The Tabletop is Dead? - Long Live the Table's Top!

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Abstract
Research with interactive tabletop displays has shown much promise for collaborative scenarios. However, tabletops never became a commercial success and rarely exist outside the research community. Being relatively expensive, heavy and immobile hardware, and only limited availability of commercial applications were some of the reasons that these systems never made it into our offices or living rooms. The timing with the introduction of multi-touch smartphones and tablets, with their smaller form factor, better mobility, support for multi touch interaction, and an app-ecosystem, made large interactive surfaces look bulky and outdated. There is, however, a shift to an increasing number of mobile and ad-hoc scenarios, where mobile devices are used on a table's top.

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Introduction
Interactive tabletop displays have rarely made it out of the research community. In the beginning tabletops were mainly custom built research prototypes. Through the introduction of the Microsoft Surface 1.0 tabletop in 2008 a commercial system was made available, which was widely used in the research community. But the vision of an interactive coffee table did not spread to people's homes. Examples of where they have been deployed successfully are museums, tourist information, shops, and other public areas, often with research purposes in mind. Despite the promising prospects of interactive tabletops for a variety of domain areas, we are not surrounded by these devices in everyday life. Even in our research community the

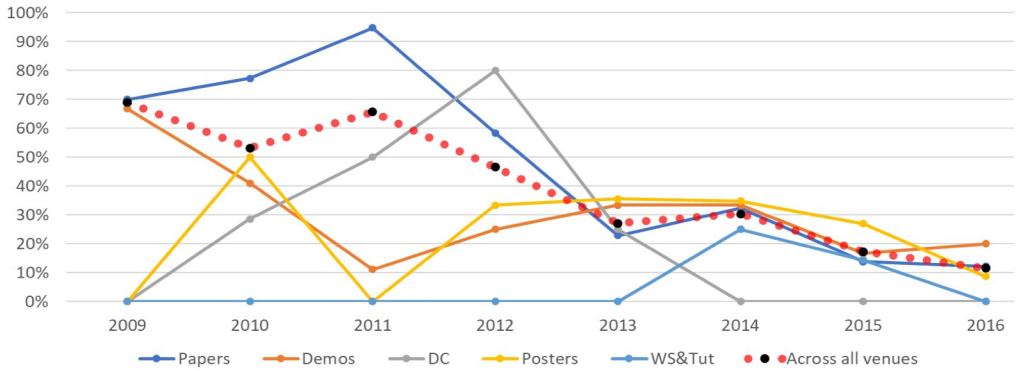

Figure 1. Percentage of unique submissions to the ITS/ISS conferences with the words "tabletop", "table-top", or "table top" in title or abstract. Note: No data available for DC 2009 and 2016, Posters 2009 and 2011, and Workshops/Tutorials 2009-2012. Data source: Table of Contents of each Proceedings in the ACM Digital Library.

interest declined (see Figure 1), with fewer publications addressing work around interactive tabletops over the course of the years. Unsurprisingly, this trend is also reflected in the name change of the *International Conference on Interactive Tabletops and Surfaces (ITS)* to *International Conference on Interactive Surfaces and Spaces (ISS)*, dropping the "tabletop" from its title.

What are the reasons for this shift? To answer this question, we first examine benefits interactive tabletops have shown and what they support well. We then look at the issues that remain around tabletops and why they have not made it outside research environments and (small) case studies. Lastly, we describe how we envision the way forward on research around tables.

Tabletop's benefits

Tabletop displays have shown benefits for group collaboration.

Shared focus and overview. Tabletops provide groups with a shared overview and focus point for their collaboration [1, 11], fostering closely coupled collaboration [7].

Horizontal surface increases collaboration and awareness. Horizontal tabletop displays foster group collaboration by enabling a face-to-face working style, compared to side-by-side working style on vertical displays [12]. Increased awareness [16] and switching of roles enables groups to explore more ideas [12].

Direct manipulation of objects. Being multi-touch capable, tabletop displays afford direct manipulation of objects on the screen, enabling quick learning and ease-of-use even for novice users [3].

Spatial organisation of information items. The large surface area of tabletop displays fosters spatial organisation of information items, similar to how physical paper and files are organised, stacked, and arranged on desks [11].

Tangible items or tools. Tabletops afford objects to be placed on them, such as paper documents or physical artefacts, digital devices (e.g. [6, 16]), and physical tools (e.g. [9]). Recognition is done either through markers or optical recognition. Exchange of information enables for a fluid physical-digital workflow.

Is the Tabletop Dead? What are the issues?

While the affordances of tabletop displays make them well suited for collaborative environments, issues persist of either technical or organisational nature.

Non-mobile. Tabletop displays are large and heavy, requiring a permanent place to be setup. However, in modern working styles people conduct ad-hoc meetings, work in changing environment, and meet in unanticipated situations. For these nomadic workflows, a long planning- and preparation-phase is detrimental

to spontaneous collaborations.

Occlusion and clutter. Direct touch manipulation, the prevalent input style on tabletops, creates issues of occlusion and reach [17]. While increased display space enables the use by multiple people, displaying multiple people's content creates clutter [11].

Working on horizontal workspace. Text entry with virtual keyboards is cumbersome, and several researchers have addressed this, e.g. through multiple keyboards [5] or digital pens [4]. However, working on a tabletop's horizontal surface over an extended period of time can cause neck strain [10].

Orientation of information and people. Orientation of information items and people can be an issue in collaborative settings [8, 15], as information one person sees is upside-down for another facing them. A tabletop cannot simply be turned around to temporarily share a view. Recently, tabletops have been combined with external devices, such as laptops [6], smartphones [13], smartwatches [2], or the interaction space has been elevated to be above the tabletop [18], enabling more interaction space and multiple views.

Privacy. People use personal spaces to organise their material, even on shared interaction spaces. Although people generally observe other's territories [14], privacy issues arise, as tabletop displays cannot be tilted or moved out of another person's view.

Price and lack of applications. Besides the issues research has shown and been addressing over the course of the years, the lack of suitable application / an application ecosystem and affordability are issues that prevented tabletop displays to get into everyday lives.

Long Live the Table's Top!

Groups already gathered around tables and desks long before the introduction of technical systems. Despite the interest in tabletop displays declining, we believe that co-located collaborative work around the flat surface of a table will continue to play a major role in the foreseeable future. A table's affordances make it well suited for collaborative situations – however the technology will be a different one.

People move more and more towards mobile and handheld devices, such as laptops, tablets, and smartphones. These devices are readily available and more affordable than tabletop displays. On the technical side, they meet (multi-touch, computational powerful) or even exceed (resolution, mobility) tabletop displays' properties. Only in terms of available screen estate, a tabletop display is still larger. However, with higher information density through higher resolution and distributed applications across multiple devices, we believe that these devices have and will continue to replace tabletop display applications.

The focus will shift *from the tabletop to the table's top*, as using a horizontal surface for group collaboration works well. Tablets, smartphones, and laptops can be easier positioned for shared access, moved around to declutter space, or propped up for easier viewing, compared to static tabletop displays. Being mobile, minimizes the need for a lengthy setup, and enables ad-hoc collaborations in everyday situations and on-the-go. The transition from a single-user scenario to a multi-user-collaboration is easier as this simply means sharing the view of a device or adding another.

We therefore see the time fit to let go of the "interactive coffee table" to reframe the thinking onto more mobile solutions and devices.

Discussion at the workshop

Many of the observed behaviours on traditional around-the-table collaborations have been successfully transferred to tabletop displays. Therefore, at the workshop, we would like to see a discussion which aspects of tabletop research can be transferred to the next generation of cross-surface collaboration in multi-device ecologies (e.g., relating to awareness, signalling, collaborative access, shared overview, and shared understanding). This would allow to identify research opportunities on how to continue the successful tabletop research with mobile devices.

References

1. Amershi, S. and Morris, M.R. 2008. CoSearch: A System for Co-located Collaborative Web Search. *Proc. CHI '08*. ACM.
2. Brudy, F. et al. 2016. CurationSpace: Cross-Device Content Curation Using Instrumental Interaction. *Proc. ISS '16*. ACM.
3. Forlines, C. et al. 2007. Direct-touch vs. Mouse Input for Tabletop Displays. *Proc. CHI '07*. ACM.
4. Haller, M. et al. 2006. Shared Design Space: Sketching Ideas Using Digital Pens and a Large Augmented Tabletop Setup. *Advances in Artificial Reality and Tele-Existence*. Springer, Berlin, Heidelberg. 185–196.
5. Hartmann, B. et al. 2009. Augmenting interactive tables with mice & keyboards. ACM Press.
6. Houben, S. et al. 2014. ActivitySpace: Managing Device Ecologies in an Activity-Centric Configuration Space. *Proc. ITS '14*. ACM.
7. Isenberg, P. et al. 2012. Co-located Collaborative Visual Analytics Around a Tabletop Display. *IEEE Transactions on Visualization and Computer Graphics*. 18, 5, 689–702.
8. Kruger, R. et al. 2003. How People Use Orientation on Tables: Comprehension, Coordination and Communication. *Proc. GROUP '03*. ACM.
9. Marquardt, N. et al. 2009. The Haptic Tabletop Puck: Tactile Feedback for Interactive Tabletops. *Proc. ITS '09*. ACM.
10. Morris, M.R. et al. 2007. Reading Revisited: Evaluating the Usability of Digital Display Surfaces for Active Reading Tasks.
11. Morris, M.R. et al. 2010. Search on surfaces: Exploring the potential of interactive tabletops for collaborative search tasks. *Information Processing & Management*. 46, 6, 703–717.
12. Rogers, Y. and Lindley, S. 2004. Collaborating around vertical and horizontal large interactive displays: which way is best? *Interacting with Computers*. 16, 6, 1133–1152.
13. Schmidt, D. et al. 2010. PhoneTouch: a technique for direct phone interaction on surfaces. *Proc. UIST '10*. ACM.
14. Scott, S.D. et al. 2004. Territoriality in collaborative tabletop workspaces. *Proc. CSCW '04*. ACM.
15. Shen, C. et al. 2004. DiamondSpin: an extensible toolkit for around-the-table interaction. ACM.
16. Shen, C. et al. 2003. UbiTable: Impromptu face-to-face collaboration on horizontal interactive surfaces. *Proc. UbiComp '03*. Springer.
17. Shen, H. et al. 2006. Informing the design of direct-touch tabletops. *Computer Graphics and Applications, IEEE*. 26, 5, 36–46.
18. Spindler, M. and Dachselt, R. 2009. PaperLens: Advanced Magic Lens Interaction Above the Tabletop. *Proc. ITS '09*. ACM.