

Traces, Breadcrumbs, and Patina: Exploring and Designing With Traces of Activity

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Abstract

This one-day workshop invites members of the CSCW community with a research interest in activity traces to jointly explore and refine the currently ill-defined concept of *traces*. Traces are an important means for people to remember and interpret the state of things, not least when navigating collaborative situations. However, although traces and related concepts have turned up in CSCW and HCI literature over at least three decades, work has been sporadic and has not been consolidated – as evidenced, for example, by a proliferation of terms, from “traces” to “footprints” and “DNA”. As a consequence, our field does not have a good conceptual apparatus for dealing with traces, whether empirically or as a resource in design. This workshop will offer a structured forum for developing traces as a concept for use in both empirical and design work. The workshop aims to recruit broadly, from those who design with traces or build systems that use or create traces, to those who seek to understand traces empirically or theoretically. Outcomes of the workshop will include a crowd-sourced catalog of traces and one or more initial definition(s) and/or a typology of traces, both of which will be available to participants after the workshop.

CCS Concepts

• **Human-centered computing** → **HCI theory, concepts and models**; **Computer supported cooperative work**; *Social navigation*; *Social tagging*.

Keywords

traces, patina, wear, breadcrumbs, footprints, document DNA, stigmergic signs, concepts, design, interactive systems, collaboration, awareness, social translucence

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1 Introduction

The traces left over from digitally mediated practices play an integral role in sense-making when people work, coordinate activities, and collaborate [2]. Traces enable inferences about other people’s past, current, and planned activities, e.g., to assess how to fit activities into the workflow of colleagues [12]; such as when a person can tell from new revisions in a document that a co-writer recently edited several sections, and infers that perhaps it is time to have another look at the document. Traces can also help people recall or form an understanding of steps and decisions that have led to the current point [10, 23, 24], like when comparing versions of a draft helps a writer understand why it was changed [11] (Karat et al. even use the term “history and rationale databases” [10]).

There are many open questions about traces, what they are, and how people use them. While related to other cues that people perceive and act upon in cooperative practices, traces stand out through their direct connection to people’s activities by both materializing naturally as part of those activities and being closely embedded in objects of the activity [2, 24]. But the field has yet to develop a workable concept of traces that makes them more than an empirical curiosity or a vague source of inspiration for design. There is a need to open up a discussion about traces as both a concept and a resource for design.

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Collaborative work requires people to maintain overview of the material they are working with and producing, how it is progressing, and how that relates to the work of collaborators, and the way everyone involved understands the work and envisions it moving forward. People reduce this cognitive load by relying on information gleaned from their surroundings, which in the case of computer-mediated work encompasses an ecology of digital tools and content [15]. Traces of activity help people reconstruct mental context, such as plans, constraints, and connections to other people and streams of activity [23]. Not only can they support ongoing activities [1], also the resumption of work [22, 24] and reflection on past activities [10], indirectly contributing to mutual awareness and coordination in collaborative work [1, 2] through a form of social translucence where material features of a system make social information visible or otherwise tangible [6].

From a systems perspective, accessing traces is a complex challenge. A seemingly simple question such as “what open documents did I refer to during that online project meeting last week?” is deceptively difficult to provide a tool for answering. Microsoft have tried with their *Windows Recall*¹ that lets users query past traces through natural language prompts, relying on periodic screenshots and computer vision. This approach highlights several questions, including: *What constitutes a useful trace? What role can AI, or other technological solutions, play in accessing past traces?* And, more skeptically, *what should be traced in the first place?*

With this workshop, we are interested in exploring what traces are and how they are, and could be, used to keep track of thoughts and activities. The situated nature of traces is their major strength but also makes them a daunting challenge, both technically and for design and empirical work. We see several open questions for CSCW: *Are there different kinds of traces? Are traces different in different domains or settings? What do traces require of people? How do people work with traces to make sense of tasks and collaborative relationships, for example across multiple applications? How can we study traces? How can we use traces as a design material [21]? How can we experiment with traces?* To approach these questions, this workshop will bring together researchers with knowledge of different domains as well as technical, empirical, design, and theory expertise, to contribute a fuller picture for mutual benefit.

1.1 The Concept of Traces

Many tools are good at resuming system state (e.g., reopening closed tabs in a browser or automatically scrolling to where you left off in a document) but do less to help people resume mental state [24]. Despite the utility of traces and similar concepts being proposed on many occasions [e.g., 2, 7, 21], current user interfaces do not encourage the discovery and utilization of traces [2]. This can be partly attributed to a lack of strong, or generative, concepts [9]: There are no well-defined concepts to help us understand and design with traces. There is, however, a range of concepts and metaphors; from *traces* [2, 8, 16, 17, 20, 21, 27], *breadcrumbs* [14], and *footprints* [28, 29] to *patina* [13, 25] and *wear* [7, 26], all of which capture something left behind; and also *document DNA* [18, 19], which captures the provenance of information, and *stigmergic signs* [4],

which are left behind from previous activities and shape future activities. This is clear evidence of interest in the subject but also for a need to consolidate the multiple perceptions that exist in the community. The workshop will explore the notion of traces and related concepts through empirical and design-oriented activities.

1.2 Using Traces in Design

The workshop will contribute to a greater agenda of developing traces as a CSCW design concept for creating user interfaces and system infrastructures that help people connect the threads in their work. For example, computers contain a wealth of data on what files were open at a certain time, or what programs or apps have been in use when, but how are those traces made usable as a way to remember, to resume activities [24], or to reflect?

One branch of work has looked at social navigation[5], in which traces of previous system users guide current users [4]. With this workshop, we are more interested in traces that sit between people who are working together or in some other way have something actively to do with each other; or between a person’s past, current, and future situations.

To understand the role of traces in various activities and how to design both with and for traces, this workshop asks about the status quo: *What are traces? What forms do they take? How do we use them?* It also looks forward: *What forms could traces take? How can they be used? How can current uses be made better, easier, richer, ...?*

We do not think a definition is the first step to answer these questions. Rather, we envision an anatomy of traces: what parts are there to a trace; what dimensions? How are traces the same, and how are they different? We will not concern ourselves with agreeing on one term or on a definition but will, instead, allow participants to be informed by their preferred terms and definitions, and take stock of the way researchers define and understand traces. We hope that starting out broad will be conducive to a deep-founded definition in the longer run, and perhaps to delineating differences between different but related concepts.

2 The Workshop: Goals and Activities

The workshop will be a full-day event with activities aimed at eliciting real-world examples of traces and using those as a foundation for collectively developing and refining a conceptualization of traces. The activities will consist of a mix of plenary and group activities, as well as activities that can be done individually or in small groups. In the planning of these activities, the workshop will take inspiration from the unconference concept [3].

2.1 Goals

The primary goal of the workshop is for participants to leave with a more articulated understanding of what traces are; even if not necessarily the same, agreed understanding. This understanding may, for example, consist of an extended vocabulary for describing traces, a set of trace exemplars, and/or an outline of a definition. To assist this goal, the workshop activities are designed to produce:

- (1) A catalog of traces
- (2) Starting points for a typology or taxonomy of traces

¹<https://support.microsoft.com/en-us/windows/retrace-your-steps-with-recall-aa03f8a0-a78b-4b3e-b0a1-2eb8ac48701c>

These will be made available to participants during and after the workshop, through a password-protected cloud storage solution or a closed-access area on the workshop website. By enabling use of workshop artifacts by the collective of participants after the workshop, we hope to nurture a continuation of the inspiration and momentum generated in the workshop. We hope (1) that the catalog will be useful for participants in their own work, as a source of examples or inspiration, and (2) that the initial steps towards an anatomy of traces will help propel further thinking on traces.

2.2 Activities and Participants

The schedule of activities will be designed to foster close engagement and conversations grounded in concrete examples and questions. The activities will build on each other, going from identifying examples of traces to engaging with them analytically, in order to sketch out an understanding of what makes up a trace.

The workshop will, among other things, center around participants' own examples of traces and of how they have already worked with traces. To support the workshop's aim of bringing together multiple perspectives on traces, we hope for participation from a range of disciplinary approaches and a variety of example formats, including but not limited to *textual, pictorial, video, software applications, design portfolios/websites*, and a mix of these.

3 The Organizers

The organizing team brings together research expertise across CSCW, HCI, and Work and Organizational Psychology, as well as significant experience organizing and managing successful workshops.

- **Ida Larsen-Ledet** is a Marie Skłodowska-Curie Fellow at the School of Applied Psychology at University College Cork. She is currently working on the TRACE-WORK project, which aims to develop design principles for workplace technology that helps people draw on traces. Before this, her research has addressed collaborative writing and organizational knowledge sharing, including the use of social and information cues found in user interfaces. She has been on the organizing committee for NordiCHI and, currently, the 2025 Aarhus Decennial HCI Conference.
- **Myriam Lewkowicz** is Professor of Informatics at Troyes University of Technology. She is interested in defining digital technologies to support existing collective practices or design new collective activities. This interdisciplinary research proposes reflections and approaches for analyzing and designing new products and services to support cooperative work. The main application domains for this research for the last fifteen years have been healthcare (social support, coordination, telemedicine) and industry (digital transformation, maintenance). She has organized numerous workshops at international venues related to CSCW research and has recently (2023 and 2024) chaired two workshops at ECSCW on data at the workplace. She has chaired the European scientific association EUSSET, and is deputy editor-in-chief of the CSCW journal, The Journal of Collaborative Computing and Work Practices.

- **Clemens N. Klokmoose** is an Associate Professor at the Department of Computer Science, Aarhus University. His research interests include collaboration, user interface technologies, and human-computer interaction. He is particularly interested in software platforms that inherently support collaboration in all aspects of their use, and that are tailorable while in use. He leads the development of the Webstrates platform webstrates.net, used for exploring this in practice. He is an experienced workshop organizer, was general co-chair of NordiCHI 2022, and is general co-chair of the 2025 Aarhus Decennial HCI Conference.
- **Carol Linehan** is a Professor at the School of Applied Psychology at University College Cork. Her key research interests are centered on applying psychology to understand people's experiences of work and organizations. She has particular interest in the impacts of work practices on employees' construction and performance of selves.
- **Luigina Ciolfi** is Professor of Human Computer Interaction at the School of Applied Psychology at University College Cork and academic member of Lero – The Research Ireland Centre for Software. She has long experience researching mobile and flexible work from a CSCW practice-centered lens, and has co-organized numerous international workshops at venues such as the CHI, CSCW, ECSCW and DIS conferences. She is an Associate Editor of the CSCW Journal.

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