonckt, ed., *Springer Handbook of Human Computer Interaction*. Springer.

[4] Trijsje Franssen, Sabine Roeser, Pieter Vermaas, Sense van der Molen, and Julia Cramer. 2025. *Creatively deliberating on quantum art-based creative forms of public engagement to emotional-moral deliberation on the societal impact of quantum technology*. OSF (pre-print).

[5] Lars Hallnäs and Johan Redström. 2001. Slow Technology – Designing for reflection. *Personal and Ubiquitous Computing* 5, 3: 201–212.

[6] Daniel Hentschel and Marije Kanis. 2022. *Live cartoon report Co-creating beyond green: If it looks too good to be green, it probably is*. Amsterdam University of Applied Sciences, Amsterdam.

[7] Yvonne Jansen, Pierre Dragicevic, Petra Isenberg, et al. 2015. Opportunities and challenges for data physicalization. *Proceedings of CHI'15*, 3227–3236.

[8] Marije Kanis. 2019. Physical sensemaking: Crafting for an invisible world of data. *Proceedings of CHI'19 Workshop: Troubling Innovation: Craft and Computing Across Boundaries*. Retrieved from http://www.digitallifecentre.nl/redactie/resources/chi2019physicalsensemakingmkresubmit-compressed-1.pdf.

[9] Marije Kanis, Shavonda Kewaldar, and Monique Pijls. 2019. *Revealing design: Physical & Visual results*. Amsterdam University of Applied Sciences, Amsterdam. Retrieved from http://www.digitallifecentre.nl/redactie/resources/revealing-design-zichtbaar-slimmerukfinal-compressed.pdf

[10] Marije Kanis, Astrid Lubsen, Tamara Witschge, and Monique Pijls. 2023. Engaging in (un)sustainable practices: Making data physical. *CHI'23 Workshop Physicalization from Theory to Practice: Exploring Physicalization Design across Domains*.

[11] Marije Kanis and Monique Pijls. 2022. Learner report for data physicalization in the sustainability context. Retrieved from https://www.hva.nl/kc-fdmci/gedeelde-content/projecten/projecten-creativemedia/samen-zichtbaar-duurzaam.html?origin=Lk9l%2F3mxTKWi%2Fl%2BwH1Crnw.

[12] Marije Kanis, Saskia Robben, and Ben Kröse. 2012. Miniature play: Using an interactive dollhouse to demonstrate ambient interactions in the home. *Proceedings of DIS'12*.

[13] Marije Kanis, Saskia Robben, Mettina Veenstra, and Ben Kröse. 2012. Visualizing ambient user experiences: Any how. *Workshop on Crafting urban camouflage, DIS 2012*.

[14] Marije Kanis, Sean Sabeti, Jesse Groen, et al. Ambient monitoring from an elderly-centred design perspective: What, who and how. *Proceedings of AMI'11*, Springer.

[15] Marije Kanis, Chantal Steur, Wouter Kievit, et al. Using an interactive model for designing public displays. *Proceedings of Geodesign Summit Europe 2013*.

[16] Aletta Meinsma. 2025. 'Spookachtig' en 'mysterieus': Een onderzoek naar communicatie over quantumtechnologie ('Spooky' and 'mysterious': A study concerning communication about quantum technology). Retrieved January 25, 2026 from https://inpress.studiowetenschap.nl/alettameinsma/#page=1.

[17] Michael Nielsen and Isaac Chuang. 2010. *Quantum computation and Quantum information: 10th Anniversary Edition*. Cambridge University Press.

[18] John Preskill. 2018. Quantum computing in the NISQ era and beyond. *Quantum* 2: 79.

[19] Rebecca J. Rosen. 2011. The slow-science manifesto: "We don't Twitter." *The Atlantic*. Retrieved from https://www.theatlantic.com/technology/archive/2011/07/the-slow-science-manifesto-we-dont-twitter/242770/.

[20] Tanja Janssen. 2011. Het learner report als onderzoeksinstrument (The learner report as research instrument). Retrieved September 3, 2021 from https://slideplayer.nl/slide/12906162/.

[21] Dunja Wackers, Aletta Meinsma, Gudrun Reijnierse, Margriet van der Heijden, Ionica Smeets, and Julia Cramer. 2025. "Like a light switch that is On and Off at the same time". A content analysis of signaled metaphors for quantum science and technology in Dutch newspapers. *SSRN*.