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Exploring the Horizon of Computation for Creativity

The advent of machine learning models, such as DALL-E, Midjourney, and ChatGPT, has prompted artists and researchers to revisit the concept of creativity. As with any new technology being introduced in practice, reactions diverge, ranging from the enthusiastic embrace of new possibilities to apprehensive avoidance. This current time exacerbated by social media echoes Walter Benjamin's criticisms regarding reproduction technologies such as photography and film [1]. With the democratization of art-making through these technologies, will art lose its "aura," its uniqueness? Of course, it won't! Art is founded on human expressivity and spirituality and its value is ultimately validated through its potential to create emotional connections between artists and audiences. While tools like machine learning models can certainly support artistic expressiveness, art transcends mere tool usage and remains a testament to human creativity.

In this issue, we explore the various ways in which computation can assist in creating media, art, design, and craft. With our selection of authors, we wished to encompass a broad spectrum of computational support that ranges from practitioners manually creating most of the outcome with light forms of computer automation to practitioners minimally guiding the outcome with fully generative computational processes. To examine this spectrum, we have brought together artists, designers, and researchers with diverse expertise to discuss their respective practices, spanning digital fabrication to support craft practices, human-robot collaborative performance, and AI-generated visual design.

Research focused on familiar materials and objects can facilitate the development of ubiquitous computing.

The objective is to present perspectives acknowledging both the potential advantages and drawbacks of integrating automation to support creativity. These perspectives are presented with a focus on understanding how artists and researchers define their interactions with computers and how these interactions affect their creative process. Specifically, these articles will investigate the different roles taken by computational technologies within this creative spectrum: a tool for reducing tedium, a guide for exploring a creative space, a creative medium for enabling new forms of art, a collaborator with its own intentions, or a nuanced combination of these different roles.

Our investigation starts with discussing the role and implication of AI for creativity support. Our first article, authored by Dr. John Chung, draws parallels between AI-powered tools for art production and the introduction of technology (AI or not) in creative domains. They democratize both the distribution and production of creative outputs. He further delves into the crucial role of designers of creativity-support tools that utilize artificial intelligence. Chung proposes for AI-powered tools to effectively support artistic processes, they must seamlessly integrate into existing workflows and enable the expression of subtle intentions through gradual changes. For Chung, designers hold, therefore, a crucial role, as these tools will influence whether such technologies benefit or harm society.

Professor Lydia Chilton's examines the use of AI in the design process, which provides further insights into this topic. She analyzes both the successes and failures of designing with AI and concludes that, while AI can be helpful, it requires human guidance to truly become a powerful creative tool. To reach this conclusion, she shares her journey in demystifying the "magic" of the design process and the role generative AI systems can play in that process. Chilton describes neither of these is magical, but instead requires work to execute or understand. She identifies the "flare" portion of the design process as a place where AI can support the design process by providing access to a wide range of inspiration.

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By 2032, the global market value of the wearable devices industry is expected to grow at a CAGR of 14.6% according to Market.US. Powered by microprocessors, wearable technology products can transmit and receive data to aid with real-world applications.

In line with Chilton's perspective on human-AI collaboration, Dr. Jun Kato, presents the concept of toolsmith: A role researchers can play when engaging in system development for artists. He emphasizes that being a toolsmith requires sustained engagement with a community of artists and like-minded individuals. This long-term engagement provides the essential space to develop, test, and update creativity-support tools that fully acknowledge the creative practitioners' sociocultural backgrounds and needs. Kato notes such valuable insights cannot be obtained through quick-turnaround paper production cycles and require running against the tide (or embracing HCI pun enthusiasm, against the chi-de? 👀) and encourages researchers to consider joining him in his journey from researcher to toolsmith.

Transitioning from AI-aided technology toward computational support for tangible art and craft, we had the privilege of interviewing Sougwen Chung, a renowned researcher and artist 🤖. Chung creates beautiful artworks in collaboration with her robots,

Jane E

Sam Bourgault

spanning from intricate finished paintings to live performances of their collaborative creative process. In addition to exhibits and performances, she is an inspirational speaker—giving talks internationally at both computer science and art conferences and disseminating her work through residency programs across the world. (She is also one of our personal fav creatives out there 💅.) In our interview, she shares how she believes beauty arises from the inherent fallibility of human-machine interactions, rather than simply relying on the machine's learning capabilities. This perspective aligns with David Pye's concept of the "workmanship of risk," where art and craft thrive in the delicate balance between skill, care, and unpredictability [2]. Shedding light on alternative approaches to engaging with machines, Chung describes her latest work as a ritual, "a kind-of endangered experience" that she tries to bring back by offering collaborative experiences to her audiences through the integration of robots, drawing, and meditation.

Continuing our investigation of computer-aided systems for craft-making, Professor Laura Devendorf, Ph.D. student Shanel Wu, and Dr. Mikhaila Friske discuss the potential of design metaphors in fostering human-machine coproduction. By drawing from metaphors from textile production and

80% **of 20 to 39 year-olds were willing to attend video telehealth visits, according to RAND researchers who surveyed 1,600 American adults from February 2019 until March 2021. Telehealth is growing quickly due to an increasing need for remote healthcare due to the the COVID-19 pandemic.**

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describing their own captivating experiences, they emphasize four design rules that consider materiality, personal stories, and traditional knowledge. Through their exploration, they encourage researchers to challenge their interpretation of what is "working" and to embrace the unexpectedness of collaborating with a computational system as a creative partner rather than a tool.

In step with Devendorf et al.'s material-driven research, Ph.D. students Jasper Tran O'Leary and Gabrielle Benabdallah, along with Professor Nadya Peek, also envision a collaborative creative process between the human and the machine. They propose the notion of physical-digital programming; a programming paradigm for digital fabrication that takes materiality into consideration and focuses on non-trivial and exploratory tasks. They see opportunities in using programming as a language that can be both physical and computational. By enabling an interaction paradigm with machines that focuses on programming, they imagine a future where users can explore the machine actions as a part of their creative process, adjusting code to iterate on ideas with the machine rather than using the machine as a means to produce a final pre-imagined design.

With an industrial design perspective, Professor Clement Zheng demonstrates how research focused on familiar materials and objects can facilitate the development of ubiquitous computing in ways that integrate everyday-life practices. Through two case studies presented in his article, Zheng illustrates how traditionally non-computational objects can serve as a resource for human-computer interaction, challenging the conventional notion of technology driving human behavior, and instead highlighting the potential of objects in shaping our interactions with computing systems. Zheng envisions a world where we not only see objects for their predetermined purposes and structures but also consider their potential as materials for furthering our creative possibilities.

In our final article,

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Ph.D. student Alyshia Bustos, artist Nanibah Chacon, and Professor Leah Buechley present the concept of culturally responsive learning environments through two case-study workshops. During these workshops, diverse youth were introduced to electronics and programming. Students also learned to integrate electronic components with paint in the creation of interactive artworks, creating beautiful paintings as well as a collaborative mural in their local neighborhood. These workshops demonstrate how community engagement can support STEAM skills acquisition in the context of creative endeavors. Bustos et al. demonstrate the impact of art not only as a means for growing community and empowering children but also as a strategy to introduce them to engineering concepts along the way. Through such experiences, these students are exposed to a side of technology that goes beyond the computer screen and can be tangible and fun.

This group of outstanding artists and researchers pushes the boundaries of computer-aided tools for creative applications. We observe two important trends in their contributions: 1. the pivotal role of designers and their understanding of the context explored, which fundamentally impacts how these technologies support human creativity, and 2. material-driven approaches can support computational design tools in integrating concrete artistic practices. While these two approaches may appear contrasting, they are two sides of the same medal 🥇🥇. Both emphasize the need for a better understanding of real-world creative activities.

Chilton and John Chung suggest context is key to the development of successful and ethical AI technologies. Kato reflects on the nature of the academic paper cycle turnaround that hinders long-term collaborations with professional artists and designers. Tran O'Leary, Benabdallah, Peek, Devendorf, Wu, Friske, and Zheng all present their individual insights on addressing the disconnect that exists between material realities and computer-aided technologies. They share guiding principles, programming paradigms, and case studies that can support researchers when working across physical and digital domains. Through artistic engagements, Sougwen Chung, Bustos, Chacon, and Buechley bring notions of care, collaboration, and community to the development and use of computational systems.

The World Economic Forum predicts sustainable agriculture technology, such as drip irrigation and soil moisture sensors, can lead the world to achieve net-zero, nature-positive results by 2030. Digital farming solutions, soil health analytics, and regenerative farming can aid farmers to cut greenhouse gas emissions and use less resources.

Finally, as highlighted by Kato and Devendorf et al., the impacts of these complex technologies often transcend disciplinary boundaries. To comprehensively examine their effects, it may be necessary to work collaboratively across disciplines and even begin asking questions from the perspective of non-human entities.

We are excited about how this collection of articles has come together and the range of perspectives and insights they present as a whole. We hope readers are equally inspired to investigate new forms of human-machine-material collaboration and engage deeply in need-specific artistic communities. Have fun creating. ✨

References

[1] Benjamin, W. *The Work of Art in the Age of Mechanical Reproduction.* 1935.

[2] Pye, D. *The Nature and Art of Workmanship.* Cambridge University Press, Cambridge, 1968.

Biographies

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Jane E is a postdoc at The Design Lab at UCSD under the guidance of mentors Steven Dow and Haijun Xia. She recently earned her Ph.D. in computer science from Stanford University, where she was co-advised by James Landay and Pat Hanrahan. Her research lies at the intersection of human-computer interaction and computer graphics with a focus on designing tools to support creativity through novices in developing their "artistic vision."

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MILESTONES

Redefining Creativity

Computer-generated media has transformed the way people create and consume media, from video games to AI art, and everything in between.

1962 Sketchpad, the first computer graphics program, is created by Ivan Sutherland while he is a Ph.D. student at MIT, for which he will receive the Turing Award in 1988.

1972 Ed Catmull creates the first computer-generated animation, "A Computer Animated Hand," while working on his Ph.D. thesis.

1982 Autodesk introduces AutoCAD, the first widely used computer-aided design software, which will become the most extensively used CAD program worldwide.

1990 Adobe Photoshop 1.0 is released for Macintosh computers, revolutionizing digital image manipulation.

1995 "Toy Story," the first feature-length computer-generated film, is released by Pixar Animation Studios.

2019 Disney's remake of "The Lion King" features photorealistic computer-generated animation used to create lifelike animals and environments.

2021 OpenAI releases DALL·E, a neutral network that can generate images from text; they follow up with a beta launch of DALL·E 2, releasing the API November 2022.

—Deepak Mahto

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