

**Automatic device connection**

Users want the devices to pair automatically and do not want to fiddle around with the setup.

I 001

**Common ground**

In order to manage successful cross-surface settings, an underlying framework is needed to collect and manage communication and information flow across devices to facilitate cross-device interaction

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**Device equality**

It is assumed that in cross-device settings, every device is connected to all other devices on equal grounds (no hierarchy): No device should be isolated and no device should control other devices.

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**Semantic and responsive web design is needed to create integrated information and interaction spaces.**

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**Many applications and online services notify us about updates.**

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**Using the same app on multiple devices aggravates the issue of disruptive notifications.**

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**When connecting devices there is value in seamfulness.**

For example, an explicit pairing step (e.g. scanning a QR code) provides information of possible intentions to co-located users of a system.

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**For cross-surface applications to be successful in the wild, security concerns need to be addressed.** There are trade-offs between ease of use (e.g. automatically grouping devices) and privacy (not allowing strangers to pair with my device).

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**Major challenges in cross surface ecologies**

To establish successful cross surface interaction in the wild, four technological challenges have to be overcome: 'platform heterogeneity', 'Network and device management', 'Performance, efficiency, stability, and low latency are crucial to user experience', and 'Security and safety'

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**Notification interference through unmanaged personal devices.**

In people's ecologies of personal devices (e.g. smart watch+smartphone+tablet), notifications can be disruptive as the devices are not aware of each other

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**Consider spatial and temporal relationships**

Not only the spatial relationship between devices is important, but also the changes of this relationship over time.

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**Develop new models for a new age.**

Current design models in HCI are not suited for the multi-user multi-device ecologies that become more and more common.

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**Industrial applications require roles**

Different from consumer cross-device applications, industrial applications require role-based tasks and task-flows.

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**Minimize technical obstructions**

Engaging with an application within a multi-display environment requires setting up the personal device, e.g. install app, logon to systems, putting device on tabletop, etc. - Users (consciously/sub-consciously) have to agree to certain aspects before they do this, e.g. trust the system, trust other participants, understand what might happen at worse, etc...

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**Collaborating and sharing in a multiple-device environment is socially coordinated and participants curate information from their personal "space" before sharing in the shared space.**

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**Personal preferences and social conventions govern how we share, e.g. showing documents on personal device to collaborator, but more reluctant to hand over the personal device.**

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**Shared display “space” is used to create overview and presenting part of the work/ information residing on the more personal devices.**

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**Device fragmentation (and idiosyncratic use/configuration) challenges how we develop cross-device applications and design interaction.**

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**Revision of infrastructure**

Addressing the “frictions” in cross-surface (device) development and interaction requires both high level abstractions that can be mapped onto multiple configurations and low-level infrastructure.

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**Seamlessness is overrated**

Seams show how things fit together, which can be useful. Mixed-Reality ecologies should deliberately try not to replicate human experience, rather they should aim to usefully unnatural.

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**Develop for real life, do research in the wild.**

Create or use real-world ecologies right from the beginning of your creative work. Consider practical problems from the outset.

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**Design for flexibility and scalability.**

Cross-device interaction means coping with heterogeneity - of hardware, platform and context of use. Use a flexible and scalable decentralized architecture with loose couplings to master this heterogeneity.

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**Don't reinvent the wheel.**

Separate interaction challenges from technical inadequacy of your ecosystem. Concentrate on the former and let the latter be solved by the developers of cross-platform frameworks.

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**Design for relational quality.**

Explore the relationships among humans and technical entities, evaluate their (fluctuating) roles in an action and context (posture quality). Design your multi-user, multi-device ecology vibrant and interactive.

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**Gorilla Glass**

Seamlessness and transparency of interfaces prevent clarity and interpretation.

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**Campfire Call**

A collocated group will cluster around a single device rather than adopt one device per user.

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**Indistinguishable Herd**

Due to their growing number, devices lose their identities and become physical manifestation of digital documents

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**Common Goods**

Actions and changes on shared work spaces need to be preceded by an informal common agreement.

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**Cross-device interaction should leverage existing skills/knowledge of interaction and navigation in the physical toward the virtual world.**

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**Cross-device interaction in the wild should be accessible, understandable, valuable, and have reasonably low technical barriers.**

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**The same complexities that designers and technologists overcome to realize multi-device interactive systems emerge as cognitive, social, affective and technical load that limit people's willingness to use such systems.**

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**Low treshold and high ceiling.**

Cross-device UI frameworks should aim for a low treshold (easy to learn) and a high ceiling (allow complex interfaces)

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**Supporting many possible device configurations make cross-device development difficult.**

Cross-device applications that support a large number of device configurations are challenging to develop and it can be hard to test all possible configurations.

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**Beyond sequential cross-device interaction.**

Current frameworks mostly focus on sequential cross-device interaction, and don't often support using devices in parallel on the same task, interacting across devices.

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**Cross-device interaction is desired.**

People want to move information and work between devices.

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**Discoverability.**

It should be easy to see which devices are available.

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**The web is everywhere.**

Web applications run on mobile and desktop systems, TVs, gaming consoles, digital cameras, watches, and many application are transitioning into web versions (e.g., Office 365)

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