

Collaborative computing

~~Computer-Supported Cooperative Work~~

~~Groupware and Collaborative Interaction~~

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Thanks to Nicolas Roussel, Inria,
Cédric Fleury, ENIB,
Anastasia Bezerianos, U. Paris-Saclay



<https://www.lri.fr/~mbl/CSCW>

Humans are social beings ...

Groups structure human activity

Professional life: teams, management chain,

Private life: family, friends, sport teams, choir, etc.

Groups are more than the sum of their parts

- Division of labor

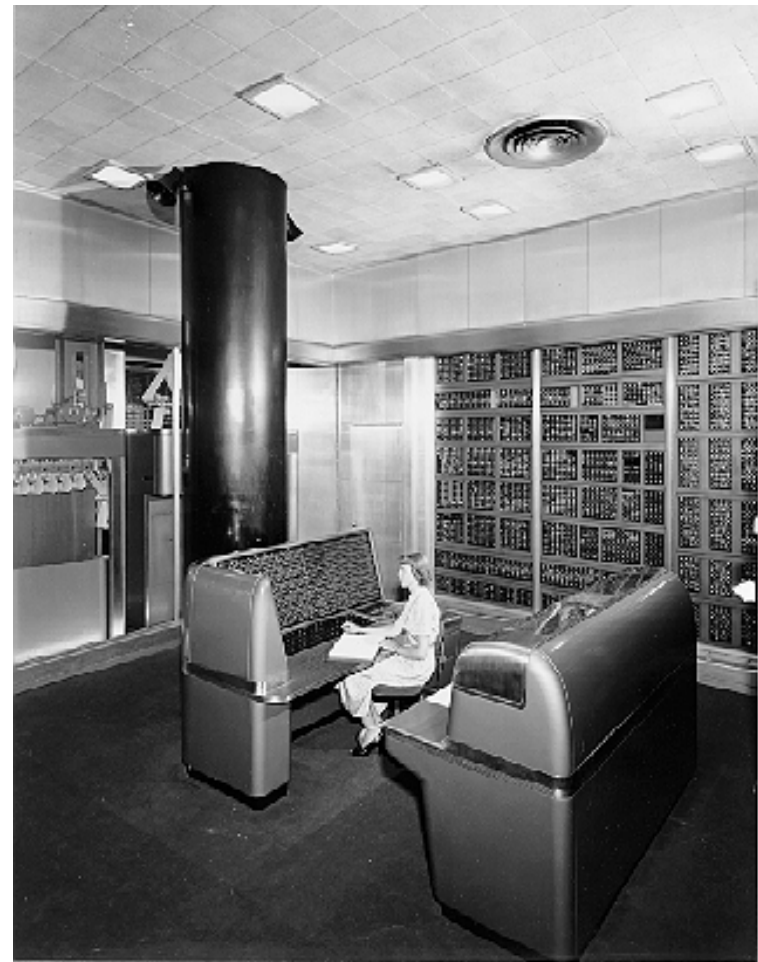
- Take advantage of different expertise

- Transfer of skills: learning

... but computers are (mostly) personal

Time-sharing systems create the illusion that each user has access to all the resources and do not support awareness of what other users are doing.

Example: file system



IBM SSEC, 1948

The PC is ... the personal computer

Designed for one user
performing one task
with one computer



We live in a “connected” world

Or do we?



Trapped inside applications

Email:
open and interoperable

Social networks:
closed and proprietary



Disowned of our files

My files:
personal control



The cloud:
sharing means giving away



No control over the means of communication

Telephone:
choice of operator and device



Videoconferencing: everybody
must use the same service



Walled gardens

We are trapped in
“app ecosystems”



Information silos

We don't own our data



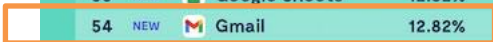
Why?




<https://clario.co/blog/which-company-uses-most-data/>

23	▼		Ryanair	25.64%	•••	•	•••	•	•	•
24	▼		Ocado	25.64%	•••	•	•••	•	•	•
25	▲		Sleepcycle	25.64%	•••	•	•••	•	•	•
26	▼		Paypal	25.64%	•••	•	•••	•	•	•
27	▲		Google Maps	23.08%	••	•	•	•	•	•
28	NEW		YouTube	23.08%	•••	•	•••••	•	•	•
29	NEW		Slack	23.08%	••	•	••	••	•	•
30	▼		IKEA App	23.08%	•••	•	•••	•	•	•
31	▼		Amazon	23.08%	•••	•	•••	•	•	•
32	▼		Trainline	23.08%	•••	••	••	•	•	•
33	▼		Slimming World	23.08%	••••	•	••	•	•	•
34	▼		Walmart	23.08%	••••	••	•	•	•	•
35	▲		Whatsapp	20.51%	••	•	••	•	•	•
36	NEW		Zoom	20.51%	•••	•	•	•	•	•
37	▼		Deliveroo	20.51%	•••	••	•	•	•	•
38	▲		Protect Scotland	20.51%	••	••	•	•	•	•
39	▲		CoStar	20.51%	•••	•	•	•	•	•
40	▼		CVS Pharmacy	20.51%	••••	•	•	•	•	•
41	▼		Offerup	20.51%	••	••	•	•	•	•
42	▼		Doordash	20.51%	••	••	•	•	•	•
43	▼		Amtrak	20.51%	•••	••	•	•	•	•
44	NEW		Coinbase	17.95%	•••	•	•	•	•	•
45	▼		JustEat	17.95%	••	•	•	•	•	•
46	—		Facetune	15.38%	•	•	•	•	•	•
47	▼		Wetherspoon	15.38%	••	•	•	•	•	•
48	▼		Pornhub	15.38%	•••	•	•	•	•	•
49	▼		McDonalds (USA)	15.38%	••	•	•	•	•	•
50	▼		Bet365 USA	15.38%	•••	•	•	•	•	•
51	NEW		Headspace	12.82%	••	•	•	•	•	•
52	NEW		Google Docs	12.82%	••	•	•	•	•	•
53	NEW		Google Sheets	12.82%	••	•	•	•	•	•
54	NEW		Gmail	12.82%	••	•	•	•	•	•
55	NEW		VSCO	12.82%	••	•	•	•	•	•
56	▼		Skybet	12.82%	•••	•	•	•	•	•
57	▼		Flo My Health	10.26%	••	•	•	•	•	•

BUT:
 Google reads
 all your email!




Increased use of face recognition




What can companies tell from image recognition?


The personal data that recognition software helps companies collect from you



Facial recognition
Recognises people and their key attributes



Background recognition
Detects elements in shot, establishes environment



Object recognition
Can identify an object or product within an image

#	Company	Face recognition	Environment recognition	Product recognition	Your contacts	Voice data/ recognition	Access to image library	Languages
1	Facebook	•	•	•	•	•	•	•
2	Instagram	•	•	•	•	•	•	•
3	TikTok	•	•	•	•	•	•	•
4	Twitter	•	•		•	•	•	•
5	Tinder	•	•		•		•	•

Find the full report at clario.co/blog/which-company-uses-most-data

The companies collecting your face, voice & environment

Ranking apps based on % of personal data collected

NEW METRICS

Image recognition

#	Company	Face recognition	Environment recognition	Product recognition	Your contacts	Voice data/ recognition	Access to image library	Languages
1	Facebook	•	•	•	•	•	•	•
2	Instagram	•	•	•	•	•	•	•
3	Tinder	•	•		•		•	•
4	Grindr	•	•		•		•	•
5	Uber	•			•		•	•
6	TikTok	•	•	•	•	•	•	•
7	Strava				•		•	•
8	Spotify					•		•
9	Myfitnesspal				•		•	
10	Clubhouse	•			•	•		•
11	Credit Karma						•	
12	Twitter	•	•		•	•	•	•
13	Airbnb	•	•				•	•
14	Lidl Plus			•				•
15	American Airlines						•	•
16	eBay			•			•	•
17	Sleepcycle					•		•
18	Paypal				•			•
19	Slimming World						•	
20	Whatsapp				•		•	•
21	Zoom	•	•		•			•
22	Protect Scotland				•			•
23	CoStar				•		•	
24	Offerup				•	•		
25	Doordash				•			•
26	Facetune	•	•				•	•
27	Google Docs				•			•
28	Google Sheets				•			•
29	Gmail				•			•
30	VSCO						•	•

Has also access to the audio of video calls

Ad-based business model



Facebook income in 2020:

\$84.2 billion - **98% from ads**

\$32.6 billion profit

38% profit margin



Apple (2020):

\$209 billion income

\$80 billion profit

38% profit margin

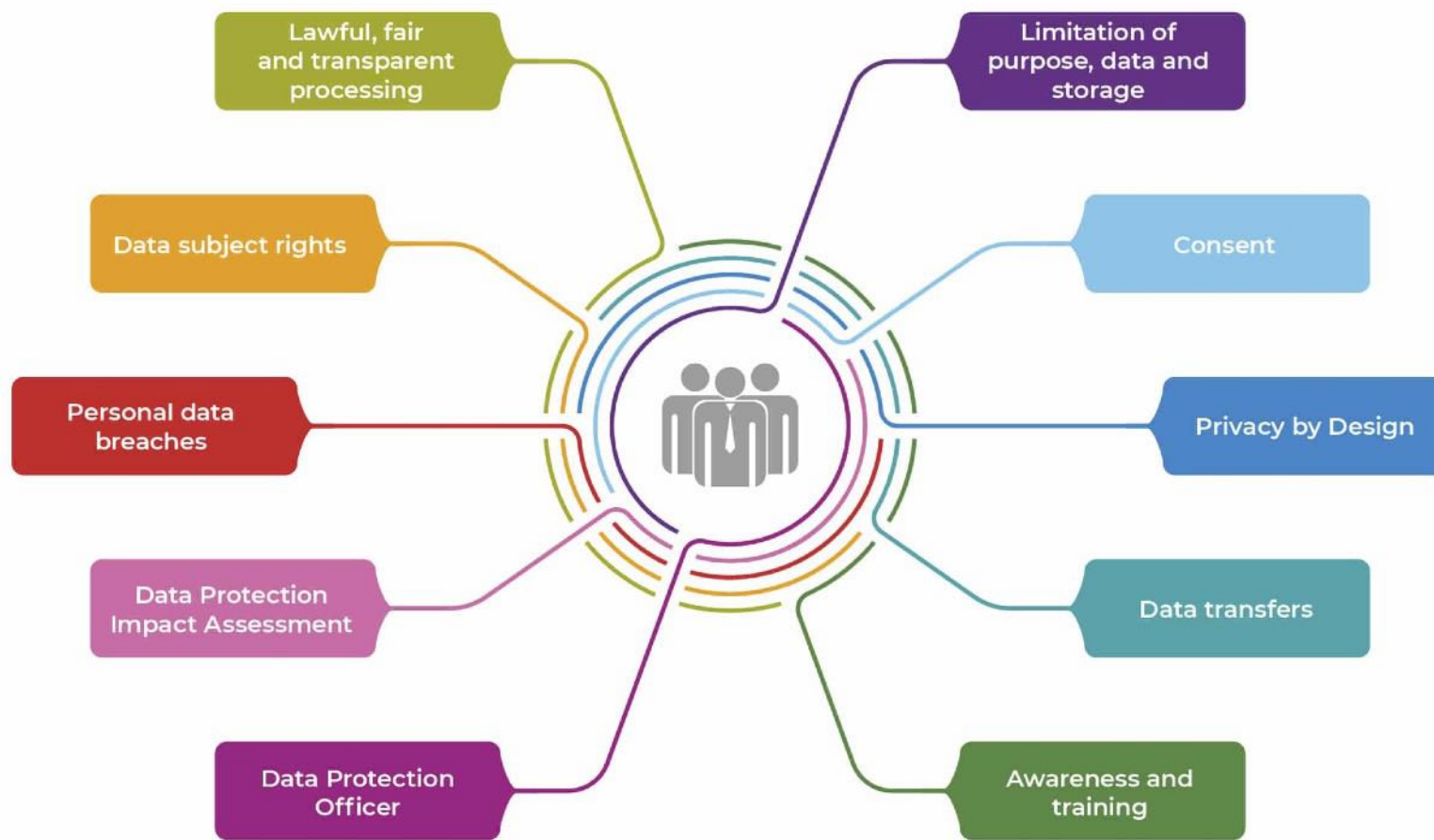
Facebook/Meta has about 3 billion users.

If each user paid \$30 per year (\$2.50 per month) to be able to use Facebook, Instagram, WhatsApp, Facebook/Meta would generate the same income



GDPR - General Data Protection Regulation

Ten key GDPR requirements



“Informed” consent

Do you know what you consent to?

YOUR LOGO Powered by **Cookiebot** by Usercentrics

Consent Details About

This website uses cookies

We use cookies to personalise content and ads, to provide social media features and to analyse our traffic. We also share information about your use of our site with our social media, advertising and analytics partners who may combine it with other information that you've provided to them or that they've collected from your use of their services.

Necessary <input type="checkbox"/>	Preferences <input checked="" type="checkbox"/>	Statistics <input checked="" type="checkbox"/>	Marketing <input checked="" type="checkbox"/>
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Deny Allow Selection Allow all

Powered by **Cookiebot** by Usercentrics

Consent **Details** About

▼ **Necessary** 33

Necessary cookies help make a website usable by enabling basic functions like page navigation and access to secure areas of the website. The website cannot function properly without these cookies.

▼ **Preferences** 14

Preference cookies enable a website to remember information that changes the way the website behaves or looks, like your preferred language or the region that you are in.

▼ **Statistics** 21

Statistic cookies help website owners to understand how visitors interact with websites by collecting and reporting information anonymously.

▼ **Marketing** 36

Marketing cookies are used to track visitors across websites. The intention is to display ads that are relevant and engaging for the individual user and thereby more valuable for publishers and third party advertisers.

▼ **Unclassified** 2

Unclassified cookies are cookies that we are in the process of classifying, together with the providers of individual cookies.

Cross-domain consent 4

Your consent applies to the following domains:

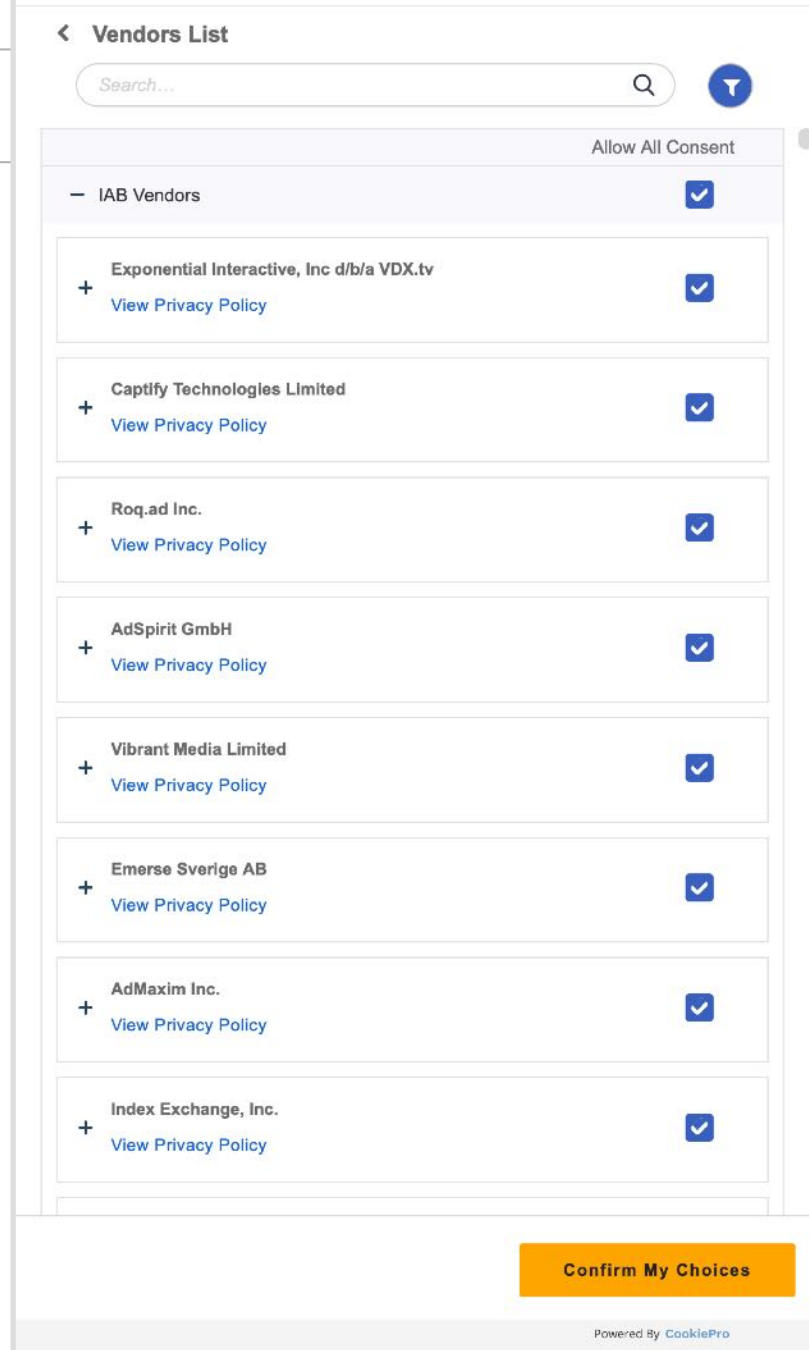
Deny Allow selection Allow all

“Informed” consent

Example (investing.com):
more than 1600 vendors

Manage Consent Preferences

+ Strictly Necessary Cookies	Always Active
+ Performance Cookies	<input checked="" type="checkbox"/>
+ Functional Cookies	<input checked="" type="checkbox"/>
+ Targeting Cookies	<input checked="" type="checkbox"/>
+ Store and/or access information on a device	<input type="checkbox"/>
+ Personalised ads and content, ad and content measurement, audience insights and product development	<input type="checkbox"/>
+ Use precise geolocation data	<input type="checkbox"/>
+ Actively scan device characteristics for identification	<input type="checkbox"/>
+ Ensure security, prevent fraud, and debug	Always Active
+ Technically deliver ads or content	Always Active
+ Match and combine offline data sources	Always Active
+ Link different devices	Always Active
+ Receive and use automatically-sent device characteristics for identification	Always Active



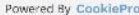
Vendors List

Search...

Allow All Consent

- IAB Vendors
- + Exponential Interactive, Inc d/b/a VDX.tv
[View Privacy Policy](#)
- + Captify Technologies Limited
[View Privacy Policy](#)
- + Roq.ad Inc.
[View Privacy Policy](#)
- + AdSpirit GmbH
[View Privacy Policy](#)
- + Vibrant Media Limited
[View Privacy Policy](#)
- + Emerse Sverige AB
[View Privacy Policy](#)
- + AdMaxim Inc.
[View Privacy Policy](#)
- + Index Exchange, Inc.
[View Privacy Policy](#)

Confirm My Choices

Powered By 

Why is this relevant?

Collaborative computing requires infrastructure to mediate the collaboration

Whoever runs the infrastructure controls who can collaborate and how

This infrastructure becomes a form of commons



Who should control it?
Under what rules?

What is Collaborative Computing?





Don Norman

*"Most work done on any complex entity
is done by more than one person"*



"Social impact of technology is hard to predict"

Augmenting the human intellect

1968 : Engelbart and his colleagues NLS/Augment, a system that supported file sharing, personal annotations, electronic messaging, videoconferencing, screen sharing, telepointers, etc.





NLS / Augment - Douglas Engelbart (1968)



Emergence of a field

Started under the umbrella of “Office Information Systems”

Software that supports group work

- Groupware (Johnson-Lenz, 1982)
- Computer Supported Cooperative Work (Greif & Cashman, 1984)

In French:

- *Collecticiel*
- *Travail Coopératif Assisté par Ordinateur (TCAO)*

Conferences: CSCW (ACM) and ECSCW since 1986

Journal of CSCW

Social definition

CSCW should be conceived as an endeavor to understand the nature and characteristics of cooperative work with the objective of designing adequate computer-based technologies. [...]

The focus is to *understand*, so as to *better support*, cooperative work.

Bannon et Schmidt, 1989

Engineering definition

Computer-based systems
that support
groups of people
engaged in
a common task (or goal)
and that provide
an interface to a shared environment

Ellis, Gibbs & Rein, 1991

Software definition

Groupware is distinguished from normal software by the basic assumption it makes: groupware makes the user aware that he is part of a group, while most other software seeks to hide and protect users from each other.

Lynch, Snyder & Vogel, 1990

Challenges

What should groupware systems do?

How to design them?

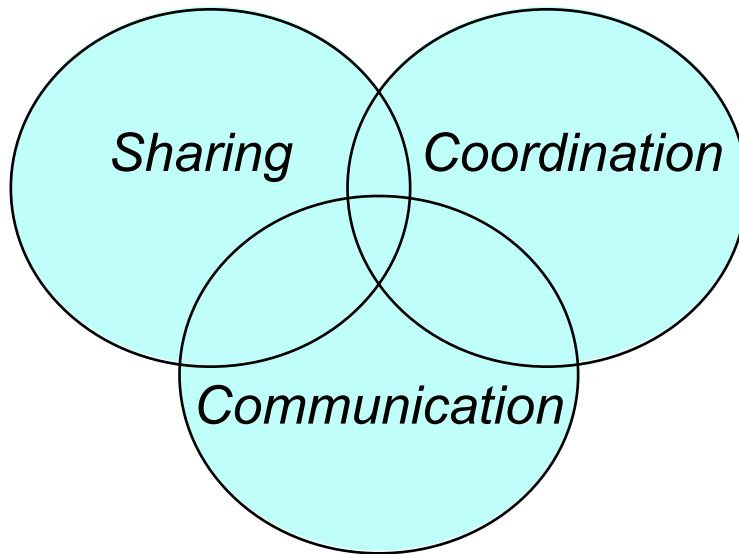
How do they affect use?

A multidisciplinary endeavor: sociology, ethnography, anthropology, design, computer science, etc.

Problems are both technical and human

Solutions are both technical and human

Functional taxonomy



Sharing

accessing and editing
digital artifacts

Coordination

division of labor
among participants

Communication

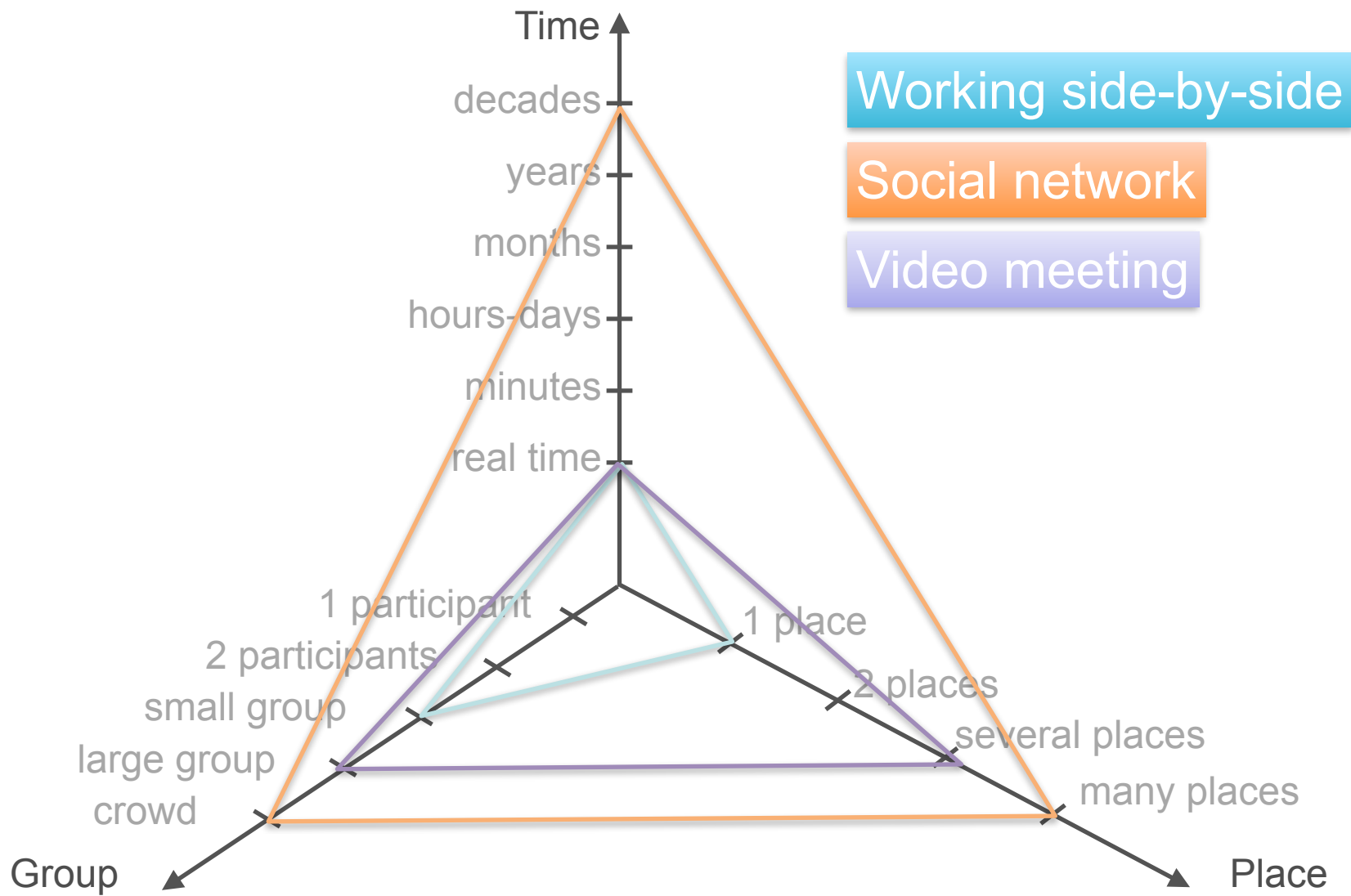
exchanging information
among participants

Space-time matrix

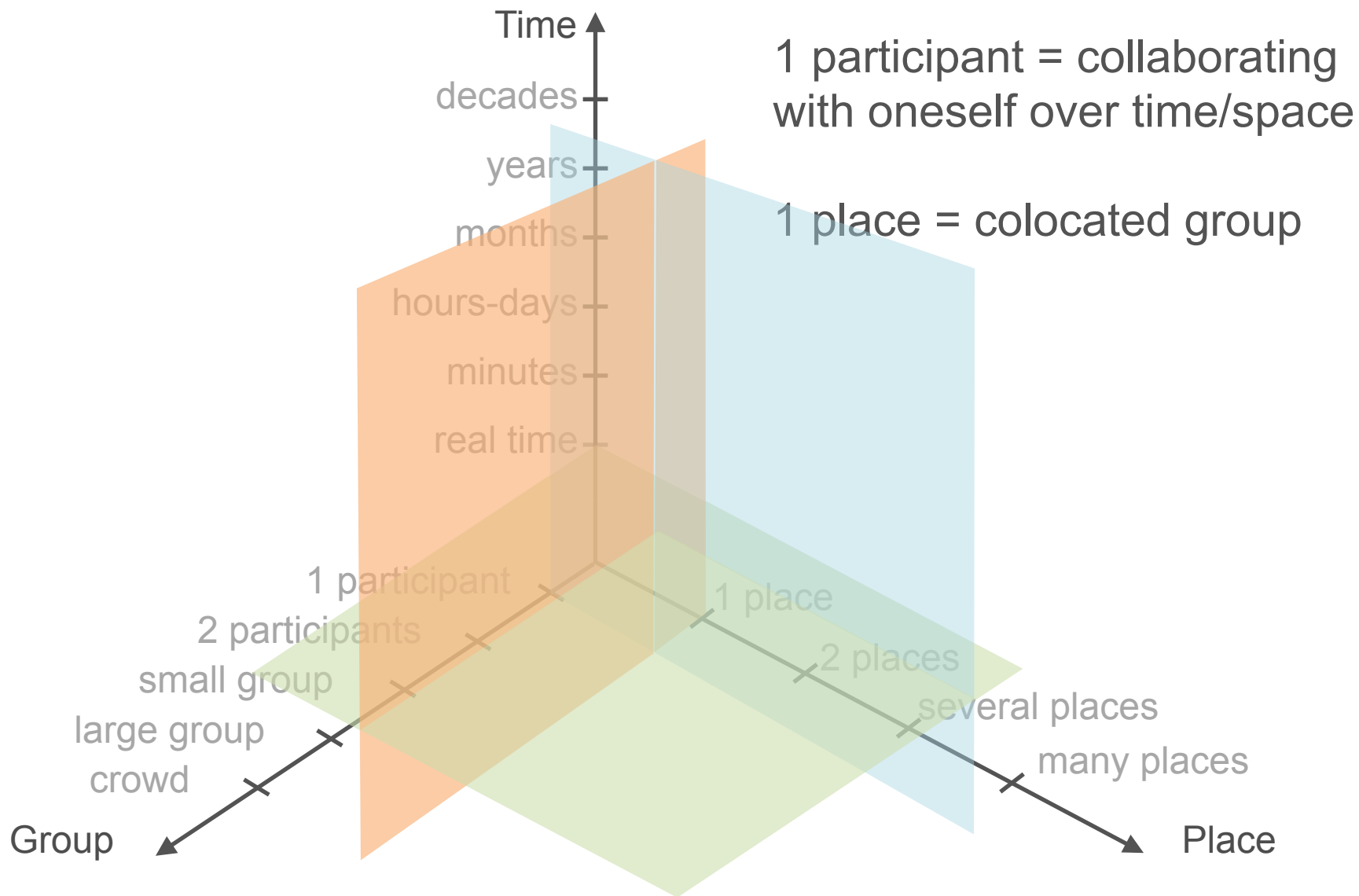
Johansen, 1988

	Same place	Different place
Same time	face-to-face conversation	telephone call
Different time	Post-it note	letter

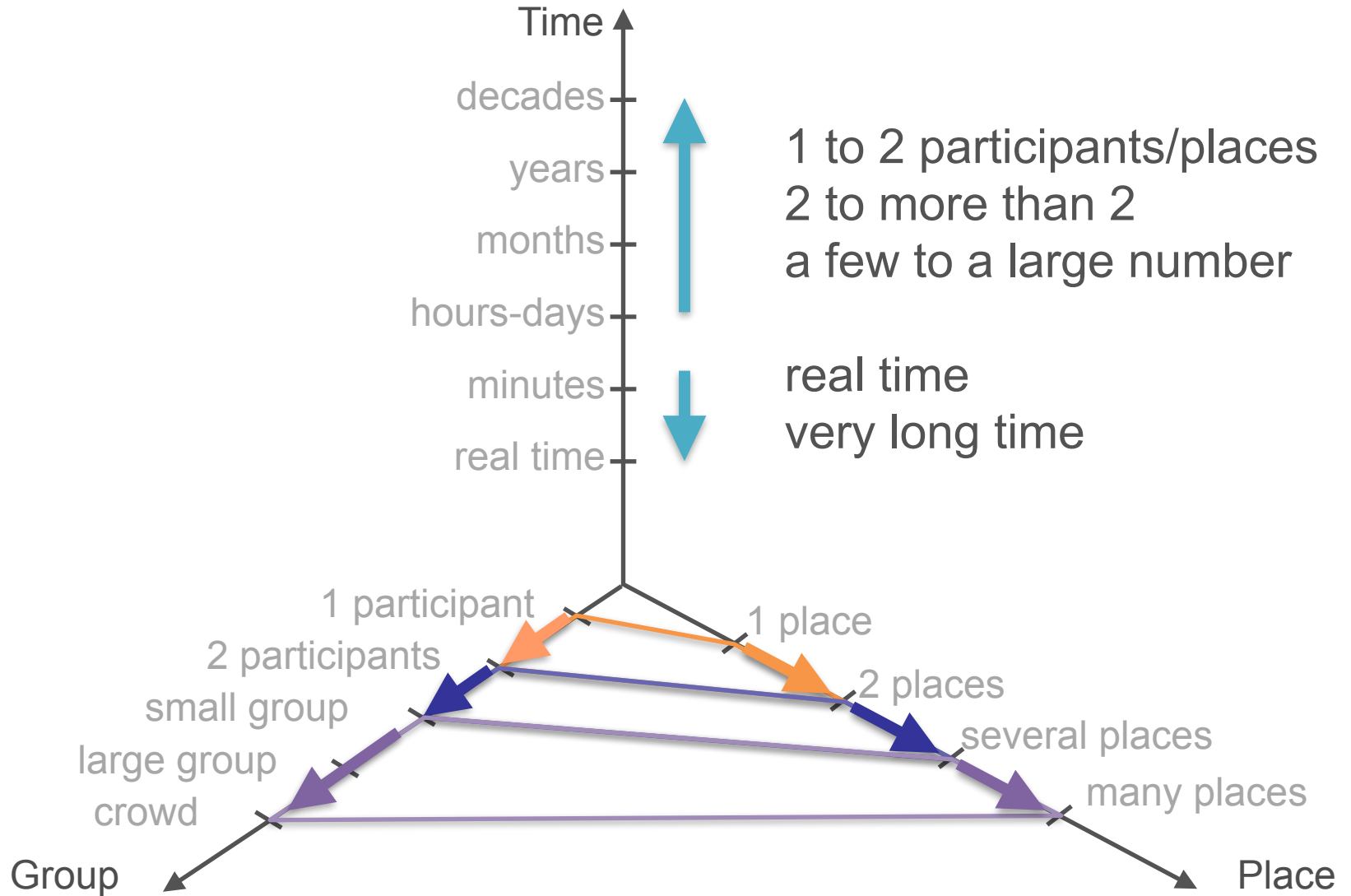
Group-time-space continuum



Group-time-space continuum



Scaling is difficult

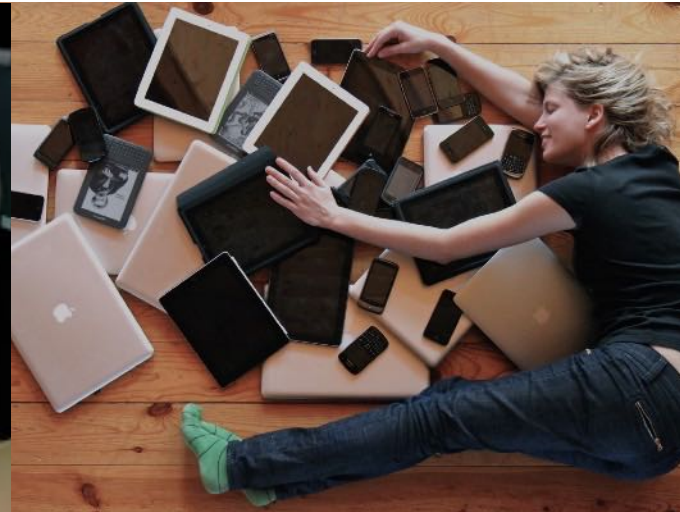


Another dimension: devices

There are usually more devices than people












Collaboration with oneself across our devices

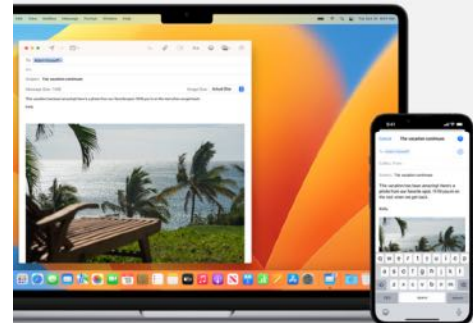
Making devices “collaborate” with each other



Apple Continuity

“All your devices, one seamless experience”

-  - Use iPhone as camera
-  - Use mouse/keyboard for tablet
-  - Use tablet for desktop
-  - AirPlay between devices
-  - Get messages across devices
-  - Unlock screen with watch
-  - Answer call on desktop
-  - Airdrop files across devices
-  - Copy-paste across devices
-  - Start editing on one device, finish on another
-  - Use phone as hotspot
- ...



Collaboration is fluid

During the course of a collaborative activity,
the mode of collaboration changes, sometimes quickly

- from real time to different time
- from sharing to communicating to coordinating
- from tight coupling to loose coupling
- from everyone together to hybrid to fully remote

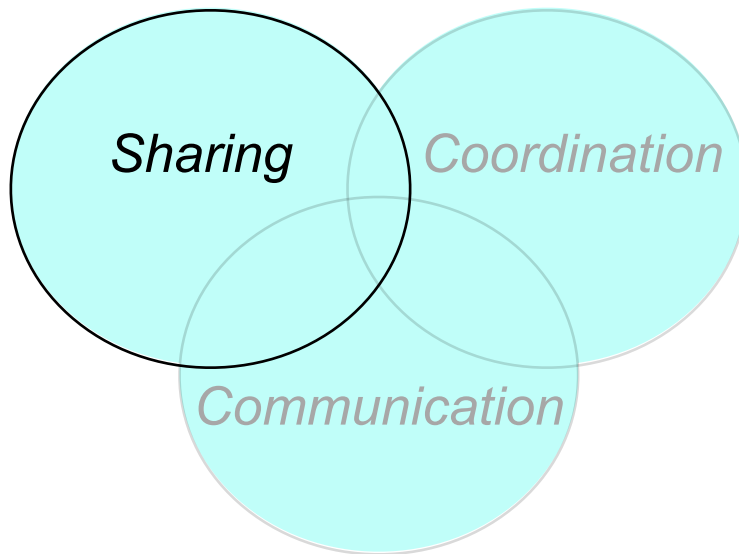
BUT most software do not address these transitions

A sample of collaborative systems

Share



Functional taxonomy



Sharing

creating and editing
digital artifacts

Coordination

division of labor
among participants

Communication

exchanging information
among participants

Colab

Stefik et al., 1987

Meetings of small group in a specially-equipped room

“Shared external memory”

Boardnoter : hand drawing

Cognoter : outlining ideas

Argnoter : argumentation spreadsheet



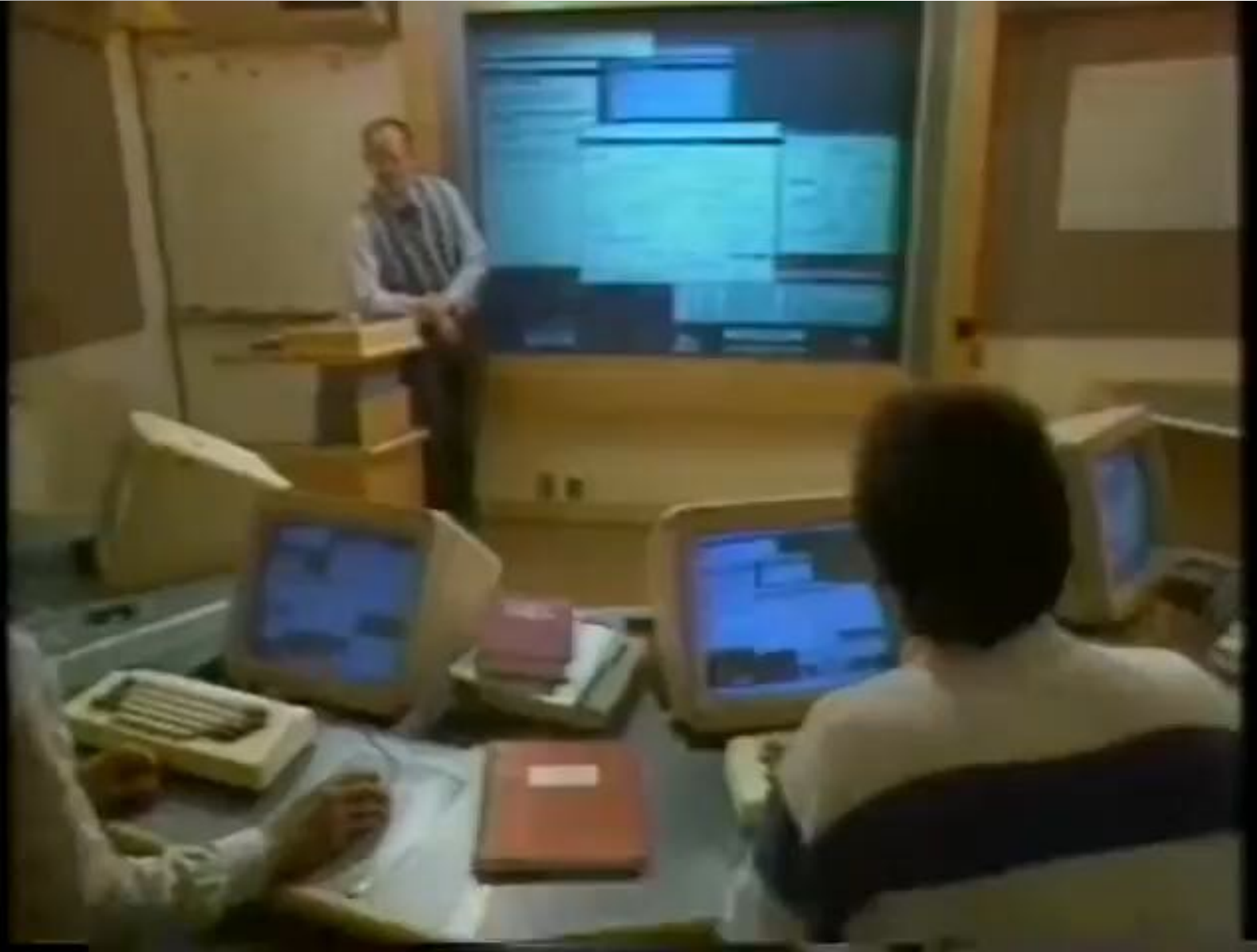
View, space and time congruence

What You See is What I See

What You See Is Almost What I See

Colab

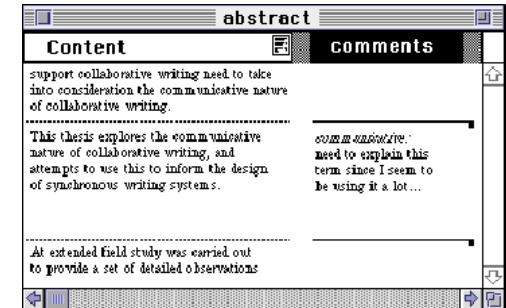
Stefik et al., 1987



Shared editing

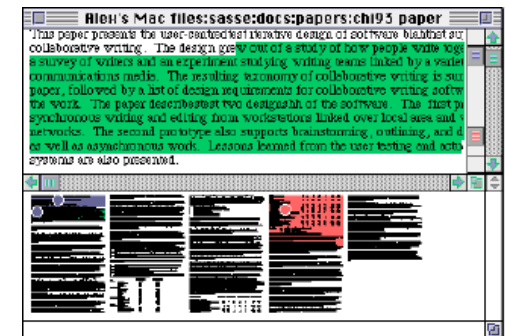
Text, asynchronous

- Quilt (Leland, Fish & Kraut, 1988)
- Prep (Neuwirth et al., 1989)



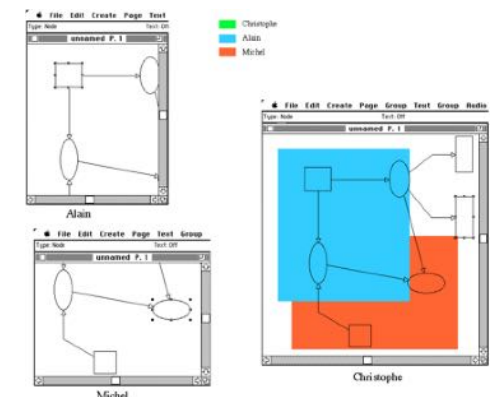
Text, synchronous

- Grove (Ellis, Gibbs & Rein, 1989)
- ShrEdit (McGuffin & Olson, 1992)
- SASSE (Baecker et al., 1993)

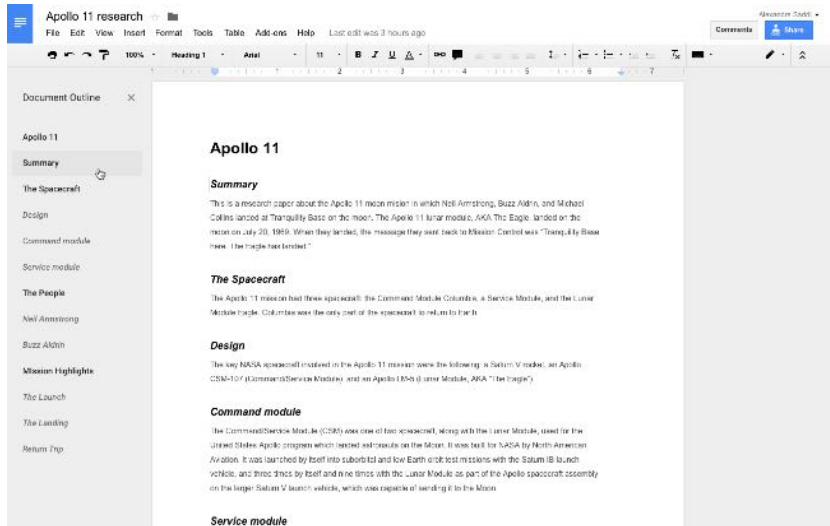


Graphics, synchronous

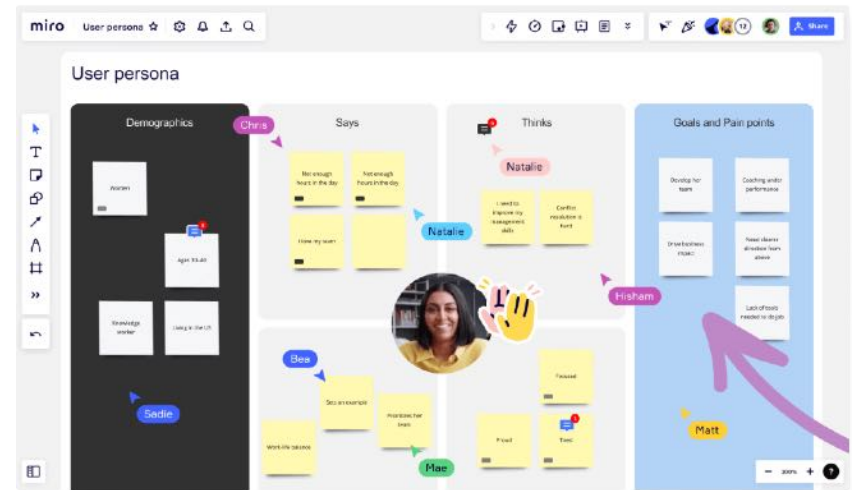
- GroupDesign (Karsenty & Beaudouin-Lafon, 1992)



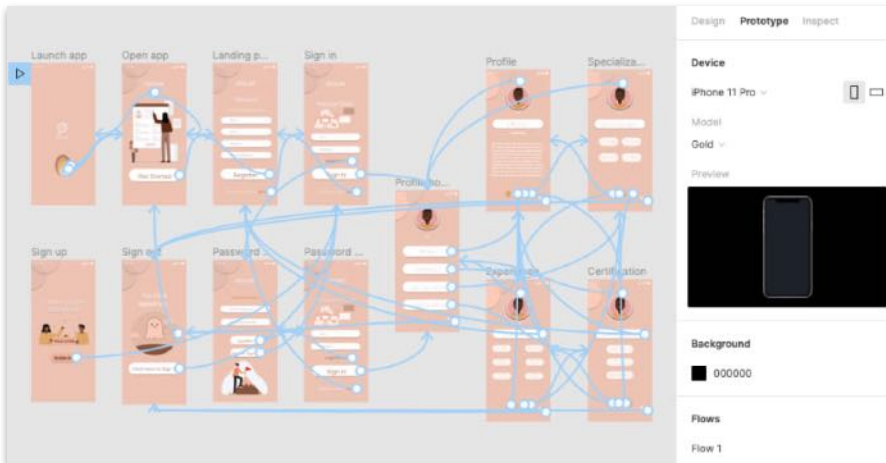
Web-based shared editing is now common



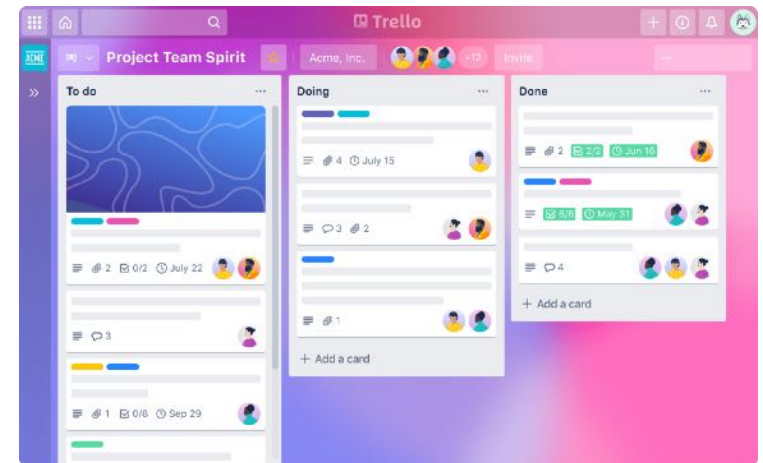
Google docs



Miro



Figma



Trello

Webstrates

Klokmoose, Eagan, Baader,
Mackay, Beaudouin-Lafon, 2015

The image shows a side-by-side comparison of a webstrates editor and its rendered output. The left window is the editor, and the right window is the preview.

A modular approach to collaborative heads-up displays

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ABSTRACT
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AUTHOR KEYWORDS
Lorem, ipsum, dolor, it.

ACM CLASSIFICATION KEYWORDS
H5.m. Information interfaces and presentation (e.g., HCI); Miscellaneous.

INTRODUCTION
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Author Keywords
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ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI); Miscellaneous.

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RELATED WORK
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Tabletop interaction

DiamondTouch (Dietz et al., 2001)

Interactive multitouch table

Participant identification

DiamondSpin (Shen et al., 2004)

User interface toolkit for tabletops

Reactable (Jordá et al., 2005)

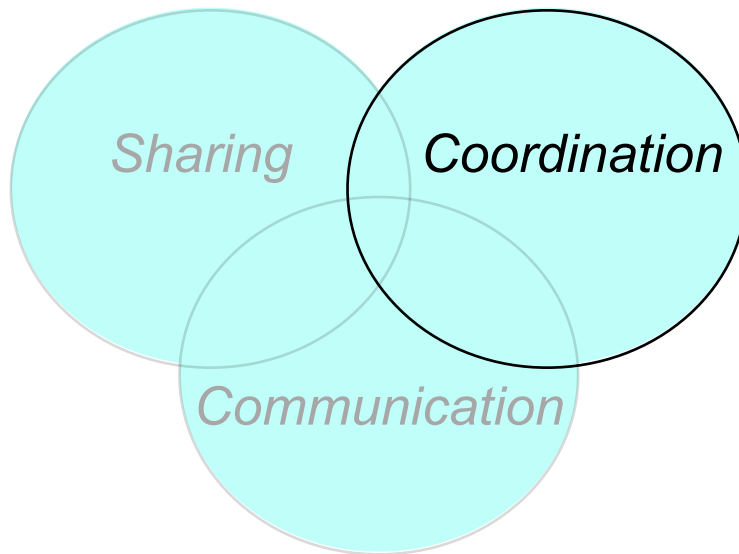
tangible interaction



Coordinate



Functional taxonomy



Sharing

creating and editing
digital artifacts

Coordination

division of labor
among participants

Communication

exchanging information
among participants

Information lens

Malone et al., 1987

Rule-based processing of email

“**if** email from mbl@lri.fr **and** subject includes Master
then file under Courses/Groupware”

To:
From: Thomas Malone
Cc: Anyone
Subject : LENS Meeting This Monday
Topic : Lens
Day: Monday
Meeting Date: Time: 3:00
Place: E53-301
Text:

Workflow systems

Managing a document across an organization

Example : a document includes metadata describing its path through an organization

- must be written by Anne by April 15
- must be proofread by Bob by April 22
- must be approved by Charlie by April 29
- must be sent to Charlie by May 4

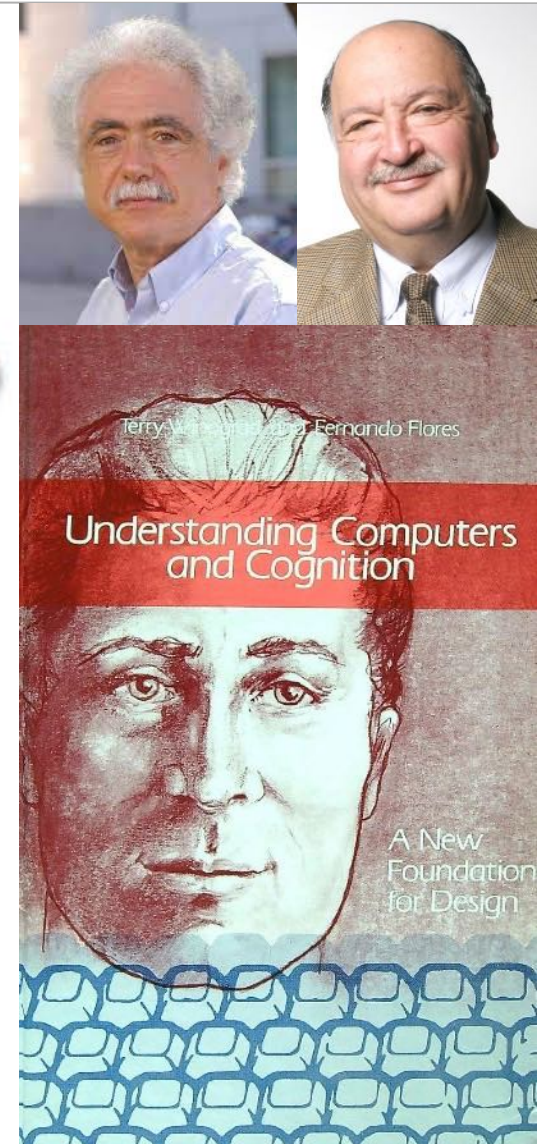
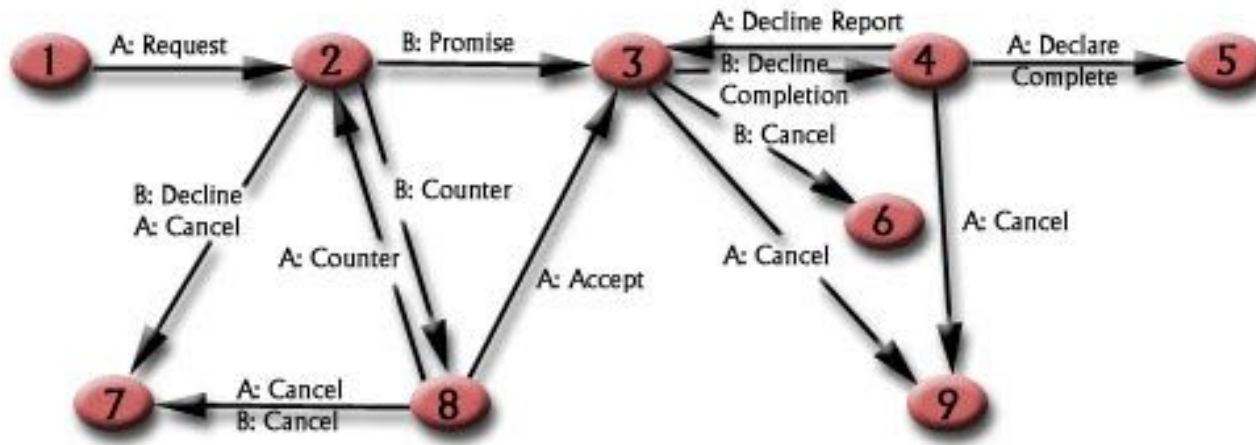
The document "knows its way"
and can send reminders
to the various people involved



The Coordinator

Winograd & Flores, 1988

Based on the theory of speech acts (Searle)



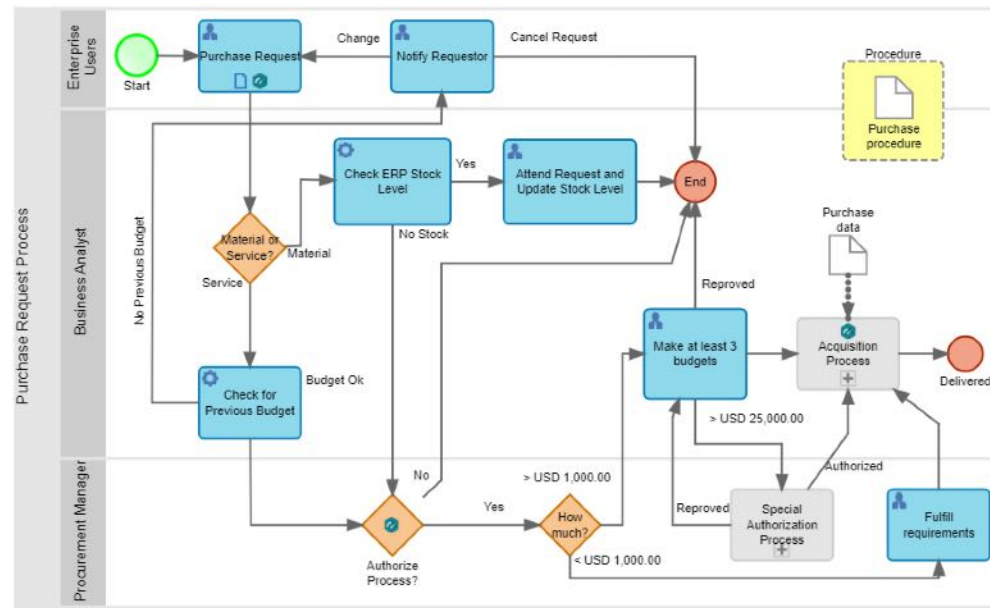
Critique by Lucy Suchman

Business Process Management (BPM)

Optimize enterprise processes
Automate where possible

Large companies: SAP, SalesForce

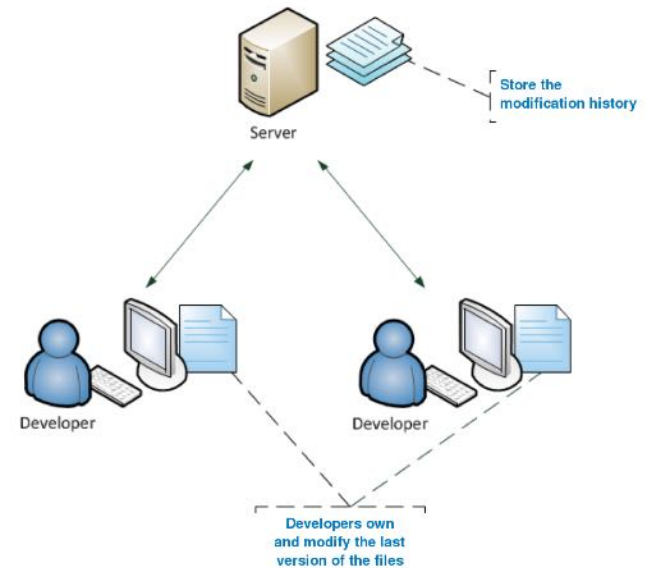
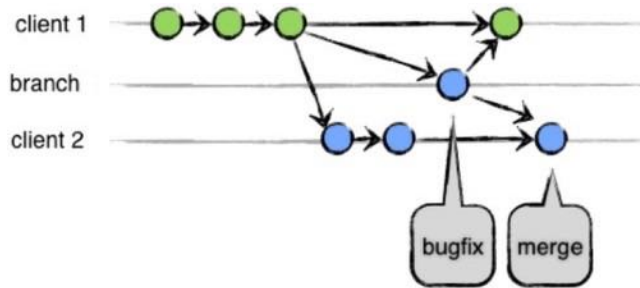
Modern form of Taylorism:
Humans must conform
to the processes



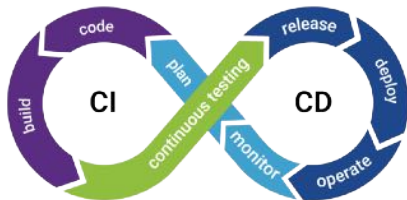
Collaborative software development

Manage complex software system development

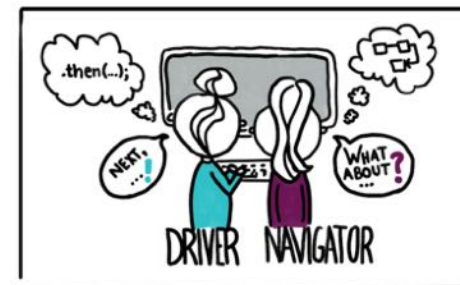
Version control



Continuous integration



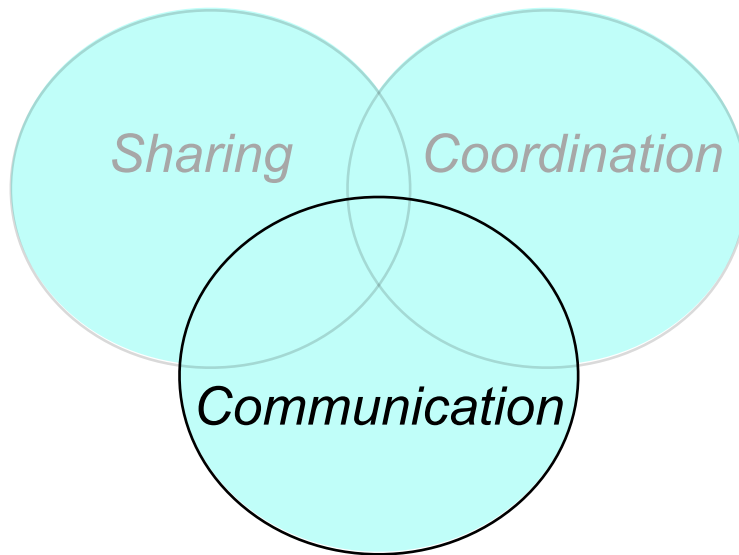
Agile development methods



Communicate



Functional taxonomy



Sharing

creating and editing
digital artifacts

Coordination

division of labor
among participants

Communication

exchanging information
among participants

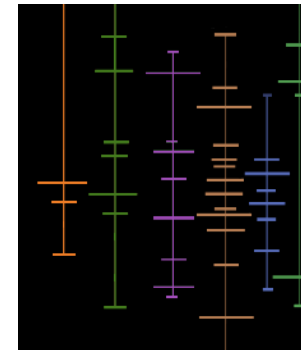
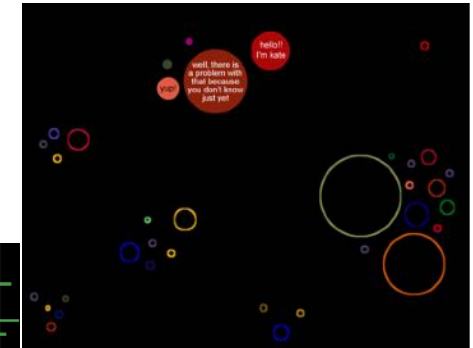
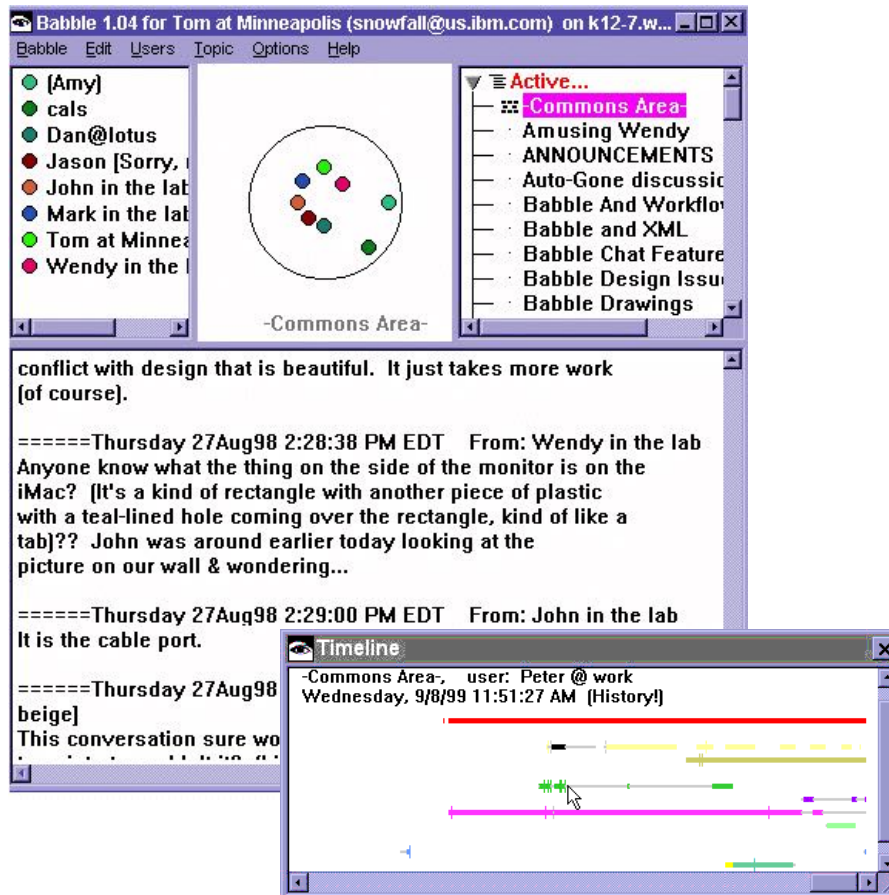
Text-based real-time communication

```
[No connection yet]
[Connection established with hipo@localhost.]
hi glad to talk ya t00
how iz life ??
```

```
hi hi ;)
Glad to talk you here.
```

Unix talk

Chat rooms: for small groups



Babble (Bradner et al., 1988)
<http://www.research.ibm.com/SocialComputing/babble.htm>

Chat circles (Viégas et al., 1999)
<http://web.media.mit.edu/~fviegas/circles/>
<http://web.media.mit.edu/~fviegas/CC2/>

Video-mediated communication

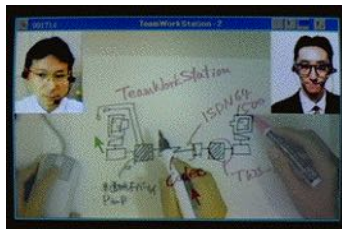
Hole-in-Space (1980)



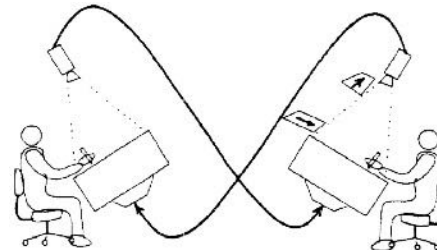
Mediaspaces (1983-)



TeamWorkStation (1990)



VideoDraw (1991)



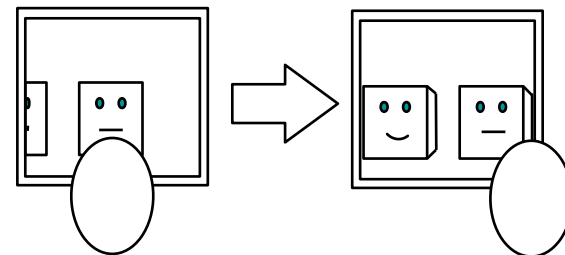
ClearBoard (1991-94)



Videoplace (1974-85)



Virtual window (1995)

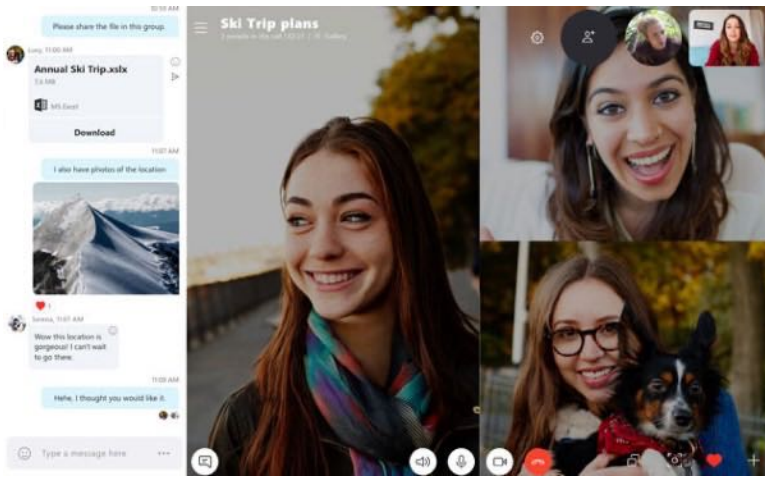


Clearboard

Ishii et al., 1992



Videoconferencing: all the same



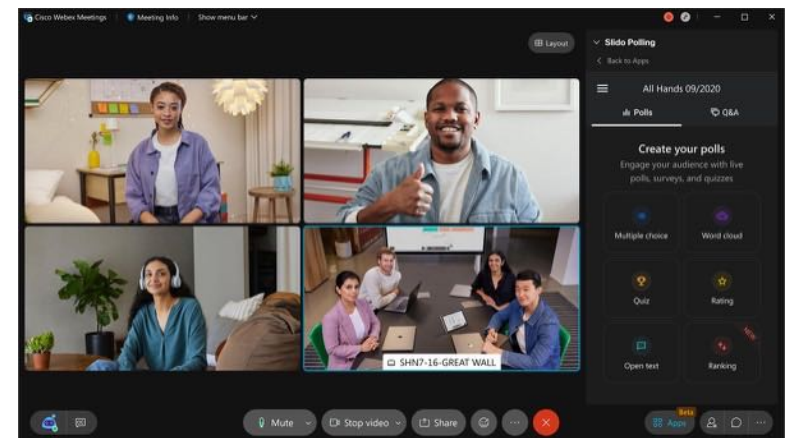
Skype



Zoom



Teams



Webex

Social networks: scale up



Social networks: scale up

From small, “intimate” social networks
to large groups of “followers”

Explosion of the number of users

Shift towards pushing information to sustain “engagement”
for better (Arab springs, ...)

and for worse (fake news, harassment, ...)

The fight for user attention to sustain the business model

Large-scale experiments without informed consent

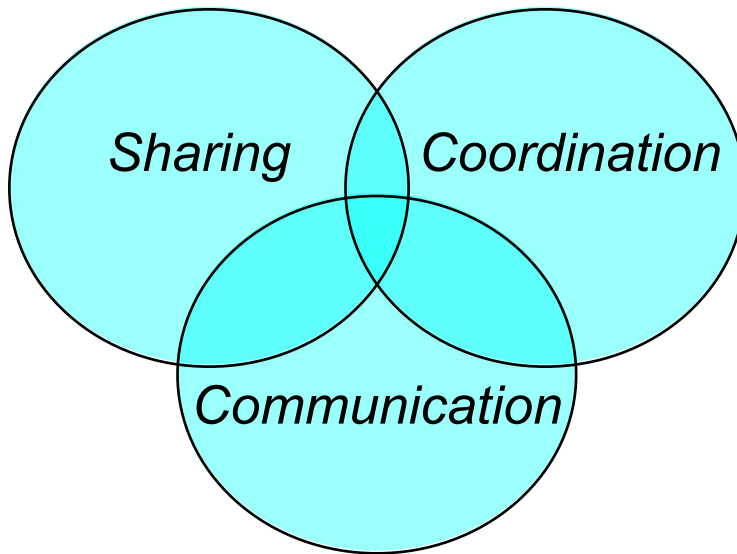
Evidence that social media affects teens’ self-esteem

Regulate, but how?

Collaborate



Functional taxonomy



Sharing

creating and editing
digital artifacts

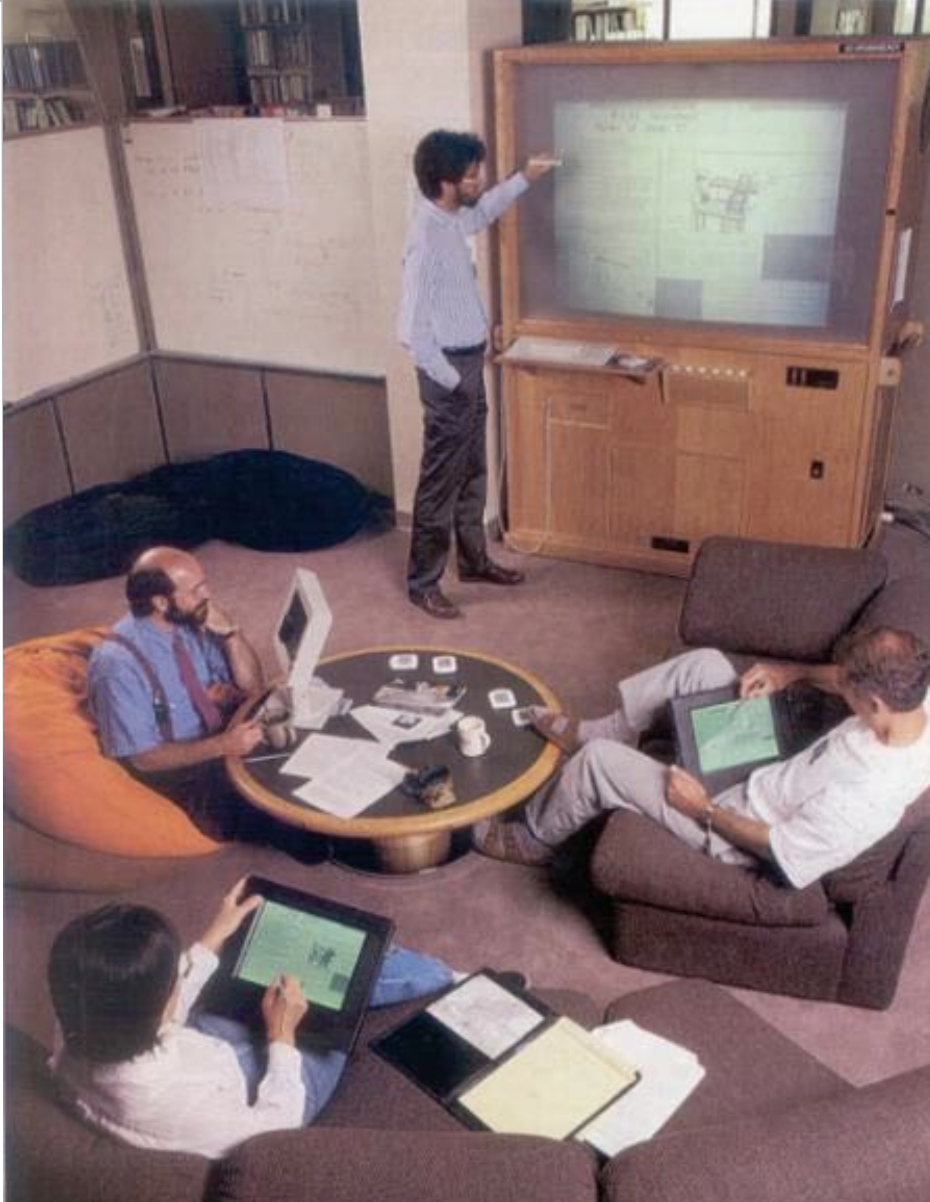
Coordination

division of labor
among participants

Communication

exchanging information
among participants

Collaborative spaces



Cooperative buildings
(Streitz et al., 1998)

Ubicomp (Weiser, 1991)

Interactive spaces

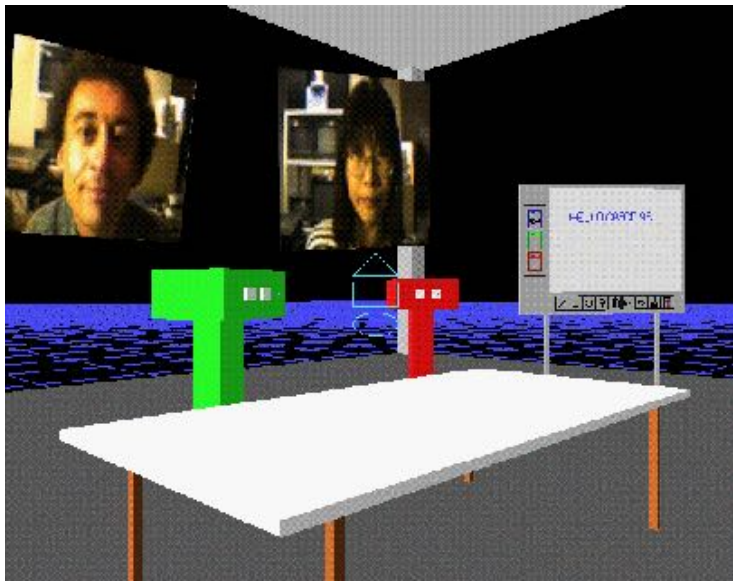
Collaborate on a wall-sized display

CoReach: collaborative gestures (Liu et al., 2017)



Collaborative Virtual Environments

Represent participants by avatars in a virtual world



DIVE (1991)



Second Life (2005)

Networked games

Real-time massively multiplayer games



World of Warcraft (2004)



Fortnite (2017)

The metaverse: utopia or dystopia?



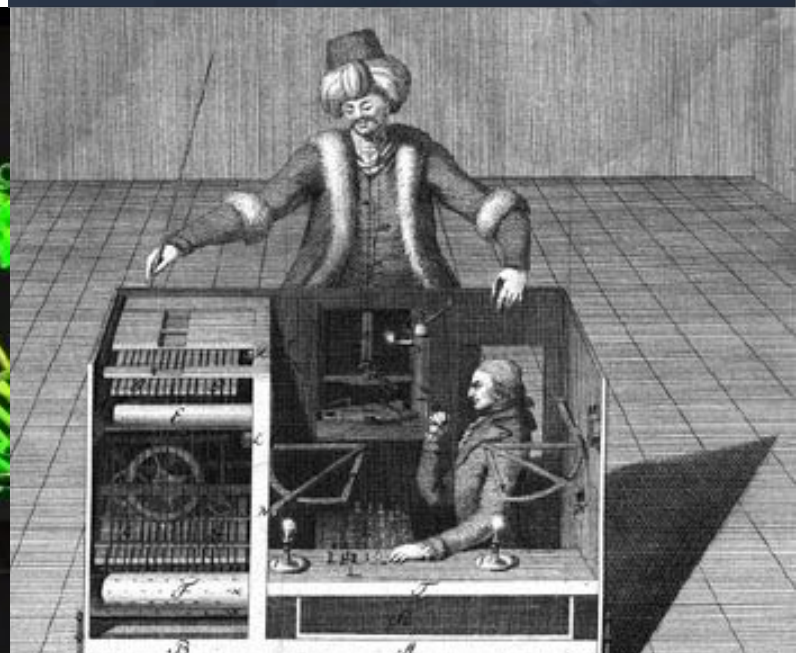
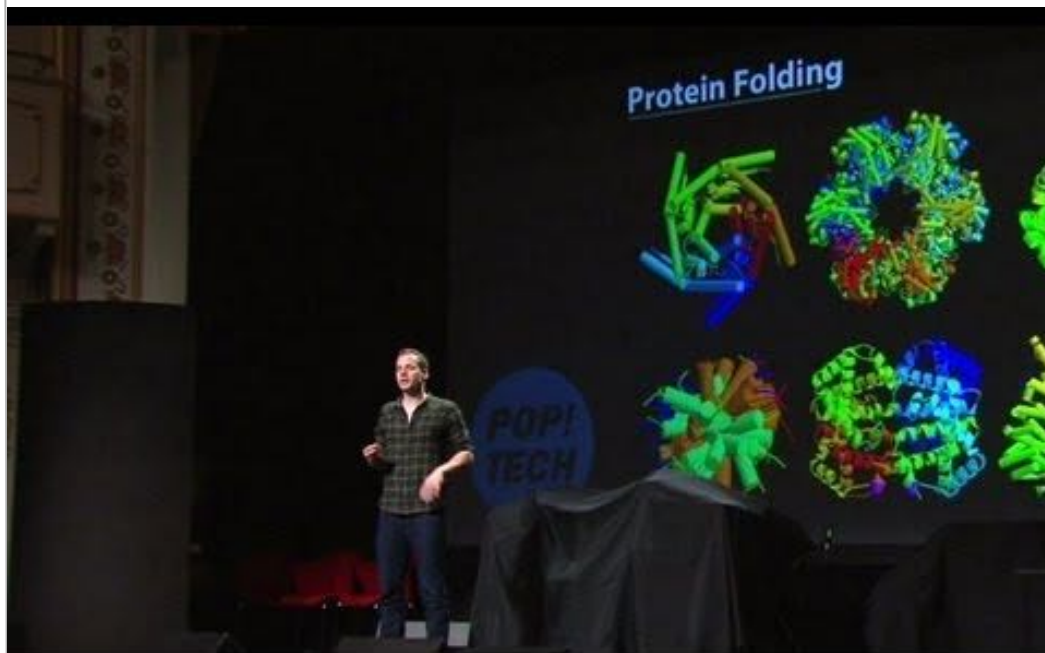
Crowdsourcing: Human-machine collaboration

Harness the power of the crowd

Combine human intelligence
with machine computation

Amazon Mechanical Turk

Access a global, on-demand, 24x7 workforce



Challenges for designers

Grudin (1994)



Jonathan Grudin

- Who does the work vs. who gets the benefit
- Critical mass and Prisoner's dilemma problems
- Disruption of social processes
- Exception handling
- Unobtrusive accessibility
- Difficulty of evaluation
- Failure of intuition
- Careful adoption process

Privacy, and other social behaviors



"On the Internet, nobody knows you're a dog."

Plausible deniability



Some references

- C.A. Ellis, S.J. Gibbs, and G. Rein. "Groupware, some issues and experiences". *Communications of the ACM*, 34(1):39-58, January 1991.
- J. Grudin. "Groupware and social dynamics: Eight challenges for developers". *Communications of the ACM*, 37(1):92-105, January 1994.
- R. Baecker, editor. *Readings in Groupware and Computer-Supported Cooperative Work : Assisting Human-Human Collaboration*. Morgan-Kaufmann, December 1992. 882 pages.
- M. Beaudouin-Lafon, editor. *Computer Supported Co-operative Work*. John Wiley & Sons Ltd, 1999. 258 pages.
<http://www.lri.fr/~mbl/Trends-CSCW/>