

Bridging Workspace Awareness and Creative Activity Traces: Toward a Taxonomy of Real-Time Trace Visualization Idioms

JEB THOMAS-MITCHELL, University of Toronto, Canada

LEPING QIU, University of Toronto, Canada

FANNY CHEVALIER, University of Toronto, Canada

Research on workspace awareness in collaborative systems and research on creative activity traces (CATs) face structurally parallel visualization challenges: both must communicate what changed in a shared artifact, where, by whom, and when, without disrupting the primary task. This position paper argues that awareness theory offers the CAT community a principled framework for reasoning about real-time trace rendering, while creative activity trace research offers the collaborative awareness community a rich and underexplored application domain. Drawing on ongoing work developing a taxonomy of visualization idioms for human awareness of AI agent activity in collaborative writing, we propose two key dimensions that structure the shared design space: spatial relationship to the artifact (embedded vs. detached) and temporal immediacy (concurrent vs. retrospective). Crossing these dimensions reveals that the embedded–concurrent quadrant could afford real-time trace analysis that supports dynamic and reflective creative processes. We discuss what each community stands to gain from this connection and pose questions for workshop discussion about how awareness concepts might motivate new trace visualization idioms for AI collaboration and creative tools more broadly.

ACM Reference Format:

Jeb Thomas-Mitchell, Leping Qiu, and Fanny Chevalier. 2026. Bridging Workspace Awareness and Creative Activity Traces: Toward a Taxonomy of Real-Time Trace Visualization Idioms. 1, 1 (February 2026), 5 pages. <https://doi.org/10.1145/nnnnnnn.nnnnnnn>

1 Introduction

Research on workspace awareness in agentic AI writing and research on creative activity traces (CATs) face structurally parallel visualization challenges. Both must communicate what changed in a shared artifact, where the change occurred, who or what caused it, and when, in real time, without overwhelming the person doing creative work. This paper argues that awareness theory [8, 9], developed over decades of research on collaborative systems, offers the CAT community a principled framework for reasoning about real-time trace rendering, and that creative activity trace research offers the collaborative awareness community a rich and underexplored application domain.

We are developing a taxonomy of visualization idioms for supporting human awareness of AI agent activity in collaborative writing systems. In building it, we have found that the core design challenges faced in supporting collaborative awareness, such as what to render, where relative to the artifact, and at what temporal perspective, map directly onto open questions in CAT research. The taxonomy dimensions we propose are grounded in awareness theory but operationalized in terms that are directly relevant to trace visualization. The remainder of this paper grounds this connection: first by identifying the shared constraints that link awareness and trace rendering, then by presenting

Authors' Contact Information: Jeb Thomas-Mitchell, University of Toronto, Toronto, Canada, jebthomas@cs.toronto.edu; Leping Qiu, University of Toronto, Toronto, Canada, leping@dgp.toronto.edu; Fanny Chevalier, University of Toronto, Toronto, Canada, fanny@cs.toronto.edu.

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 the author(s) 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.

© 2026 Copyright held by the owner/author(s). Publication rights licensed to ACM.

Manuscript submitted to ACM

Manuscript submitted to ACM

taxonomy dimensions that bridge the two, and finally by sketching what each community stands to gain from the connection.

2 Background

Workspace awareness is a collaborator’s ongoing understanding of others’ interactions with a shared workspace [9]. The concept emerged from research on collaborative writing and editing, where Dourish and Bellotti [8] identified that participants need ongoing perceptual access to each other’s activities in order to coordinate effectively. Gutwin and Greenberg [9] formalized this into a descriptive framework organized around a set of elements that the workspace must make perceivable: who is present, what they are doing, where they are working, and when actions occur. Critically, this framework was designed for exactly the kind of real-time, artifact-situated perception that real-time trace rendering demands.

In parallel, research on creative activity traces has established that records of creative process are not merely documentation but dynamic resources that shape ongoing creative work. Terry and Mynatt [15] demonstrated that creative work requires continual evaluation and exploration of variations, and that different visual representations of process history foreground different creative activities. Cioffi Felice et al. [5] and Kreminski and Mateas [11] further showed that making process traces visible and interactive can deepen creative engagement, shifting trace tools from passive records to active participants in the creative act. Yet while this community has developed sophisticated methods for analyzing traces, especially retrospective ones, it lacks a systematic framework for the visualization design space of trace encodings for traces rendered in real time during creation.

The convergence between awareness and trace analysis lies in the shared set of constraints. My work in supporting awareness over agents and a future CAT design space demand visualization strategies that communicate *what* changed in an artifact, *where* the change is located, *who or what* produced it, and *when* it occurred. Effective support must do so without disrupting the primary task, whether that task is framed as collaborative coordination or creative flow. Both goals must grapple with the tradeoff between richness of information and cognitive overhead. Awareness research has spent decades developing design principles for this problem; CAT research has articulated why it matters for creative work. My proposed research on visualization idioms to support awareness therefore has potential benefits in enriching the CAT community’s understanding of real-time traces.

3 Research Context: Agentic AI Systems

The overlap between awareness and trace analysis became apparent through my work on agentic AI systems, where AI agents may draft, revise, and restructure a document with limited human oversight. Lehmann et al. [12] found that users of a multi-agent writing system struggled to maintain control and trust because textual activity logs overwhelmed their comprehension as changes accumulated faster than sequential updates could convey. This is an awareness problem: the user cannot track collaborators’ activities or understand how the workspace is evolving. But it is equally a trace rendering problem: creative activity traces are being generated continuously by AI agents and the challenge is how to make them perceptible and actionable during the creative process. AI agent activity is necessarily traced through what is syntactically and semantically observable in the evolving artifact rather than inferred cognitive states [7], such as edits made, regions changed, or meaning shifted. This constraint, far from being a limitation, makes AI-generated traces structurally similar to the artifact-level traces the CAT community already works with, and makes agentic interfaces a productive context for developing visualization strategies that may transfer to creative trace rendering more broadly.

4 Proposed Taxonomy Dimensions

The taxonomy we are developing operationalizes awareness concepts in terms directly relevant to trace rendering. While the full taxonomy is in progress, two structuring dimensions have emerged that we believe are critical. Both are grounded in core elements of the awareness framework.

4.1 Spatial Relationship to the Artifact

Awareness theory emphasizes that collaborators need to perceive *where* activity is occurring in the shared workspace [9]. In trace visualization, this translates to a dimension of spatial relationship: is the trace rendered *embedded* within the creative artifact, or *detached* from it? Embedded visualizations, such as highlights [13] or other overlays on the text, leverage the spatial layout of the document itself. Proximity, position, and extent communicate where activity is concentrated. Detached visualizations, such as a linkograph [14] displayed in a separate panel, sacrifice this spatial grounding but gain the ability to represent structural or temporal patterns that do not map neatly onto document space. Making this dimension explicit as an encoding choice of visualization idioms allows researchers to reason about when each strategy is appropriate and what is lost or gained in the choice.

4.2 Temporal Immediacy

Awareness theory equally emphasizes *when* actions occur, distinguishing between past activity and ongoing, real-time updates [9]. For trace visualization, this corresponds to a dimension of temporal immediacy: is the rendering *concurrent* with the creative activity, or *retrospective*? Many existing CAT techniques operate retrospectively, analyzing completed episodes of creative work [1, 6]. Concurrent rendering introduces distinct constraints since the trace is incomplete and evolving, but enables a fundamentally different use case: supporting the creator’s awareness as a participant rather than informing a researcher’s analysis as an observer. This is where awareness research has the most to contribute. Real-time awareness support in collaborative systems has been studied extensively [4, 9, 10], and the resulting design principles translate directly to the challenge of rendering creative traces as they unfold.

4.3 Crossing the Dimensions

These two dimensions interact to define four quadrants, each corresponding to a distinct approach to support awareness and creativity traces:

	Embedded	Detached
Concurrent	Real-time overlays on the document (e.g., semantic heatmaps [13], activity tracking [2])	Live activity dashboards, timelines, or charts [14, 16]
Retrospective	Inline diffs ¹	Session-level analysis, process timelines [1, 6]

Table 1. Spatial–temporal design space for trace visualization, with illustrative examples.

The detached–retrospective quadrant is well populated by existing CAT work. The embedded–concurrent quadrant, which is the most relevant to both real-time awareness support and in-process creative trace rendering, offers rich

¹Latexdiff uses hue to markup differences between latex files, see <https://ctan.org/pkg/latexdiff?lang=en>

affordances for creatives and collaborators and can now leverage real-time semantic understanding using large language models. Although this framework is targeted at awareness support, it affords attention to regions of the design space where the needs of the collaborative awareness and CAT communities most clearly converge, and where new visualization idioms provide the most benefit. Additional dimensions under development include granularity (individual edits vs. aggregated activity), attribution (distinguishing contributions by agent or collaborator), and semantic depth (surface-level change detection vs. meaning-shift analysis). These will be reported in future work as the taxonomy matures.

5 Discussion and Workshop Contribution

This work offers the workshop a concrete bridge via visualization between two research traditions that share goals and infrastructure. Awareness research contributes a mature vocabulary and decades of empirically tested design principles for making collaborative activity perceivable in real time, resources the CAT community can draw on as it moves from retrospective analysis to in-process trace rendering. CAT research contributes a domain in which awareness concepts can be applied and extended: creative work raises questions about process reflection and trace-as-resource that push awareness theory beyond its traditional coordination-focused scope.

Several questions follow from this framing that may be productive for workshop discussion. Which additional awareness concepts, such as feedthrough, consequential communication, or focus and nimbus [3], map onto trace rendering challenges, and what visualization idioms would they motivate? How do visualization requirements shift when traces are presented to the creator in real time versus a researcher after the fact? And as agentic AI systems generate traces of increasing volume and complexity, what principles should guide the design of visualizations that keep human creators meaningfully informed without overwhelming them? Developing a systematic vocabulary for trace visualization—one that makes explicit the spatial, temporal, and analytical assumptions embedded in each representational choice—is essential for ensuring that creative activity traces serve human understanding rather than simply accumulating as uninterpreted data. This work is an early step toward that vocabulary, grounded in the conviction that awareness research and CAT research have much to teach each other.

References

- [1] Alberto Alvarez, Jose Font, and Julian Togelius. 2022. Toward Designer Modeling Through Design Style Clustering. *IEEE Transactions on Games* 14, 4 (Dec. 2022), 676–686. doi:10.1109/TG.2022.3143800
- [2] Patrick Baudisch, Desney Tan, Maxime Collomb, Dan Robbins, Ken Hinckley, Maneesh Agrawala, Shengdong Zhao, and Gonzalo Ramos. 2006. Phosphor: Explaining Transitions in the User Interface Using Afterglow Effects. In *Proceedings of the 19th Annual ACM Symposium on User Interface Software and Technology (UIST '06)*. Association for Computing Machinery, New York, NY, USA, 169–178. doi:10.1145/1166253.1166280
- [3] Steve Benford and Lennart Fahlén. 1993. A Spatial Model of Interaction in Large Virtual Environments. In *Proceedings of the Third European Conference on Computer-Supported Cooperative Work 13–17 September 1993, Milan, Italy ECSCW '93*, Giorgio De Michelis, Carla Simone, and Kjeld Schmidt (Eds.). Springer Netherlands, Dordrecht, 109–124. doi:10.1007/978-94-011-2094-4_8
- [4] Zhuoyi Cheng, Pei Chen, Wenzheng Song, Hongbo Zhang, Zhuoshu Li, and Lingyun Sun. 2025. An Exploratory Study on How AI Awareness Impacts Human-AI Design Collaboration. In *Proceedings of the 30th International Conference on Intelligent User Interfaces (IUI '25)*. Association for Computing Machinery, New York, NY, USA, 157–172. doi:10.1145/3708359.3712162
- [5] Marianela Ciolfi Felice, Sarah Fdili Alaoui, and Wendy E. Mackay. 2018. Knotation: Exploring and Documenting Choreographic Processes. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. Association for Computing Machinery, New York, NY, USA, 1–12. doi:10.1145/3173574.3174022
- [6] Nicholas Davis, Chih-Pin Hsiao, Kunwar Yashraj Singh, Brenda Lin, and Brian Magerko. 2017. Creative Sense-Making: Quantifying Interaction Dynamics in Co-Creation. In *Proceedings of the 2017 ACM SIGCHI Conference on Creativity and Cognition (C&C '17)*. Association for Computing Machinery, New York, NY, USA, 356–366. doi:10.1145/3059454.3059478
- [7] Manoj Deshpande, Milka Trajkova, Andrea Knowlton, and Brian Magerko. 2023. Observable Creative Sense-Making (OCSM): A Method For Quantifying Improvisational Co-Creative Interaction. In *Proceedings of the 15th Conference on Creativity and Cognition (C&C '23)*. Association

- for Computing Machinery, New York, NY, USA, 103–115. doi:10.1145/3591196.3593514
- [8] Paul Dourish and Victoria Bellotti. 1992. Awareness and Coordination in Shared Workspaces. In *Proceedings of the 1992 ACM Conference on Computer-supported Cooperative Work (CSCW '92)*. Association for Computing Machinery, New York, NY, USA, 107–114. doi:10.1145/143457.143468
 - [9] Carl Gutwin and Saul Greenberg. 2002. A Descriptive Framework of Workspace Awareness for Real-Time Groupware. *Computer Supported Cooperative Work (CSCW)* 11, 3 (Sept. 2002), 411–446. doi:10.1023/A:1021271517844
 - [10] Carl Gutwin, Reagan Penner, and Kevin Schneider. 2004. Group Awareness in Distributed Software Development. In *Proceedings of the 2004 ACM Conference on Computer Supported Cooperative Work*. ACM, Chicago Illinois USA, 72–81. doi:10.1145/1031607.1031621
 - [11] Max Kreminski and Michael Mateas. 2021. Reflective Creators. In *Proceedings of the Twelfth International Conference on Computational Creativity (ICCC 2021)*. México City, México (Virtual), 309–318.
 - [12] Florian Lehmann, Krystsina Shauchenka, and Daniel Buschek. 2025. Collaborative Document Editing with Multiple Users and AI Agents. arXiv:2509.11826 [cs] doi:10.48550/arXiv.2509.11826
 - [13] Justin Matejka, Tovi Grossman, and George Fitzmaurice. 2013. Patina: Dynamic Heatmaps for Visualizing Application Usage. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, Paris France, 3227–3236. doi:10.1145/2470654.2466442
 - [14] Amy Smith, Barrett R Anderson, Jasmine Tan Otto, Isaac Karth, Yuqian Sun, John Joon Young Chung, Melissa Roemmele, and Max Kreminski. 2025. Fuzzy Linkography: Automatic Graphical Summarization of Creative Activity Traces. In *Proceedings of the 2025 Conference on Creativity and Cognition*. ACM, Virtual United Kingdom, 637–650. doi:10.1145/3698061.3726915
 - [15] Michael Terry and Elizabeth D. Mynatt. 2002. Recognizing Creative Needs in User Interface Design. In *Proceedings of the 4th Conference on Creativity & Cognition (C&C '02)*. Association for Computing Machinery, New York, NY, USA, 38–44. doi:10.1145/581710.581718
 - [16] Dakuo Wang, Judith S. Olson, Jingwen Zhang, Trung Nguyen, and Gary M. Olson. 2015. DocuViz: Visualizing Collaborative Writing. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. ACM, Seoul Republic of Korea, 1865–1874. doi:10.1145/2702123.2702517