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

| 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

| 002

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.

| 003

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

| 004

Many applications and online services notify us about updates.

| 005

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

| 006

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.

| 007

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).

| 008

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'

▌ 009

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

▌ 010

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

▌ 011

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.

▌ 012

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

▌ 013

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...

▌ 014

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.

▌ 015

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.

▌ 016

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

❙ 017

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

❙ 018

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.

❙ 019

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.

❙ 020

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.

❙ 021

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.

❙ 022

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.

❙ 023

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.

❙ 024

Gorilla Glass
Seamlessness and transparency of interfaces prevent clarity and interpretation.

025

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

026

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

027

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

028

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

029

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

030

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.

031

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)

032

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.

l **033**

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.

l **034**

Cross-device interaction is desired.
People want to move information and work between devices.

l **035**

Discoverability.
It should be easy to see which devices are available.

l **036**

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)

l **037**