

software design

& why it matters

Daniel Jackson · MIT CSAIL

Milan, Paris, Frankfurt · May 16-20, 2016



introduction

my background



PhD in Computer Science, MIT



MA in Physics,
Oxford University



Prof, MIT



Assistant Prof, CMU

other projects

Room:free : auto (number) ▾ computed by formula ▾

Formula: Save Cancel

Room		Occupant			Role	
name	sqFoot	name	role	free	title	allocSpace
text	number	text	Role	number	text	number
Dungeon Five	480	Sirius	<u>Grad. student</u>	436	Grad. student	12
		James	<u>Post-doc</u>		Post-doc	20
		Wormtail	<u>Grad. student</u>		Visiting Prof.	45
Greenhouse Two	561	Bellatrix	<u>Visiting Prof.</u>	496		
		Lily	<u>Post-doc</u>			

cyberphysical
security

new programming
paradigms



changes in
how we live
& work

growth of online activity

72% of millennials research & shop online before going to a store



27 metro areas in US

ORDER PLACED
May 30, 2013

TOTAL
\$41.76

SHIP TO
Daniel Jackson ▾

ORDER # 107-4962317-6190632
[Order Details](#) | [Invoice](#)



Goya Foods Inc Beans, Butter, 15.50-Ounce (Pack of 24)

Sold by: Amazon.com LLC

\$41.76

Buy it Again

Return or replace items

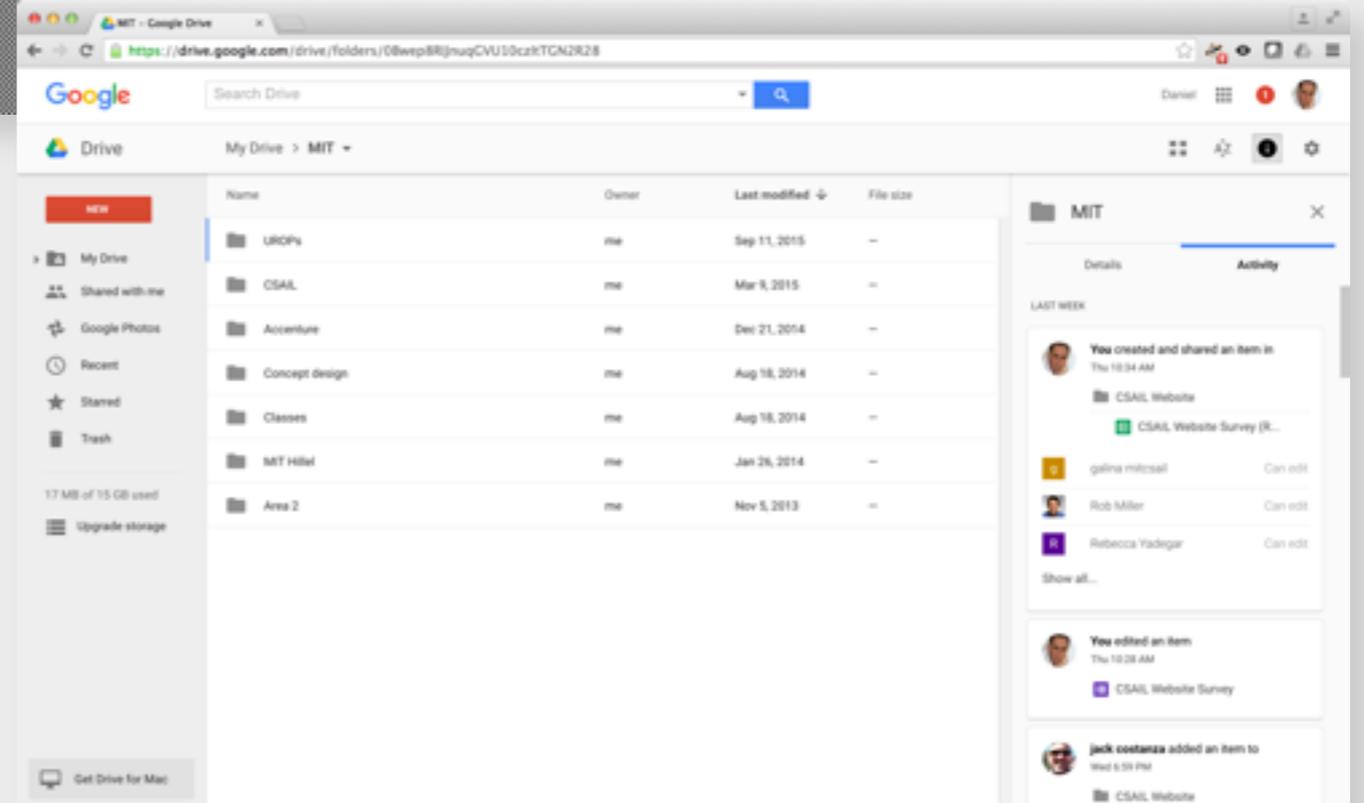
Write a product review

Archive order

connectivity



browser, 1986



browser, 2016

deprofessionalization

```
5 MARRIOTT SENIOR DISC.          305.00USD  GUAR /C-6P
TTL TAX          132.67
APPROX. TOTAL PRICE    1047.67  USD
INCLUDES TAXES AND SURCHARGES

MARRIOTT SENIOR DISCOUNT RATE, 62 YEARS AND OLDER VALID ID
REQUIRED GUEST ROOM, 1 KING OR 2 DOUBLE, CENTER OR PARK, POOL

PLACE BED TYPE AND NS REOS IN /ST

US GOVERNMENT SAFETY/FI
MD<<

** SAE

ADDITIONAL FEES - MB FC
AIRPORT SHUTTLE -N-
CAR RENTAL COUNTER -N
PARKING -Y
CHECK IN -160
CHECK OUT -120

PROPERTY INFORMATION
FITN -Y- CSNO -N-
TENS -N- BCTR -Y-
CONV -Y- PETS -Y-
JACZ -N- BKST -N-
INTR -Y- RMSV -Y-
EXEC -Y- BECH -N-
```

Sabre

The screenshot shows the hipmunk.com website interface. The browser address bar displays the URL: <https://www.hipmunk.com/flights#f=BOS;t=PAR;d=2016-05-15;r=2016-05-22>. The page header includes the hipmunk logo and navigation links for Flights, Hotels, Cars, Packages, and Deals. The search parameters are displayed as "BOS ↔ PAR: Sun May 15 – Sun May 22, 1 person, Coach". Below the search bar, there are options to compare rates on partner sites like CheapTickets, SmartFares, justfly.com, StudentUniverse, and Justairticket. The main content area shows flight options with a timeline from Boston to Paris. The first option is priced at \$960.29+, the second at \$1,284.69+, and the third at \$1,075.61+. The United logo is visible at the bottom of the flight results section.

hipmunk.com

example: book publishing



design layout
Adobe Indesign



printing
Blurb



marketing
Facebook,
Twitter, etc

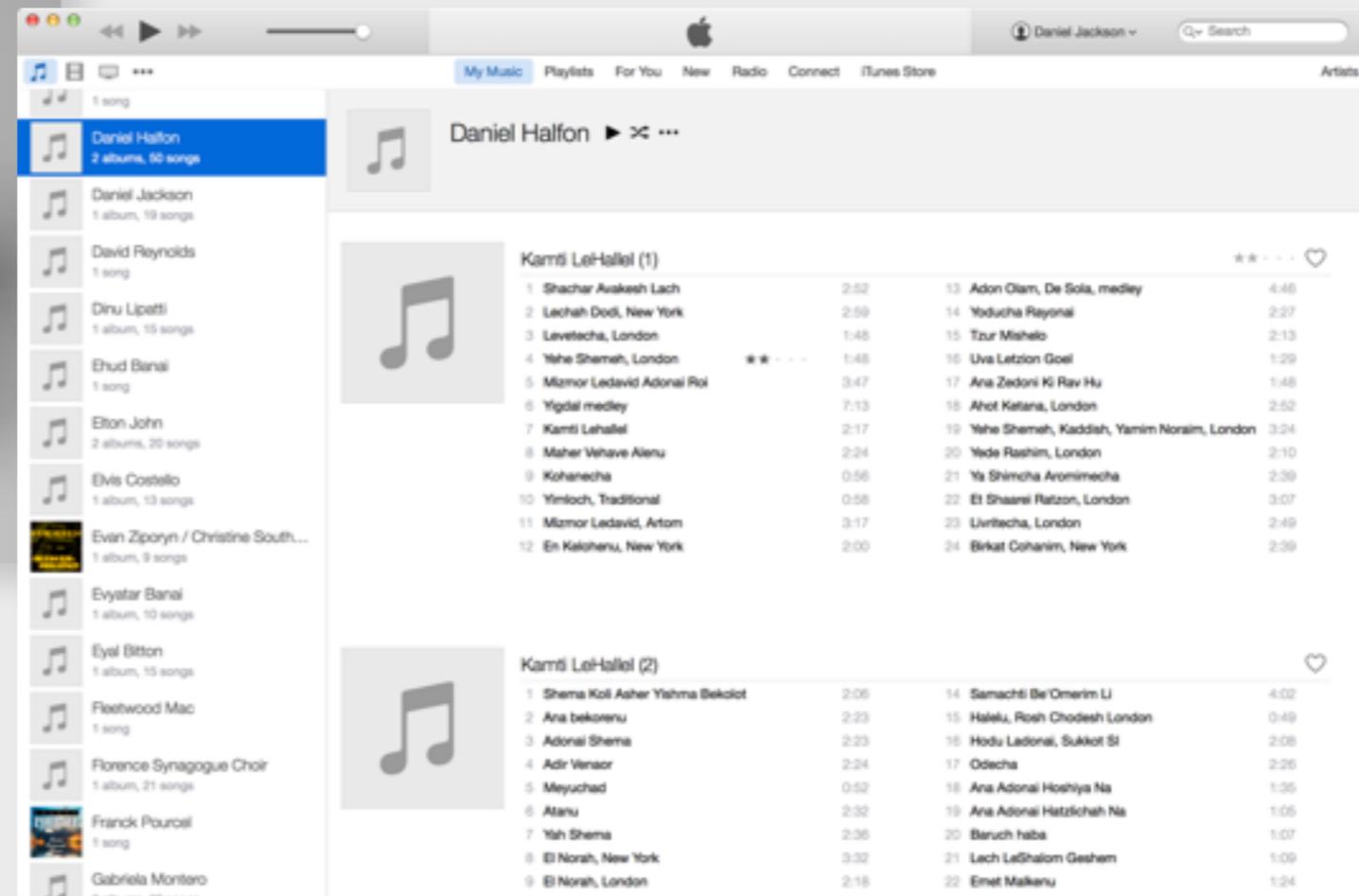


distribution
Amazon

complexity



Braun SK4 by Dieter Rams (1957)



Apple iTunes (2016)

collaboration



changes in
how things
are made

expectations of usability

The image shows a browser window displaying the Rev.com website. The browser's address bar shows the URL <https://www.rev.com>. The website header includes the Rev logo, a 'SIGN IN' link, and navigation tabs for 'SERVICES', 'ABOUT', and 'CONTACT'. The main hero section features a rocket ship illustration and the text 'A Revolution in SPEED' with the tagline 'Blazing fast on-demand services.' and a 'What We Do >' button. Below this, three service cards are presented: 'Transcription' at \$1 per minute with a reel-to-reel icon, 'Captions' at \$1 per minute with a video camera icon, and 'Translation' at 10¢ per word with a typewriter icon. Each card includes a 'Learn More' button.

Rev

SIGN IN

SERVICES ABOUT CONTACT

A Revolution in **SPEED**

Blazing fast on-demand services.

What We Do >

Transcription Captions Translation

\$1
per minute

Convert audio or video to text

Learn More

\$1
per minute

Caption & Subtitle videos

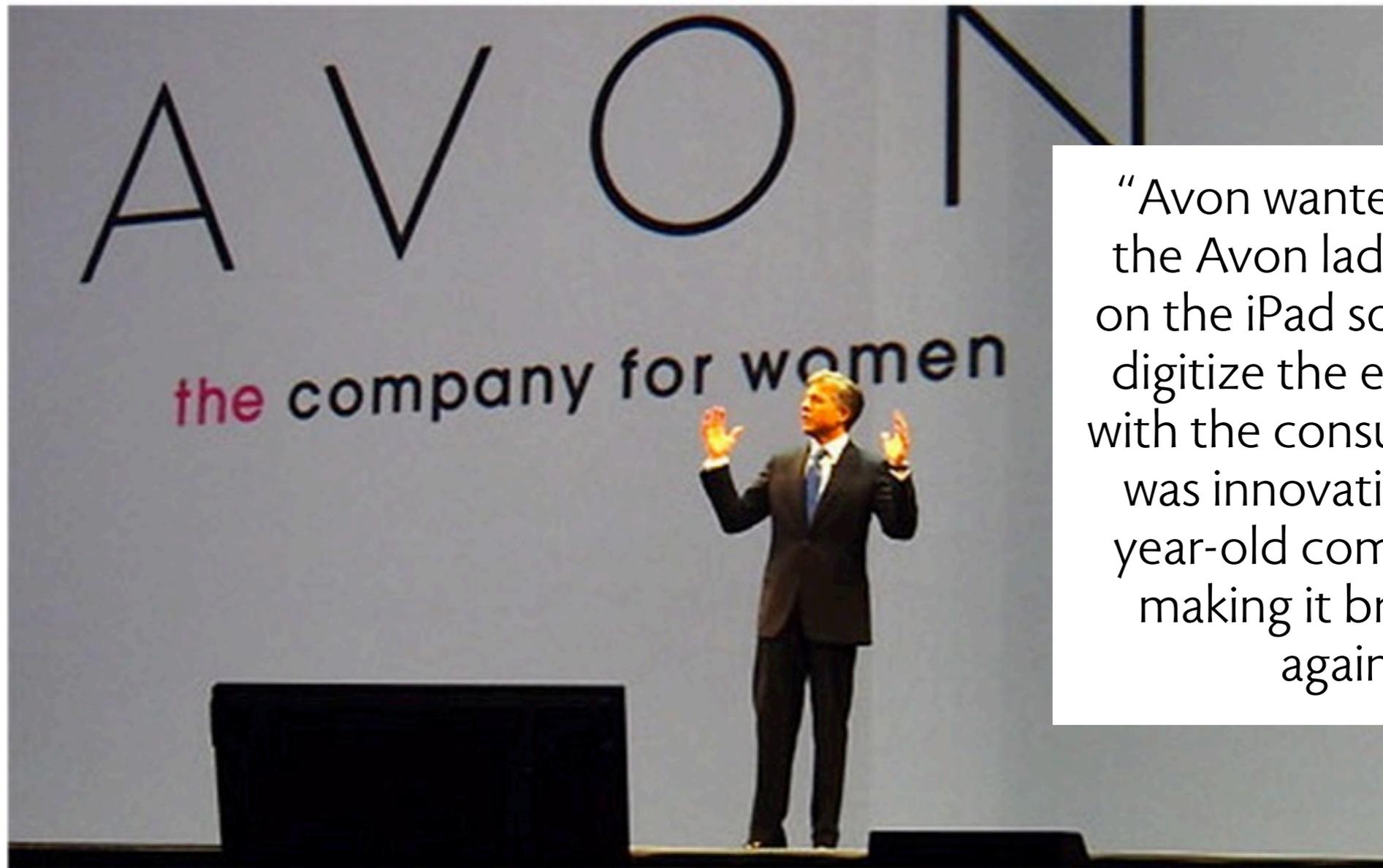
Learn More

10¢
per word

Translate documents

Learn More

an exciting launch



“Avon wanted to have the Avon lady enabled on the iPad so she could digitize the experience with the consumer... This was innovating a 100-year-old company and making it brand new again.”

AVON plans to use mobile technology to connect better with customers

SAP Sapphire Event (2011)

what happened

“While the new system based on software supplied by SAP AG **worked as planned**, it was so **burdensome and disruptive** to the representatives’ daily routine that they left in meaningful numbers.”

Avon spokesperson

Avon is pulling the plug on a \$125 million software system...

The failure is the latest – and perhaps most dramatic – example of how **usability has become a critical issue** in the workplace. People who are accustomed to using simple, well-designed applications in their personal lives have no patience for disappointing technology at work...

Wall Street Journal (2013)

outsourcing

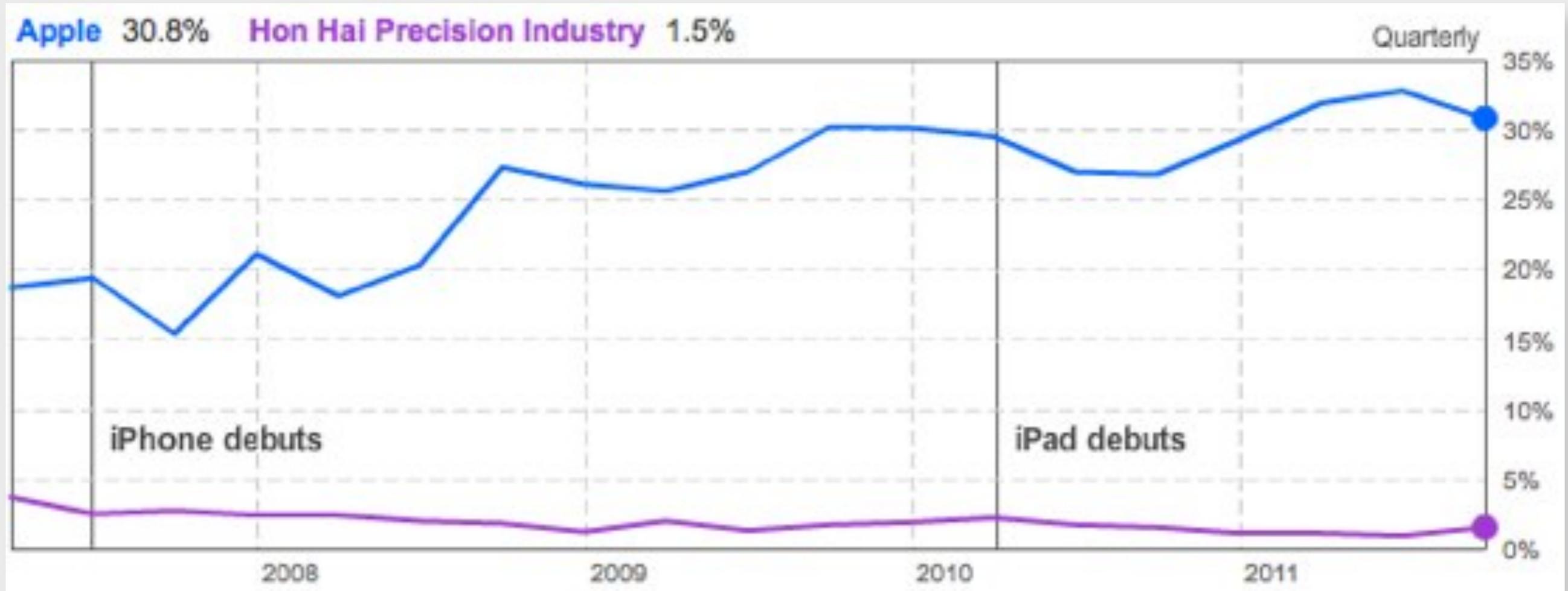
iPhone

16GB

Designed by Apple in California Assembled in China
Model No.: A1241 FCC ID: BCGA1241 IC ID: 579C-A1241



Apple vs Foxconn profit margins



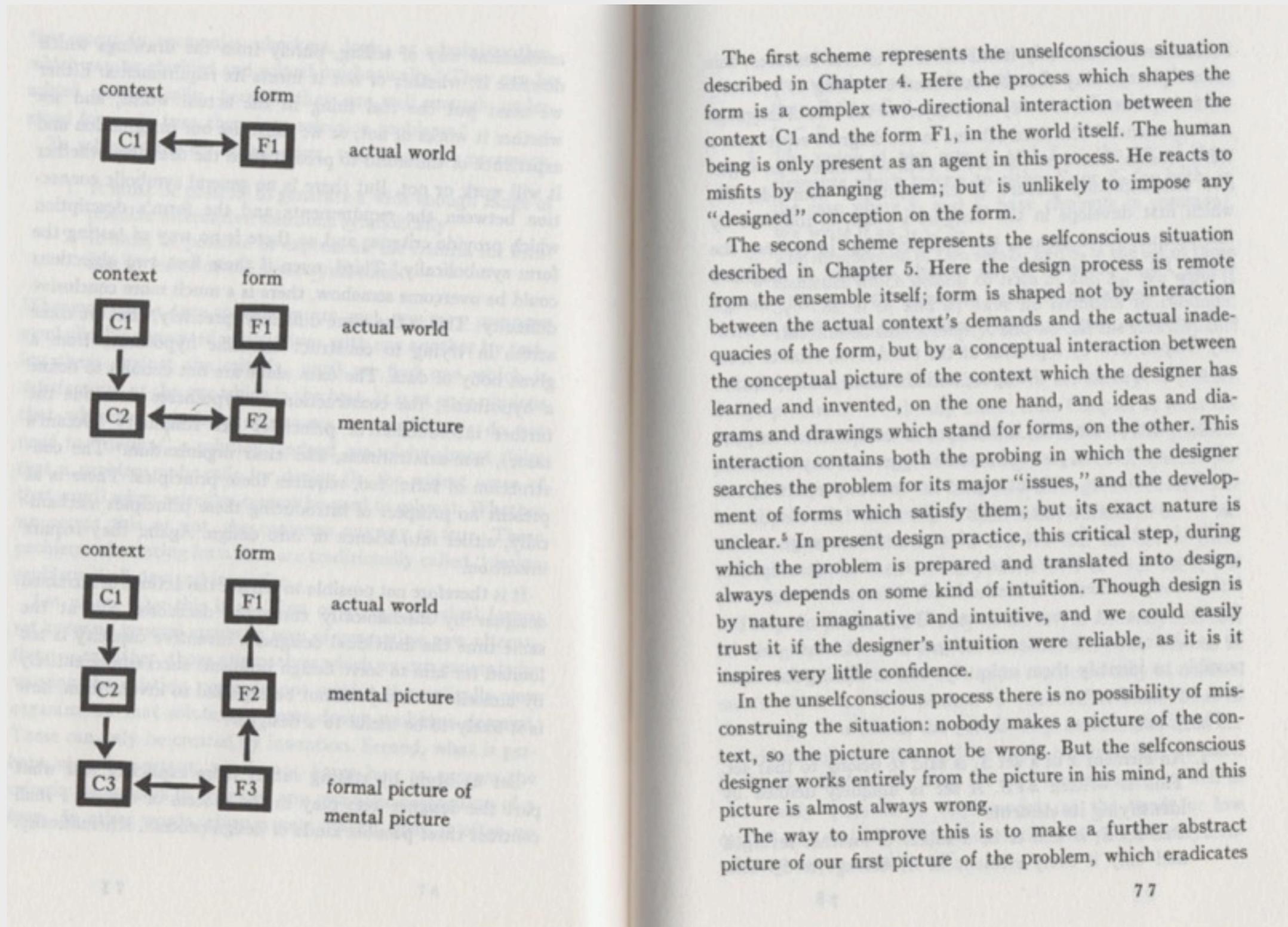
iPhone 5: where the money goes

foxconn
\$8



the
emergence
of design

progression from craft



The first scheme represents the unselfconscious situation described in Chapter 4. Here the process which shapes the form is a complex two-directional interaction between the context C1 and the form F1, in the world itself. The human being is only present as an agent in this process. He reacts to misfits by changing them; but is unlikely to impose any "designed" conception on the form.

The second scheme represents the selfconscious situation described in Chapter 5. Here the design process is remote from the ensemble itself; form is shaped not by interaction between the actual context's demands and the actual inadequacies of the form, but by a conceptual interaction between the conceptual picture of the context which the designer has learned and invented, on the one hand, and ideas and diagrams and drawings which stand for forms, on the other. This interaction contains both the probing in which the designer searches the problem for its major "issues," and the development of forms which satisfy them; but its exact nature is unclear.⁵ In present design practice, this critical step, during which the problem is prepared and translated into design, always depends on some kind of intuition. Though design is by nature imaginative and intuitive, and we could easily trust it if the designer's intuition were reliable, as it is it inspires very little confidence.

In the unselfconscious process there is no possibility of misconstruing the situation: nobody makes a picture of the context, so the picture cannot be wrong. But the selfconscious designer works entirely from the picture in his mind, and this picture is almost always wrong.

The way to improve this is to make a further abstract picture of our first picture of the problem, which eradicates





Alfonso Bialetti, 1933
La Moka coffee maker



Leica, 1953
M3 rangefinder camera



Dieter Rams, 1958
pocket transistor radio T3



IBM, 1981
Personal computer



Jony Ive, 2002
Apple iPod



Fred Bould (2011)
Nest thermostat

from digital to physical



Fred Bould (2011)
Nest thermostat



Henry Dreyfuss (1953)
Honeywell T68 thermostat



Fuji (2013?)
Instax 90 film camera



iOS6 clock app



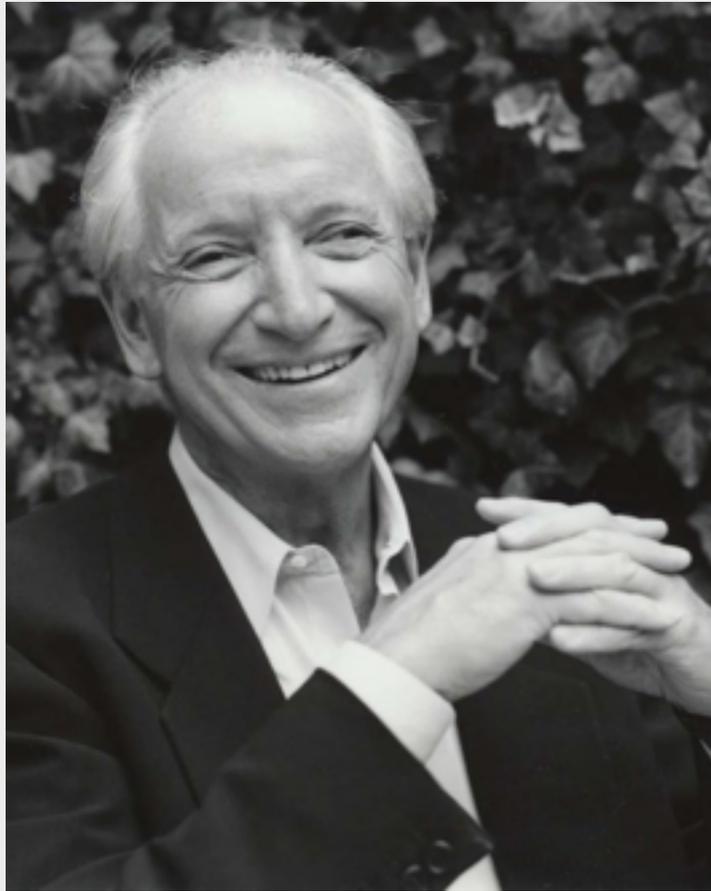
Swiss Federal
Railways
SBB clock

inclusive design



Bradley watch from Eone

design goes mass market



Michael Graves
(1934-2015)



Michael Graves (1985)
Alessi 9093 tea kettle



Michael Graves (1999)
Target spinner whistle tea kettle

design consultancies



IDEO



Frog
acquired by
Flextronics
(2004)



Fjord
acquired by
Accenture
(2013)

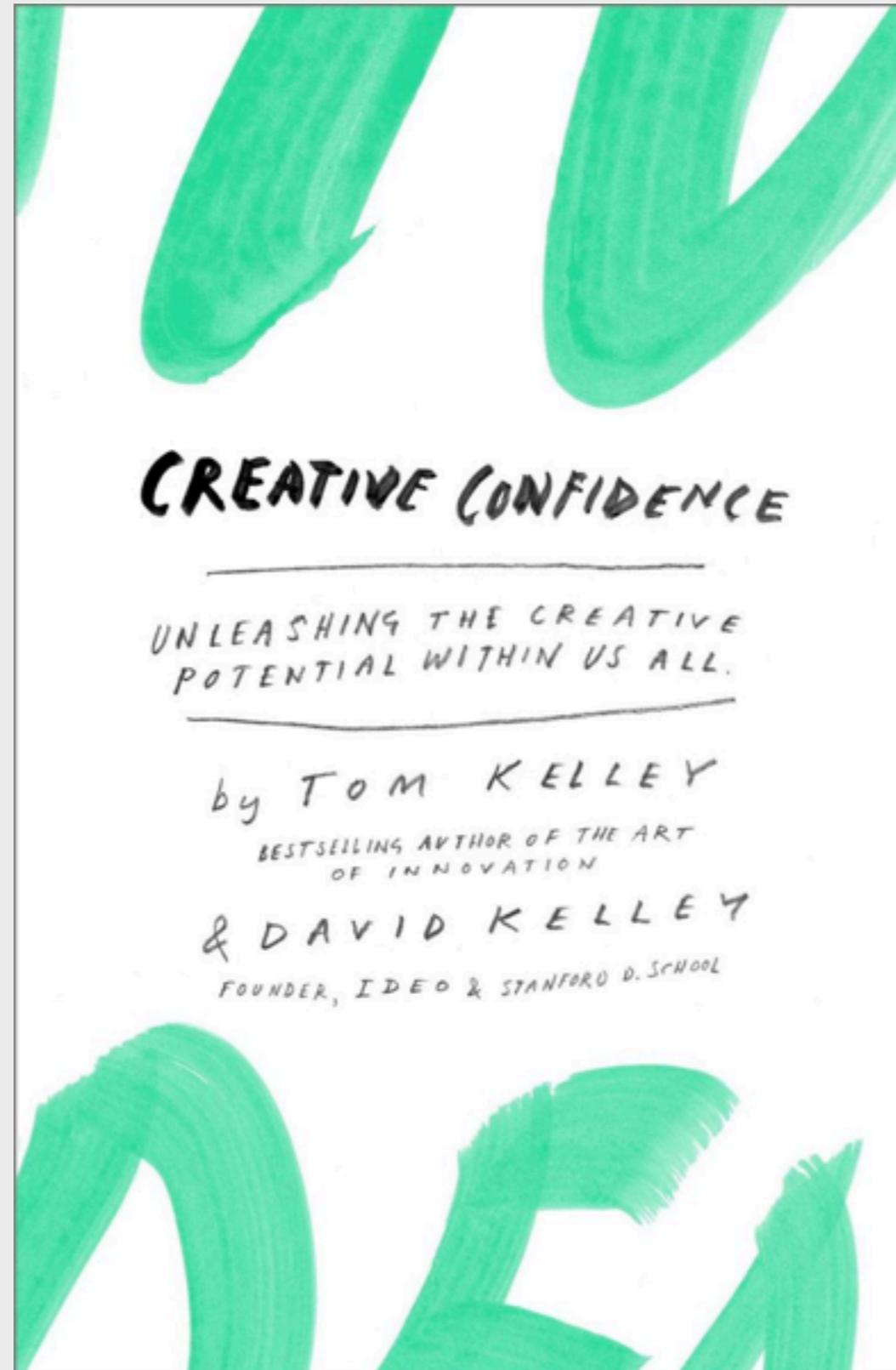
2011: GlobalLogic buys Method
2012: Google buys Mike and Maaike
2013: Facebook buys HotStudio

design schools & programs



Stanford D School founded 2004 by
David Kelley and George Kembel

design thinking for business



coworking + maker spaces





a startup whose founders met at RISD

IBM (re)embraces design



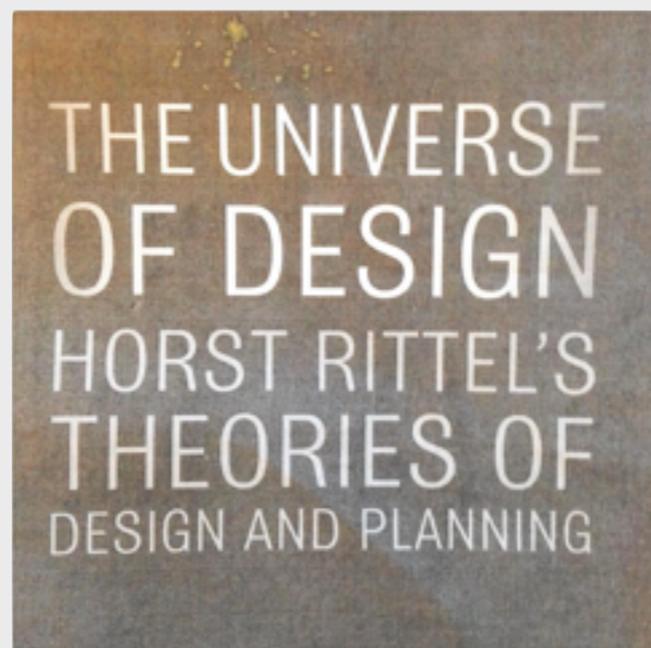
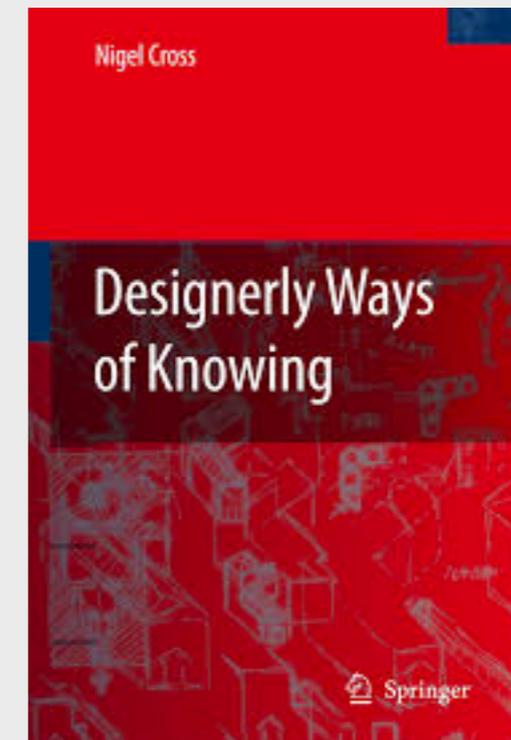
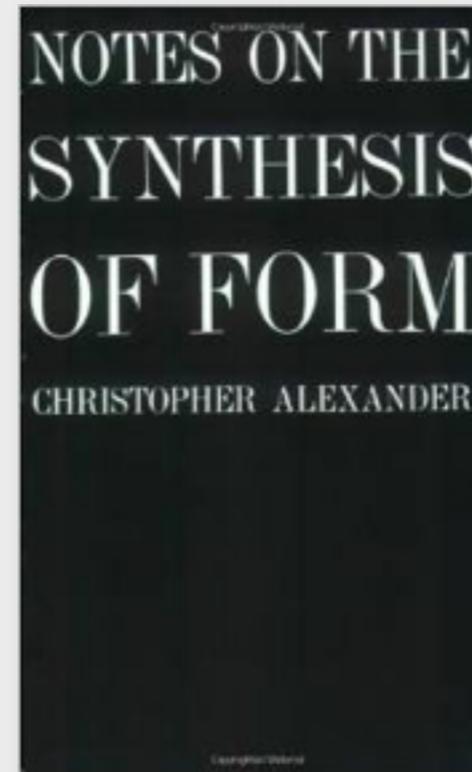
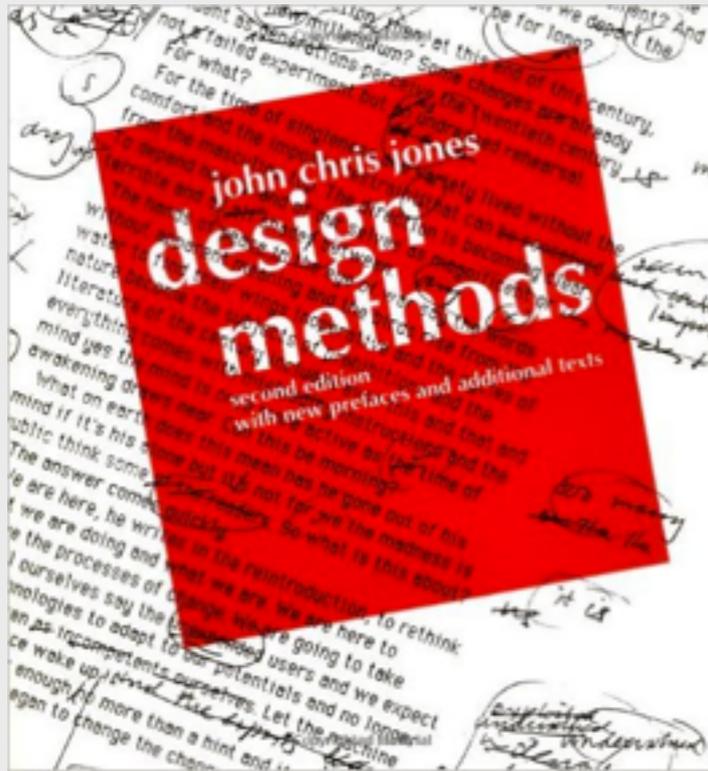
Eliot Noyes (1961)
IBM Selectric Typewriter



IBM's design studio in Austin, Texas

what is
design
thinking?

theories of design



what is design?

The central concern of Design is the conception and realisation of new things.

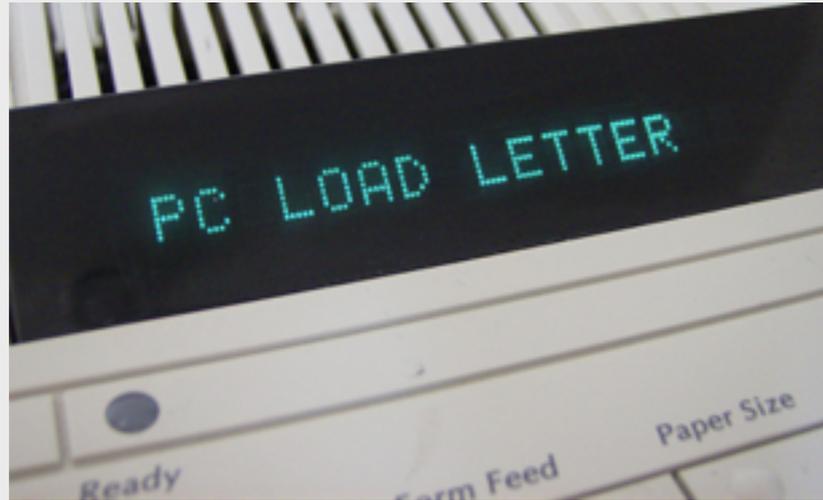
It encompasses the appreciation of material culture and the application of the arts of planning, inventing, making and doing.

At its core is the language of modelling... equivalent to aptitudes in the language of the sciences (numeracy) and the language of humanities (literacy).

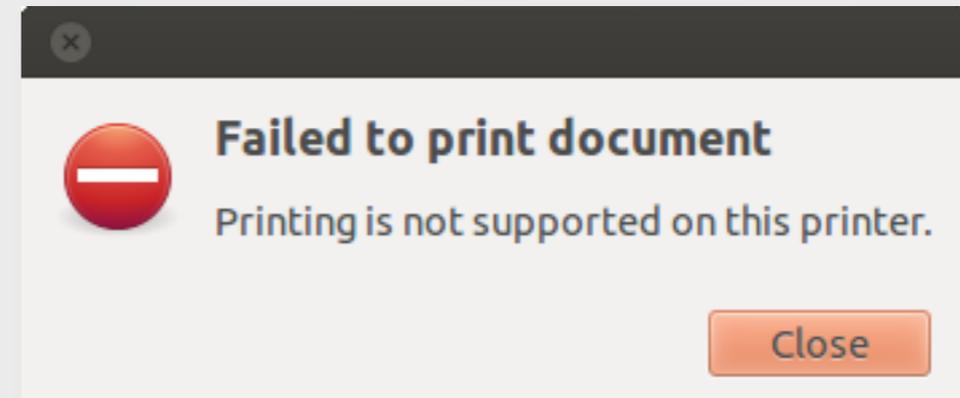
Design has its own distinct things to know, ways of knowing them, and ways of finding out about them.

Nigel Cross (1982)
Designerly Ways of Knowing
excerpted from RCA report

user centeredness



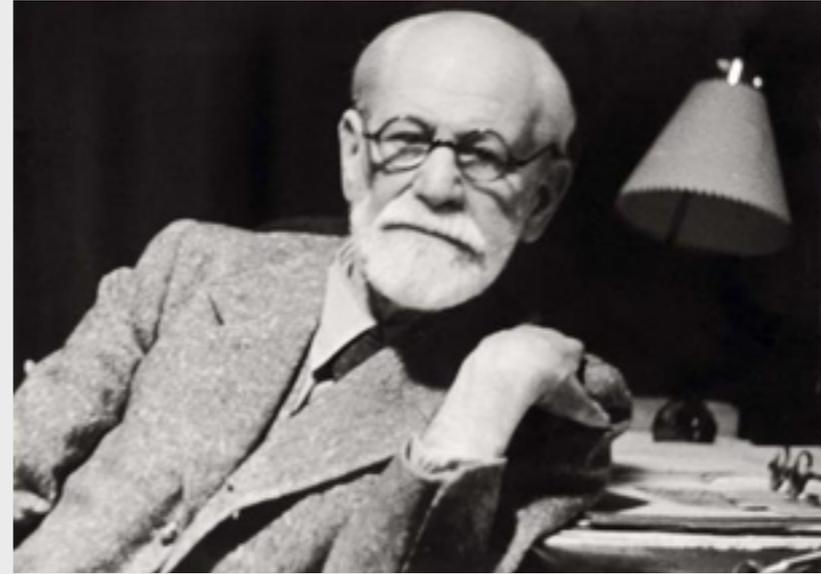
translation:
"please load letter-sized paper
into paper cassette"



diversity of contributors



anthropology



psychology



art



economics

attention to detail

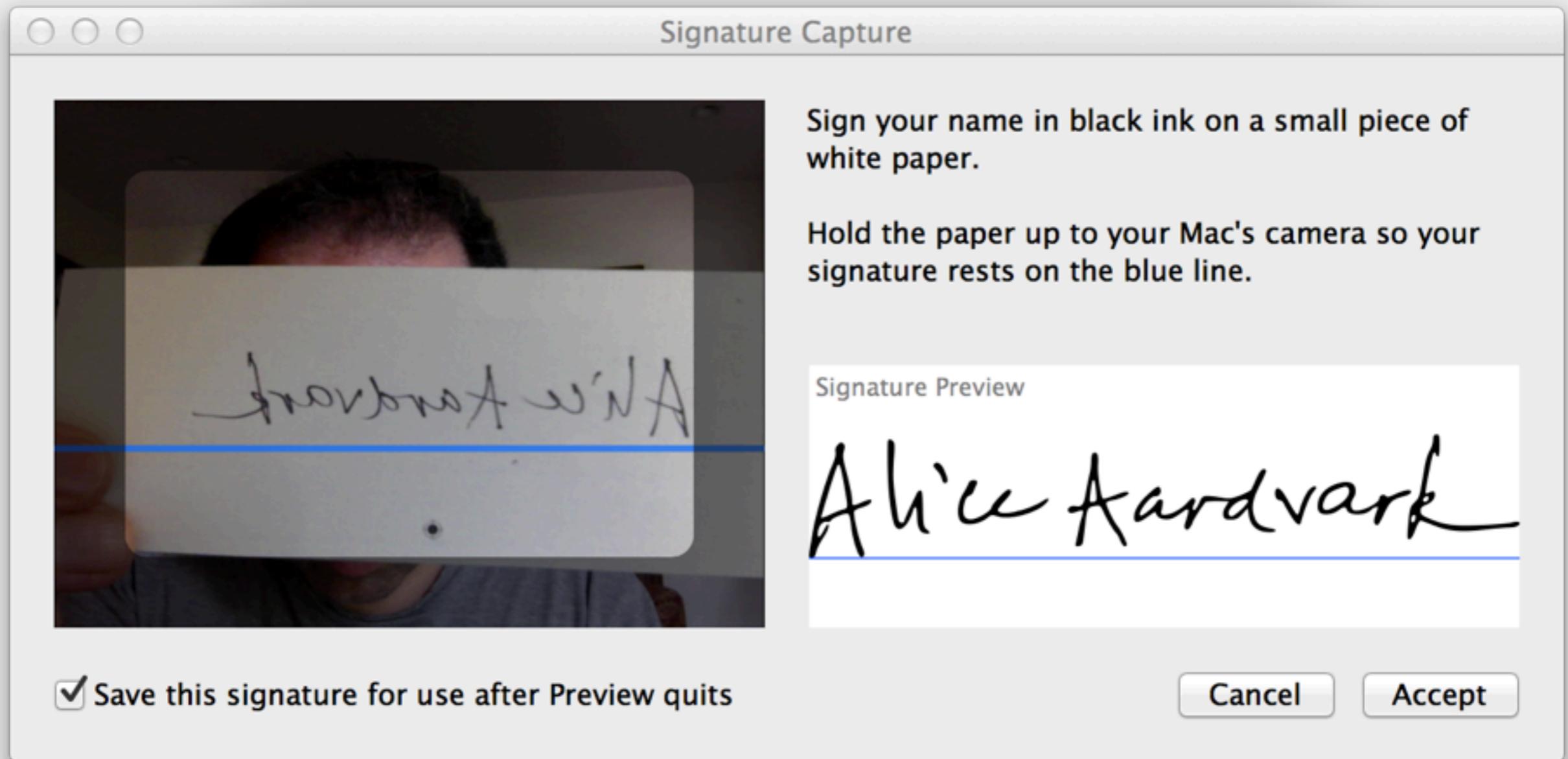


That's quite obsessive, isn't it?
Jonathan Ive in "Objectified"



The details are not the details.
These make the design.
attributed to Charles Eames by Garrett

example: signatures in Apple Preview



needfinding

The need itself is a perceived lack, something that is missing. Needfinding is thus a paradoxical activity—what is sought is a circumstance where something is missing. In order to find and articulate a need, this missing thing must be seen and recognized by someone.

Rolf A. Faste, *Perceiving Needs* (1987)

users don't know what they want



new recipe won
blind taste tests



Aeron office chair
low ratings in early tests

brainstorming

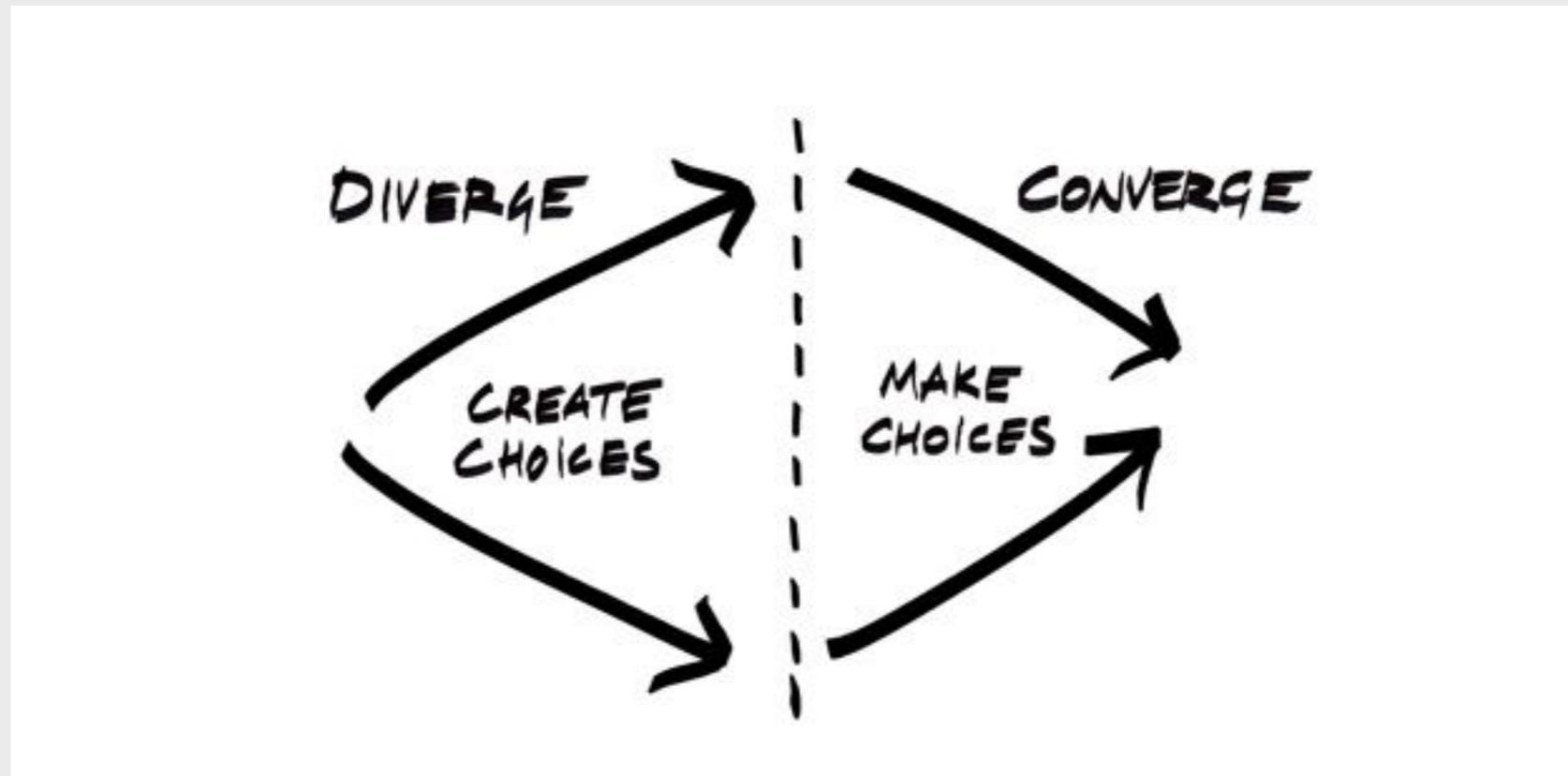
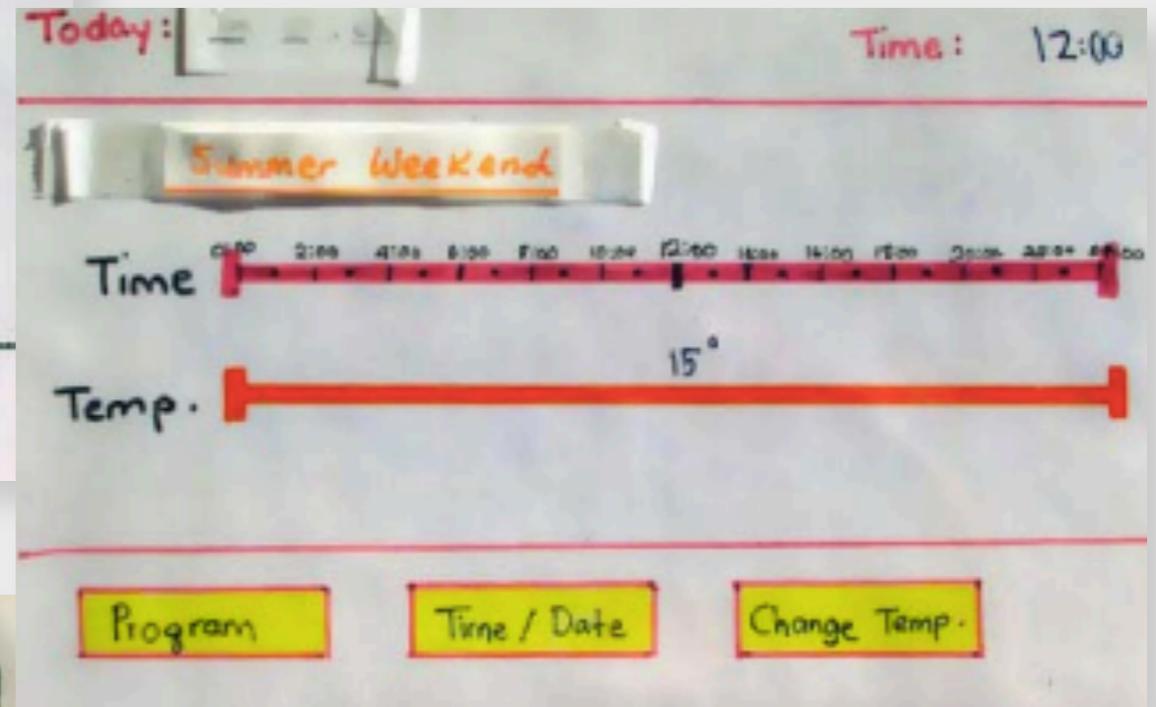
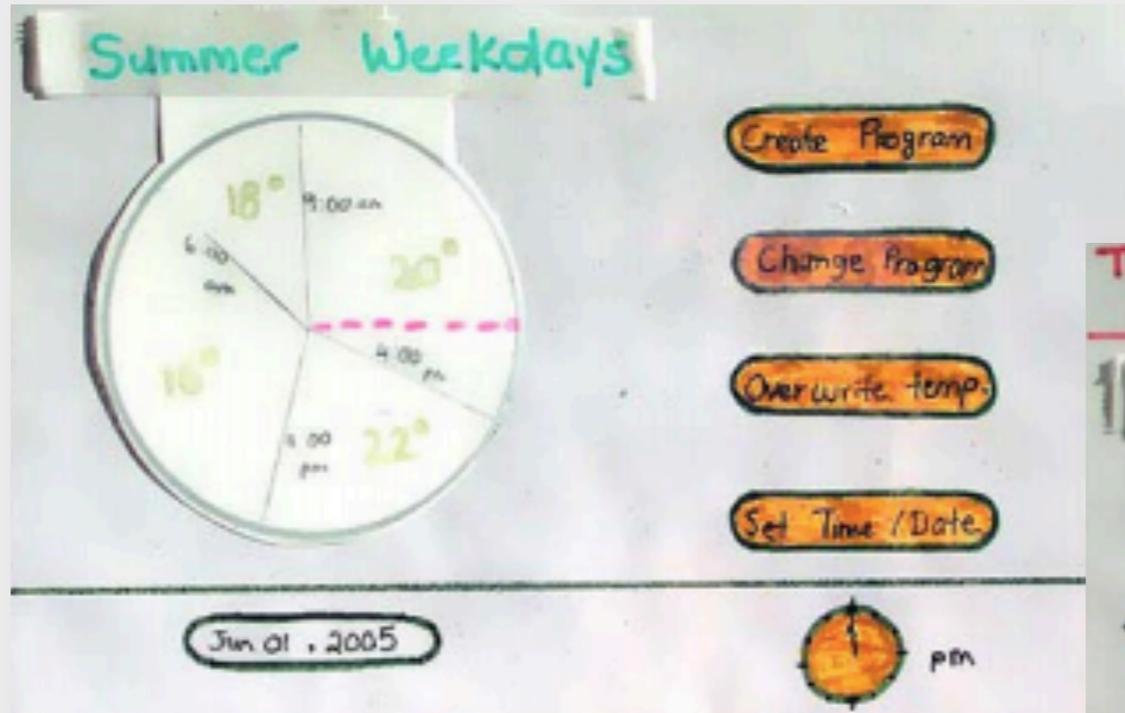


diagram from Tim Brown, IDEO

prototypes & user studies



paper prototypes

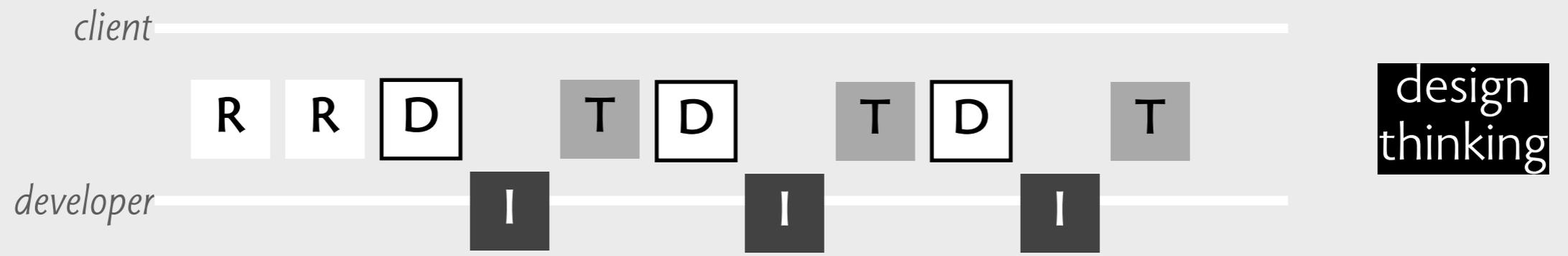
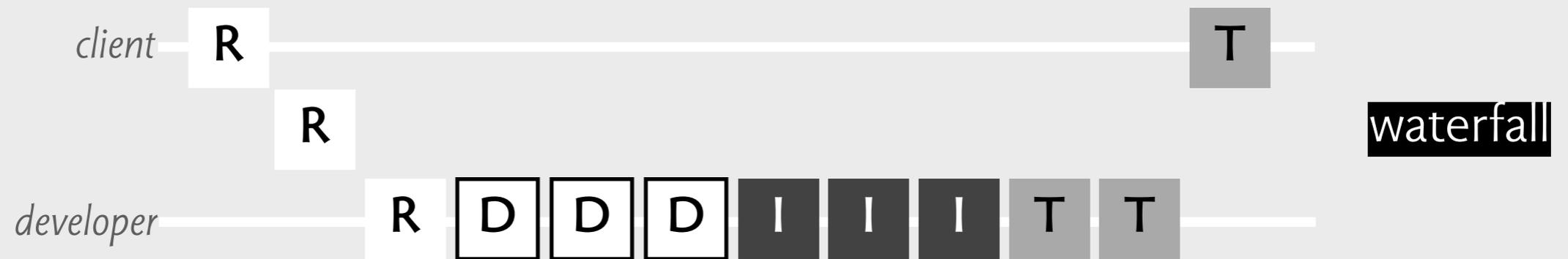


Program Summer on Vacation

	from	to	temperature
Morning	7:00	9:00	15
Day	7:00	5:00	15
Evening	5:00	12:00	15
Night	12:00	7:00	15

Date: Jun 01, 2005 Time: 12:00 pm Temperature: 23

This figure shows a paper prototype for a thermostat interface with a detailed control panel. It starts with a 'Program' dropdown menu set to 'Summer on Vacation'. Below are four rows for different times of day: 'Morning' (7:00-9:00, 15°), 'Day' (7:00-5:00, 15°), 'Evening' (5:00-12:00, 15°), and 'Night' (12:00-7:00, 15°). At the bottom, there are three sections: 'Date' (Jun 01, 2005), 'Time' (12:00 pm), and 'Temperature' (23).



so what is
software design?

designers & engineers



designer

engineer

elements

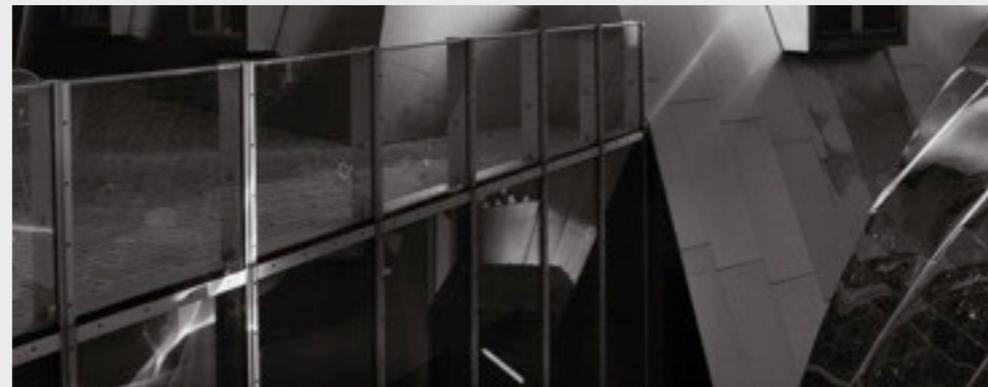
door, window, wall

column, beam, truss

goals

comfortable, convenient,
attractive

structural integrity,
durable, sustainable



software design & engineering



	designer	engineer
elements	concepts	function, object, type
criteria	concept/purpose correspondence	decoupling & localization
goals	learnable, effective, tolerant	maintainable, correct, fast

software
design tools

concepts

structuring functionality

modeling concepts

focused data models

usability heuristics

well known principles

concepts

a common view of software design

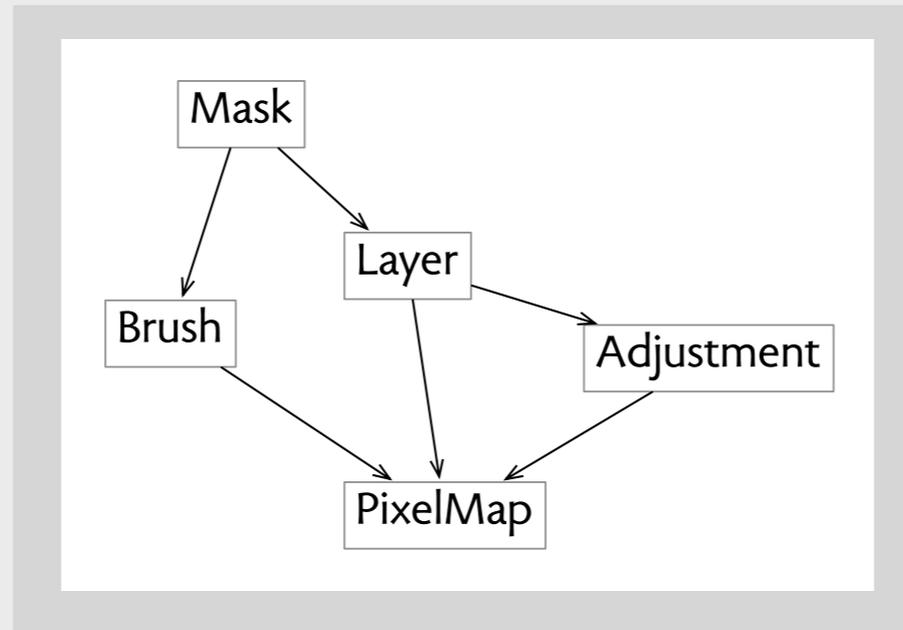


UI design
soft & human
about presentation

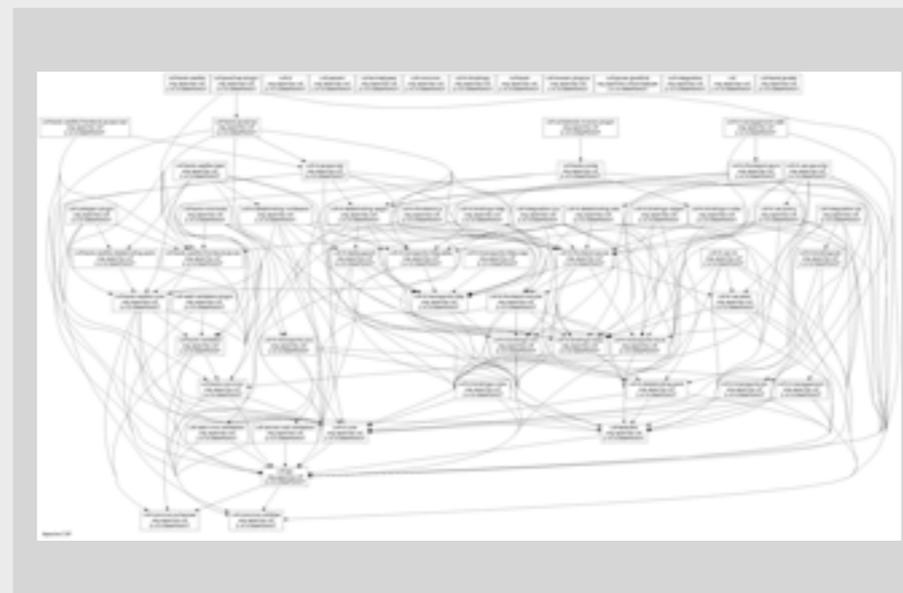


programming
hard & technical
about content

a better view of software design



conceptual design:
essential concepts
& behavior

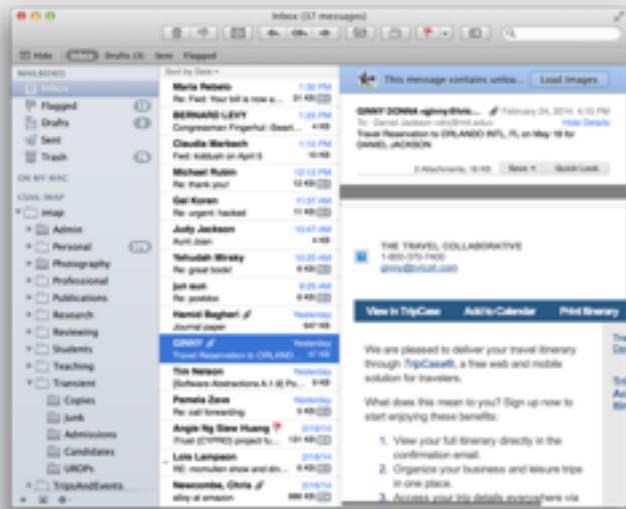


representation design:
organization & performance

what characterizes an app?

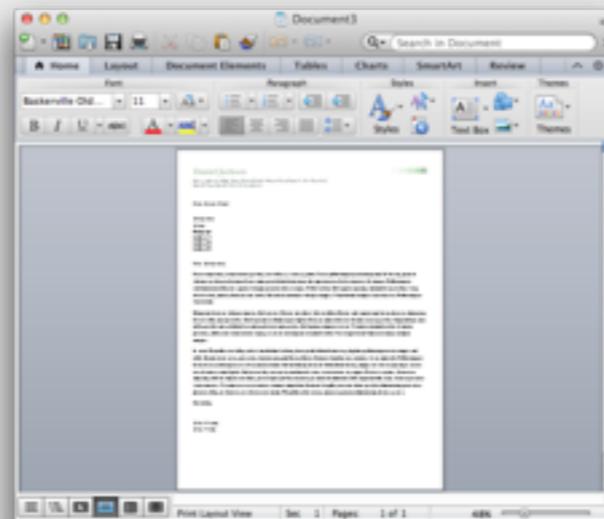
concepts!

Apple Mail



EmailAddress
Message
Folder or Label

Microsoft Word



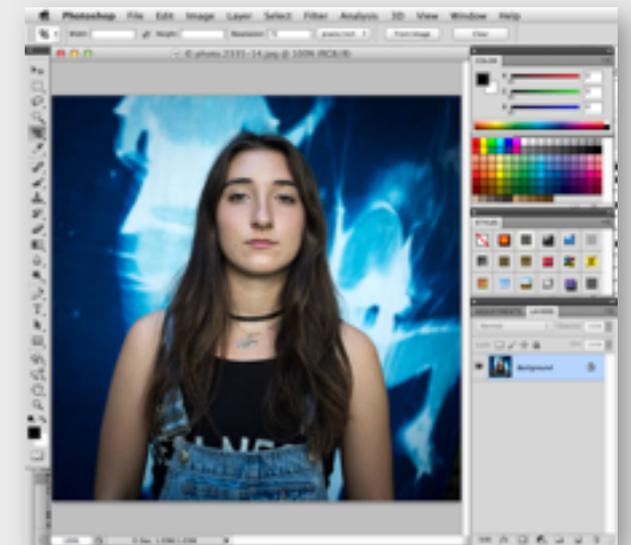
Paragraph
Format
Style

Twitter



Tweet
Hashtag
Following

Photoshop



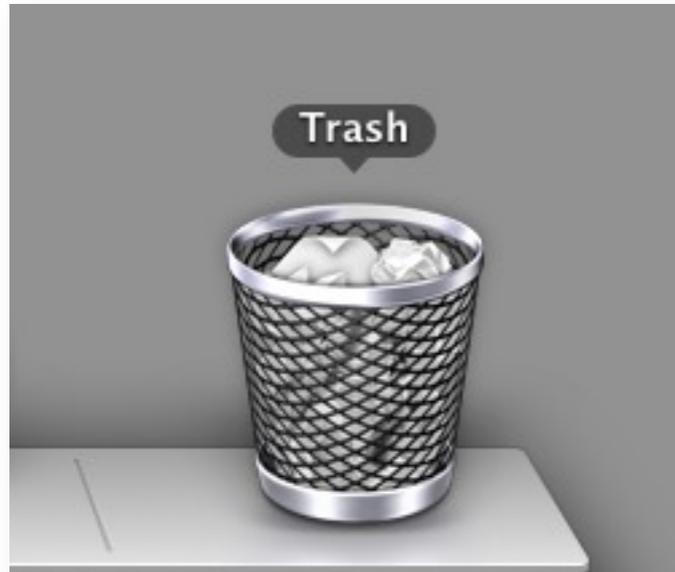
PixelMap
Layer/Mask
Adjustment

the fundamental principle

in a well-designed system
each concept is motivated by one purpose



concept, purpose, principle, misfit



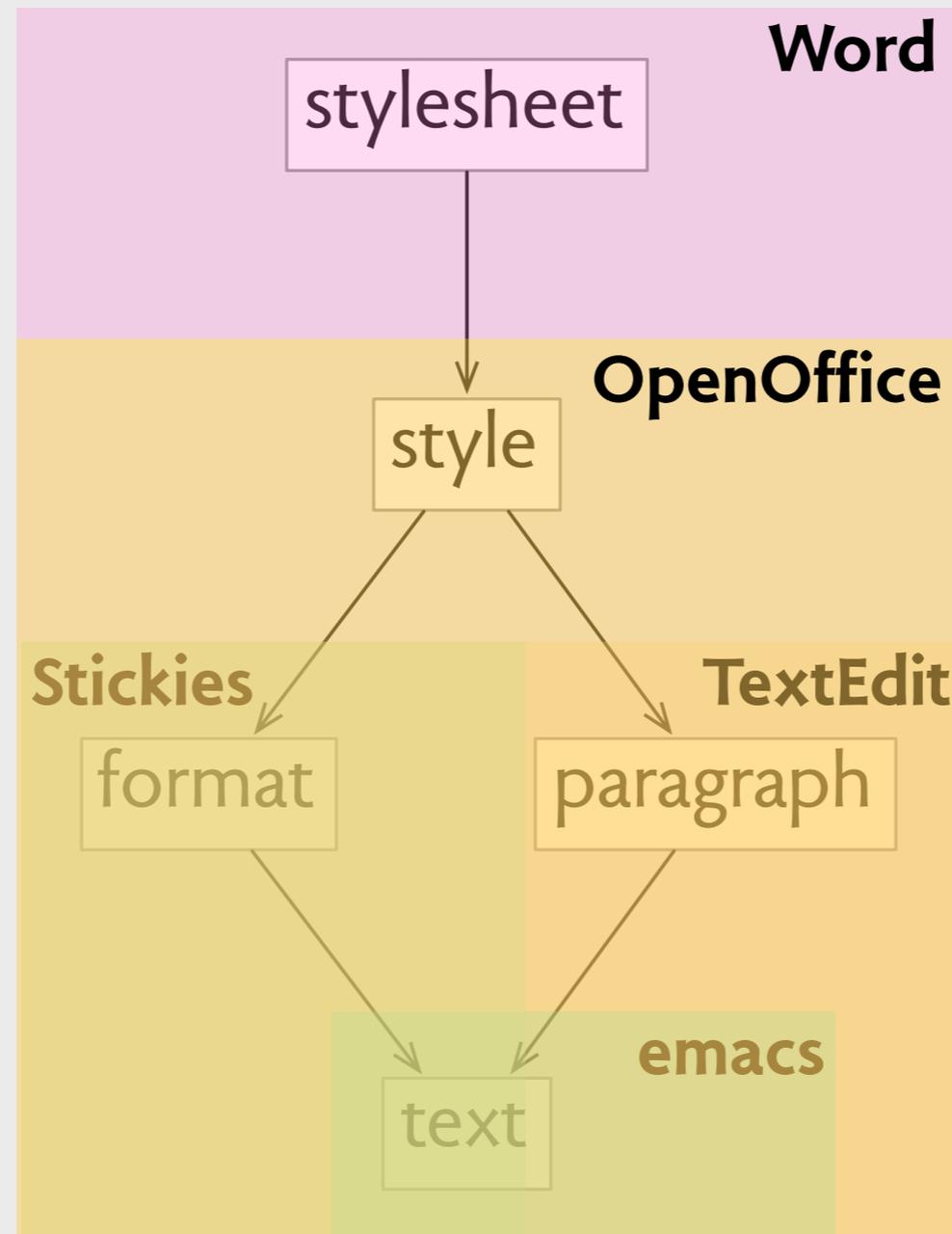
concept: trash

purpose: allow undo of deletions

operational principle: if you delete a file, it moves to a special folder; you can restore from there, but emptying it removes contents for good (and makes space on disk)

misfit: if you delete a file on an external drive, you cannot reclaim the space until you empty the trash, but then you'll lose the ability to restore files deleted from the main drive

organizing concepts

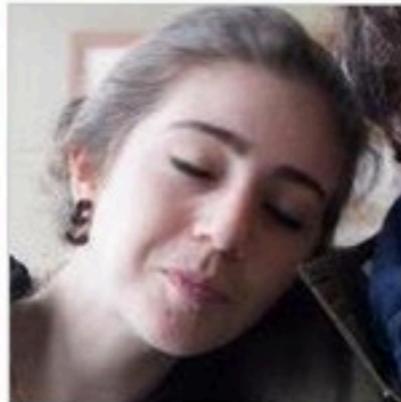


Who Is in These Photos?

To tag your friends, review the suggested names and click Save Tags at the bottom of this page. If a name is missing or incorrect, list a new name and press Enter.
Remember: If someone doesn't like a photo, they can untag themselves or ask you to take it down.



Who is this?

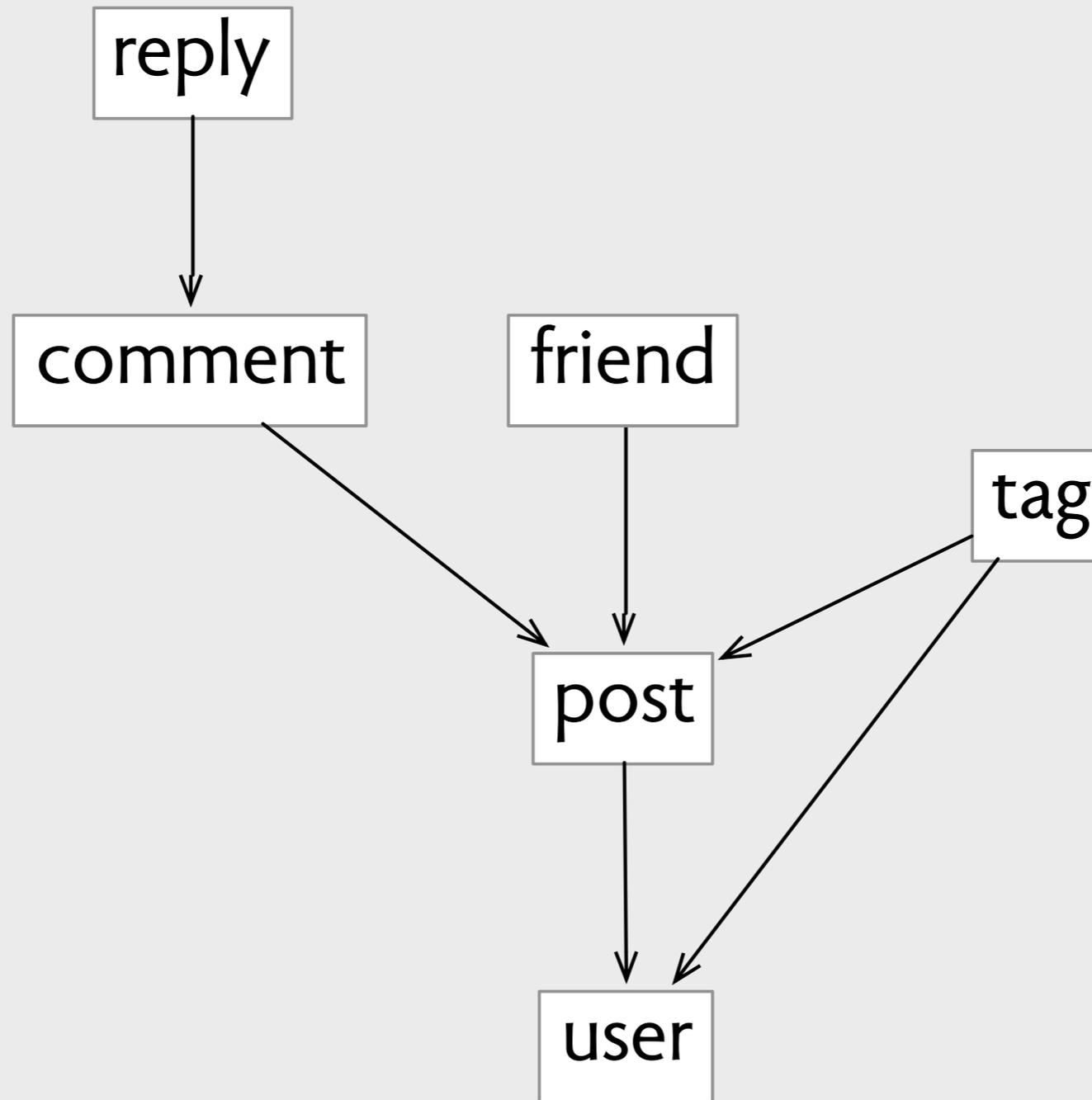


Who is this?

Skip Tagging Friends

Save Tags

facebook concepts



tag concept

real purpose: increase connectivity of friend graph?

purpose: share photo with people who appear in it

operational principle: if you tag a photo, then it becomes visible to the person tagged, and to their friends (in addition to your friends)

misfit: suppose I get drunk at a party with strangers and one of them tags me. if my boss is my friend, she will now see the photo.

skype concepts



The image shows a Skype interface during an incoming call. On the left, a video feed shows Richard Davies, a man in a blue shirt, looking down. Below his video, his name "Richard Davies" and a timer "00:36" are displayed. On the right, a dark grey call control panel is overlaid. At the top of this panel is the "skype" logo and a close button. Below that, a small profile picture of Beth Davies is shown next to the text "Beth Davies calling". Three buttons are visible: "Answer" (green with a white telephone handset icon), "Answer with video" (green with a white video camera icon), and "Decline" (red with a white telephone handset icon). Below these buttons, a message reads "Answering this call will put your active call on hold, or" followed by a "More" button with a downward arrow.

skype

Beth Davies calling

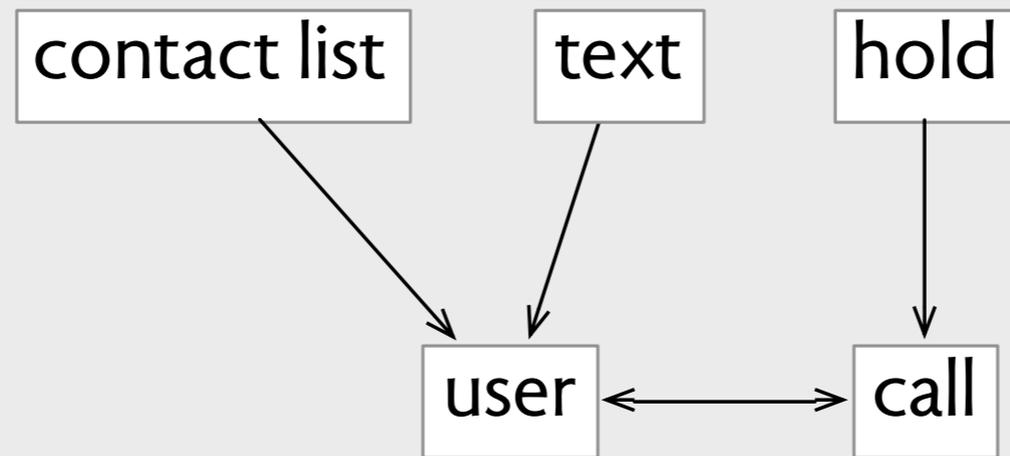
Answer Answer with video Decline

Answering this call will put your active call on hold, or More

Richard Davies

00:36

skype concepts



hold concept

why not just allow concurrent calls?

purpose: make it possible to multiplex calls

operational principle: if you put a call on hold, you can answer another call, and then switch back to the first one by putting that on hold (or ending it) and resuming the first.

modeling

the core of design

The central concern of Design is the conception and realisation of new things.

It encompasses the appreciation of material culture and the application of the arts of planning, inventing, making and doing.

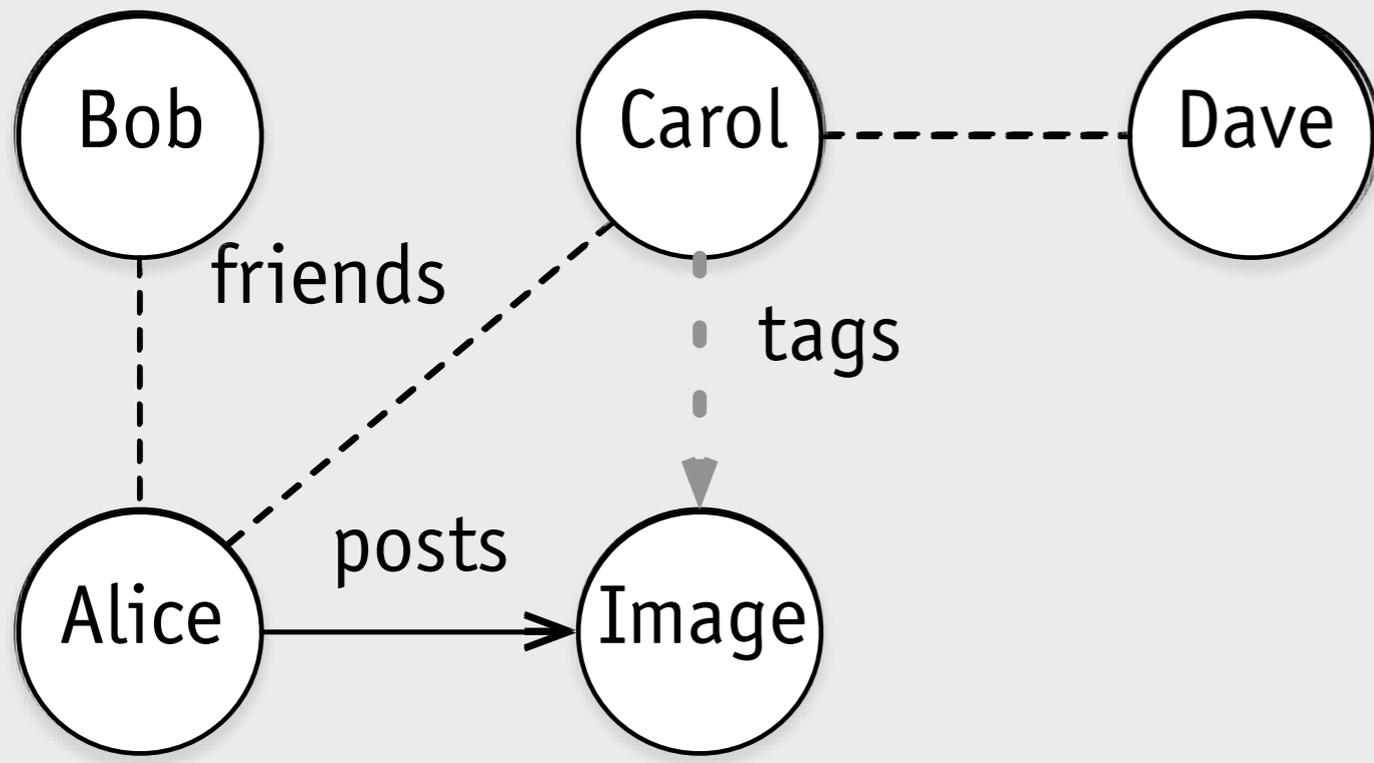
At its core is the language of modelling...

equivalent to aptitudes in the language of the sciences (numeracy) and the language of humanities (literacy).

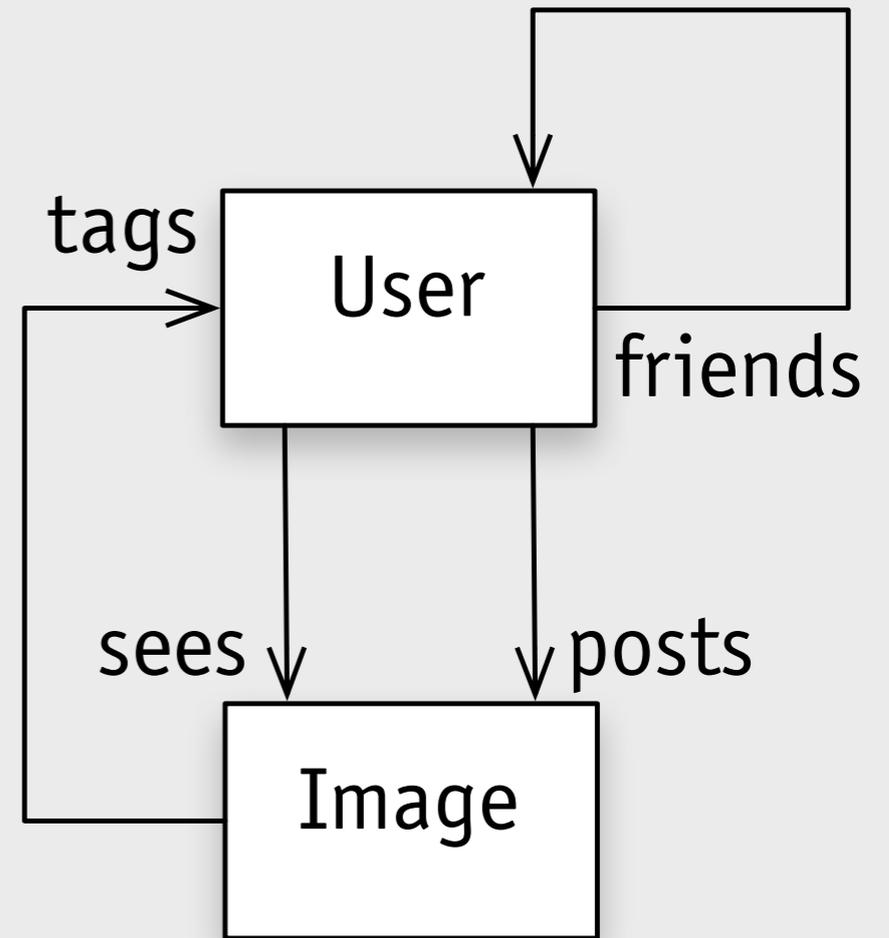
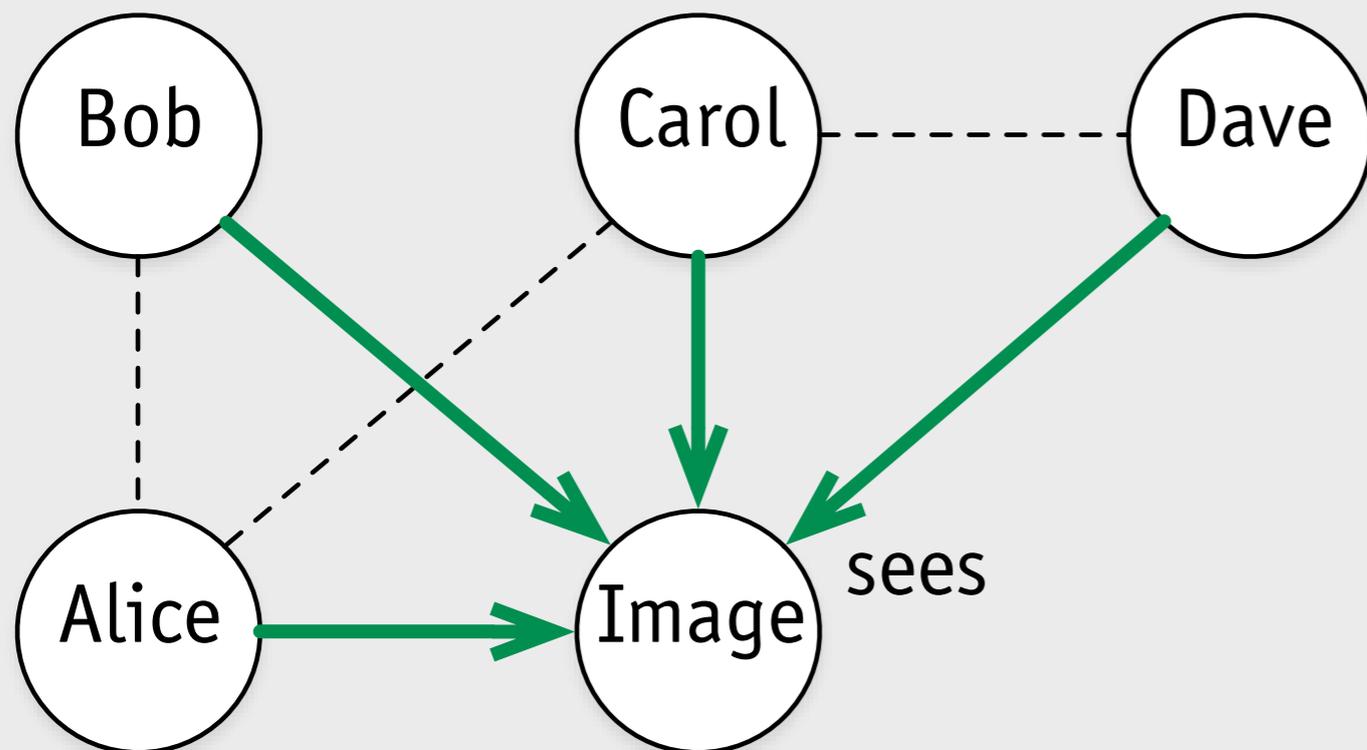
Design has its own distinct things to know, ways of knowing them, and ways of finding out about them.

Nigel Cross (1982)
Designerly Ways of Knowing
excerpted from RCA report

facebook tags



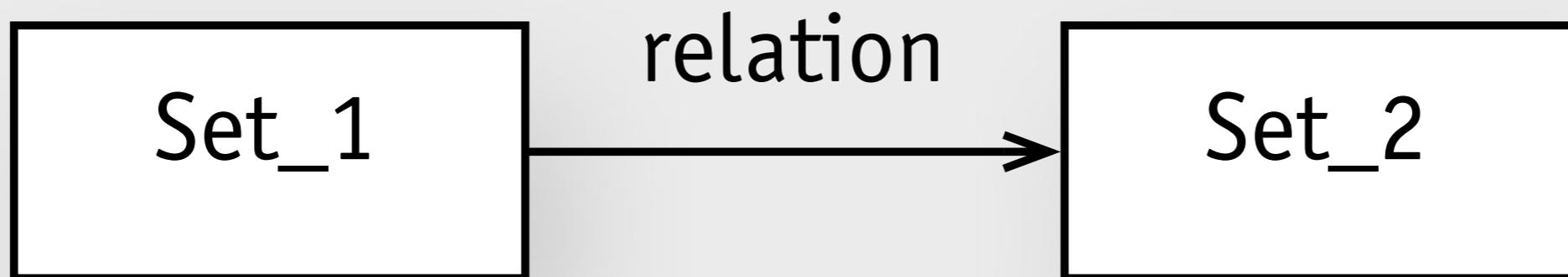
who can see the image?



$\text{all } i: \text{Image} \mid \text{sees}.i = (\text{posts}.i).\text{friends} + (i.\text{tags}).\text{friends}$

textual constraint in Alloy

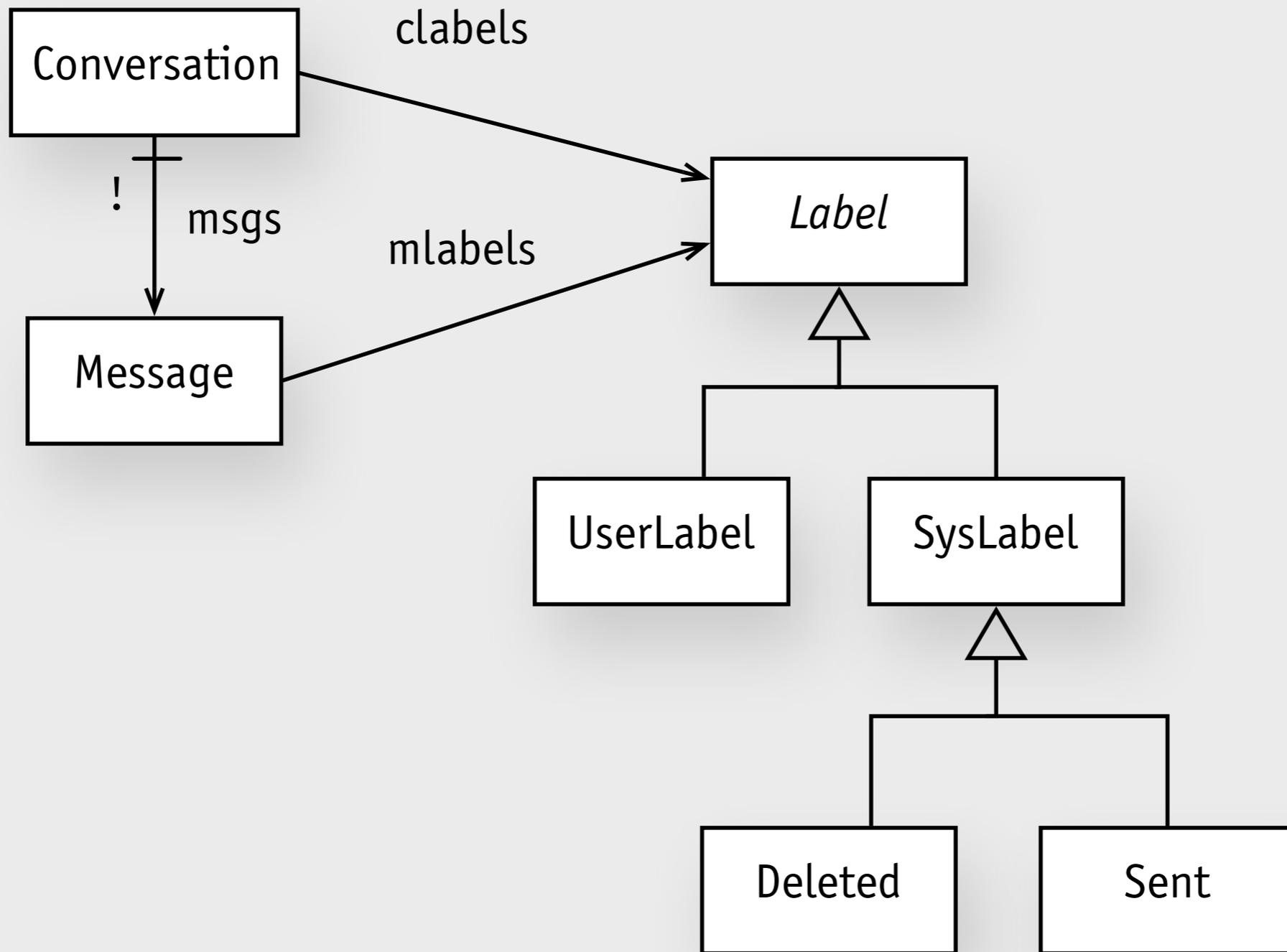
modeling data (ie, state)



means that:

the state includes two sets Set1 and Set2
and a relation that associates elements of Set1 with elements of Set2

gmail labels



constraint that explains conversation labels:

all c: Conversation | c.clabels = c.msgs.mlabels

strange consequences

search for unlabelled messages

in conversation view, shows conversations
any conversation that contains an unlabelled message
but this conversation may appear to be labelled

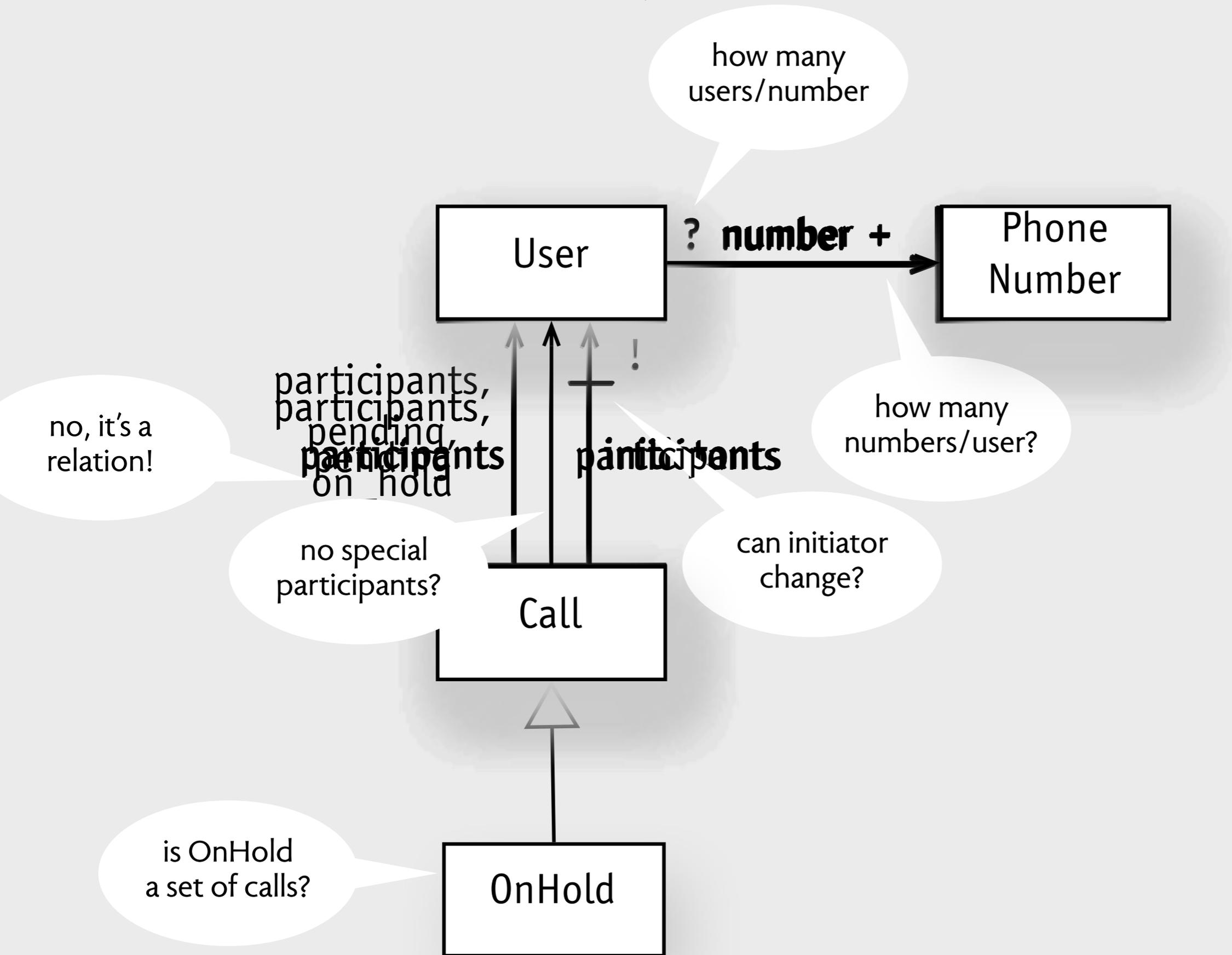
no ops?

deleting then adding a label
adding then deleting a label
both can modify a conversation

a puzzle

can a conversation have a Sent label?

skype data



heuristics

sources of heuristics



Jakob Nielsen
10 Usability Heuristics



Ben Shneiderman
8 Golden Rules



Don Norman
Design of Everyday Things



Bruce Tognazzini
First Principles of Interaction Design

consensus heuristics

visibility

of functions, state, feedback

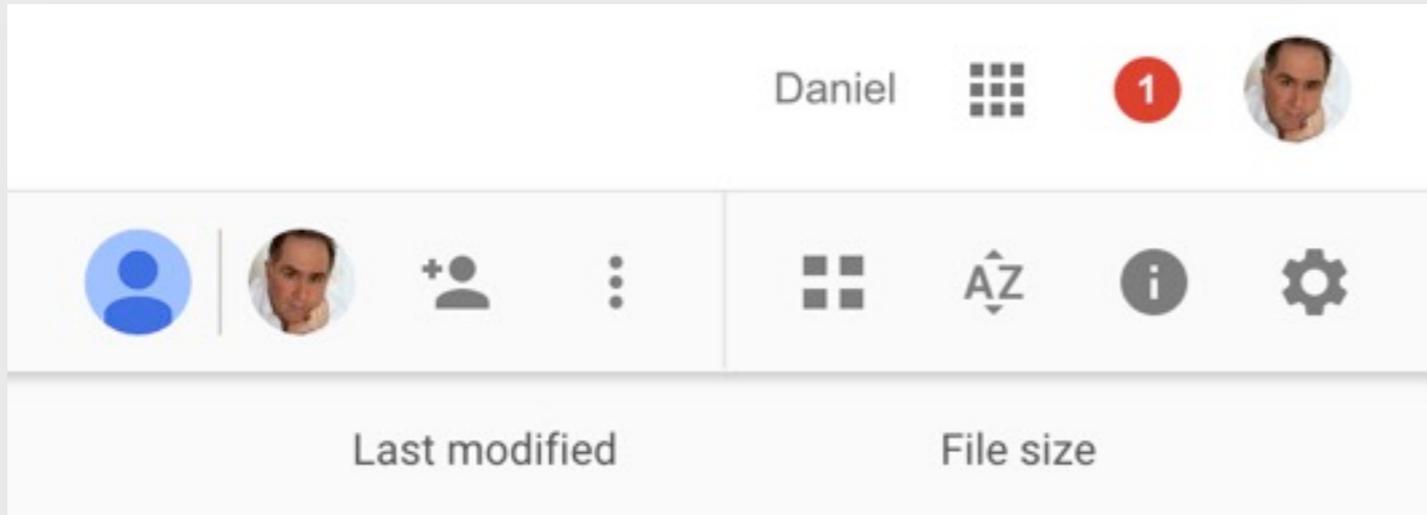
consistency

within app, platform, domain, culture

constraints

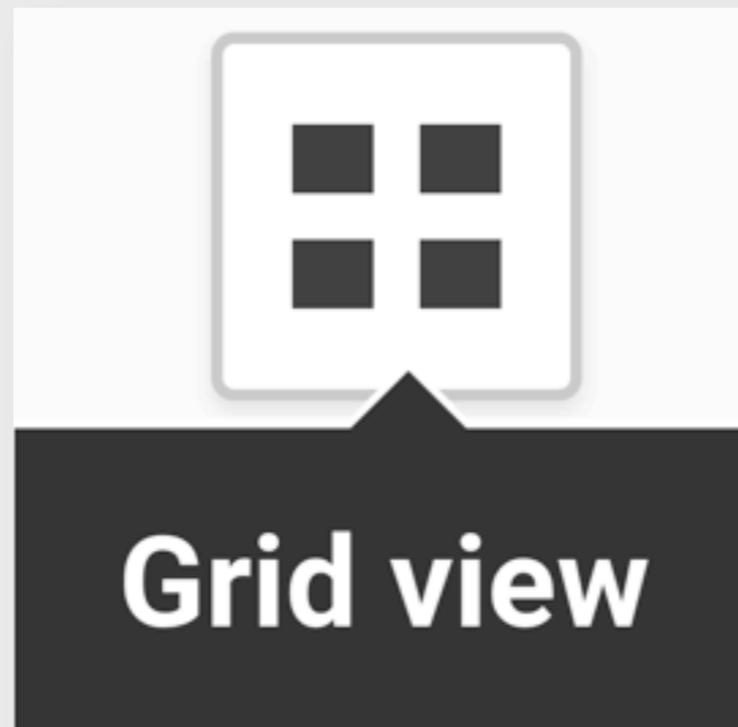
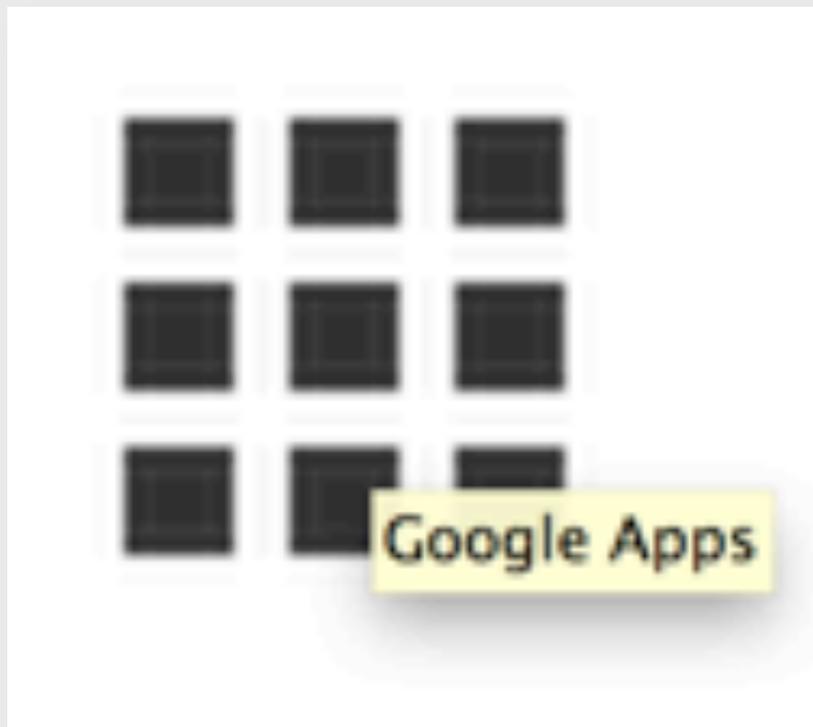
prevent errors

platform consistency



design lesson:
make sure same name or
symbol used for a
function or feature
throughout

icons shown in Google Drive



cultural consistency

Chrome

History

Extensions

Settings

About

About



Google Chrome
A web browser built for speed, simplicity, and security

Get help with using Chrome Report an issue

Version 43.0.2357.130 (64-bit)

Nearly up-to-date! Relaunch Google Chrome to finish updating.

Set Up Automatic Updates for All Users Relaunch

why is 'History' greyed out?

heuristic: information scent

Award Winners

Caldecott Medal (107)
Man Booker Prize (54)
National Book Award (49)
Newbery Medal (84)
The Pulitzer Prize (46)
Hugo & Nebula Awards (25)
Eisner Award (39)

Packaging Option

Frustration-Free Packaging (9)

Promotion

Bargain Books (142,908)

Avg. Customer Review

★★★★☆ & Up (2,903,157)
★★★★☆ & Up (3,274,714)
★★★☆☆ & Up (3,378,179)
★☆☆☆☆ & Up (3,481,555)

amazon.com

books

what's new

new releases
pre-orders
NY Times bestsellers
Target Club Picks
Only at Target

featured categories

book deals
Rosetta Stone
John Green
Dr. Seuss
signed books

kids' books

baby-3 years
4-8 years
9-12 years
teen
Common Core State
Standards
all kids' books

ToysRUs.com

design lesson:
give good scent to aid
information 'foraging'

conclusions

design thinking

will change software development

brings good ideas

user-centeredness

incrementality

prototypes

applied to software

focused data models

usability heuristics

concepts & purposes

to learn more, see references at <http://tinyurl.com/acn-refs>