



Concepts: A New Modularity for Software

Daniel Jackson · MIT CSAIL · SPLASH 2018

with

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& Maryam Archie, Czarina Lao, Barry McNamara

funded by

MIT-SUTD International Design Center

ten years ago...

a simple task: sign and return

Field Trip Permission Form

Dear Parents:

Ms. Frizzle will again be taking her second grade class on an exciting field trip. Please sign and return the permission slip below.

Thank you!

Yes, I give permission for my child to go on the second grade "Touch and Feel" trip on Friday February 13th to the NastyCo Nuclear Dump. I understood that my child may encounter the normal risks of childhood play, including grazed knees, hurt feelings and exposure to toxic waste.

Count Olaf

February 11, 2013

Parents signature

Date

acrobat to the rescue?

The image shows a screenshot of the Adobe Acrobat application interface. The main window displays a document with the following text:

Ms. Frizzle will again be taking her exciting field trip. Please sign and return the permission slip below.

Thank you!

The **Tools** menu is open, showing the following options:

- Comment & Markup
- Select & Zoom
- Advanced Editing** (highlighted)
- Typewriter
- Analysis
- Multimedia
- Customize Toolbars...

The **Advanced Editing** submenu is also open, showing the following options:

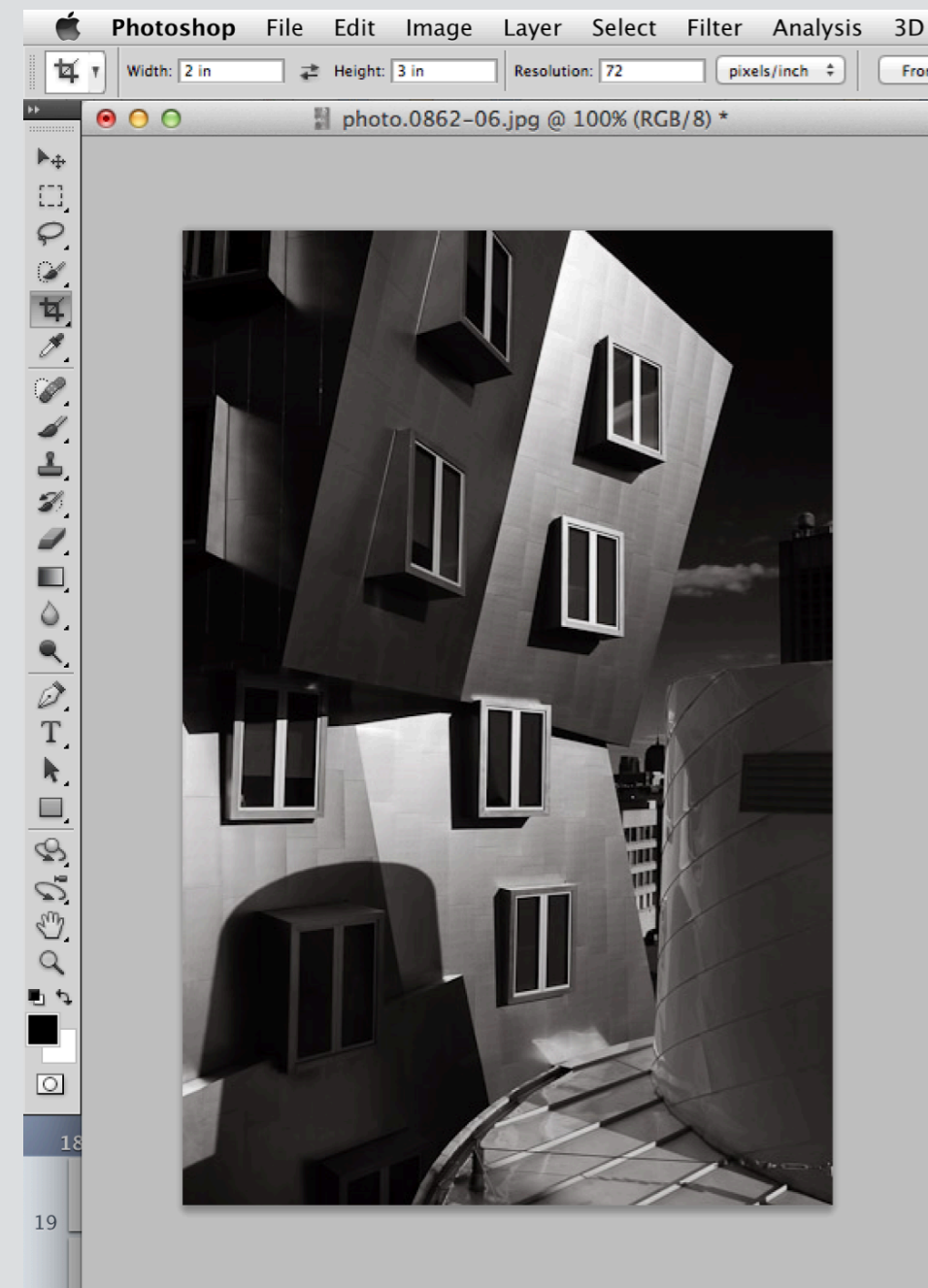
- Select Object Tool
- Button
- Article Tool
- Crop Tool
- Link Tool
- TouchUp Text Tool
- TouchUp Reading Order Tool
- TouchUp Object Tool** (checked)

In the foreground, a text editor window titled "acrobat-sig-paste.txt" is open. It contains the following text:

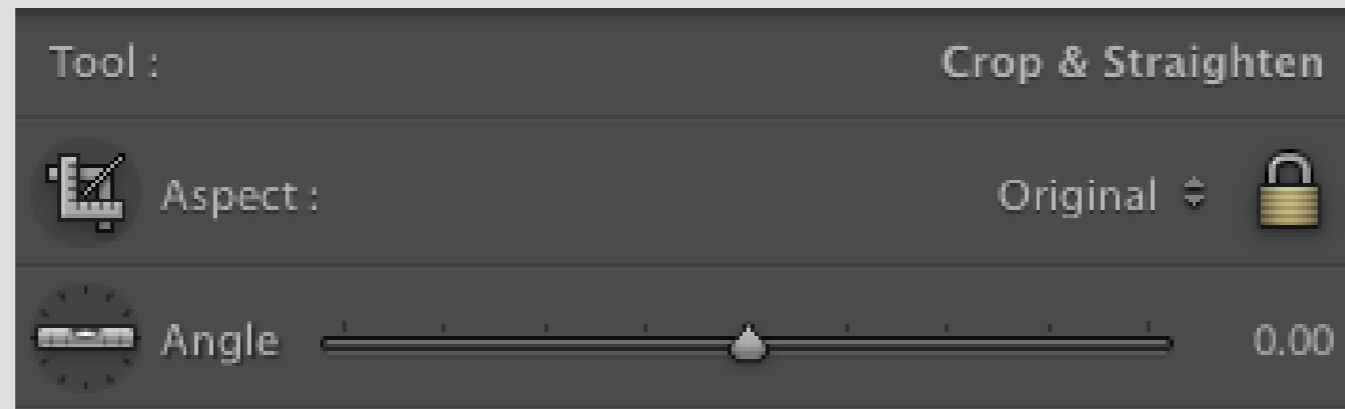
Last Saved: 8/27/09 5:20:28 PM
File Path : ~/Filestore/Advice/computers/acrobat-sig-paste.txt

1	how to add a signature in acrobat
2	-- open document in acrobat
3	-- Tools-->Advanced Editing-->Touchup Object Tool
4	-- right click at desired point Place Image...
5	then select jpg
6	
7	how to add date
8	-- Tools-->Typewriter
9	

adobe photoshop: cropping surprises



adobe lightroom: easy cropping



i'm not alone



Adobe Acrobat is a family of computer programs developed by Adobe Systems, designed to view, create, manipulate and manage files ... »

47% Love Acrobat



Tweet 1



207 Positive Opinions out of 444



Adobe Photoshop is a graphics editing program developed and published by Adobe Systems Incorporated.

70% Love Photoshop



Tweet 87



30,305 Positive Opinions out of 43,283



Adobe Photoshop Lightroom is a photography software program developed by Adobe Systems for Mac OS X and Microsoft Windows, designed ... »

89% Love Lightroom



Tweet 3



2,335 Positive Opinions out of 2,632



Adobe Acrobat is a family of computer programs developed by Adobe Systems, designed to view, create, manipulate and manage files ... »

53% Hate Acrobat



Tweet 15

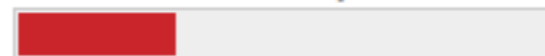


237 Negative Opinions out of 444



Adobe Photoshop is a graphics editing program developed and published by Adobe Systems Incorporated.

30% Hate Photoshop



Tweet 105

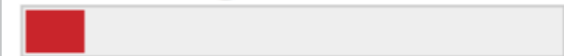


12,978 Negative Opinions out of 43,283



Adobe Photoshop Lightroom is a photography software program developed by Adobe Systems for Mac OS X and Microsoft Windows, designed ... »

11% Hate Lightroom



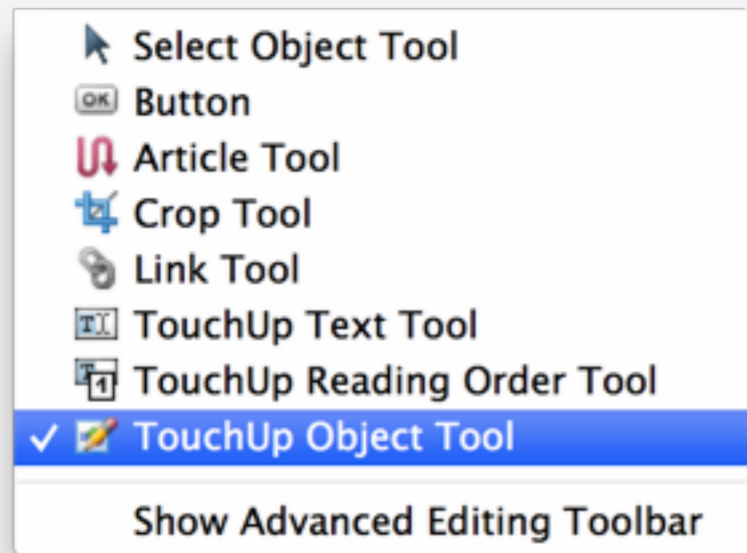
Tweet 5



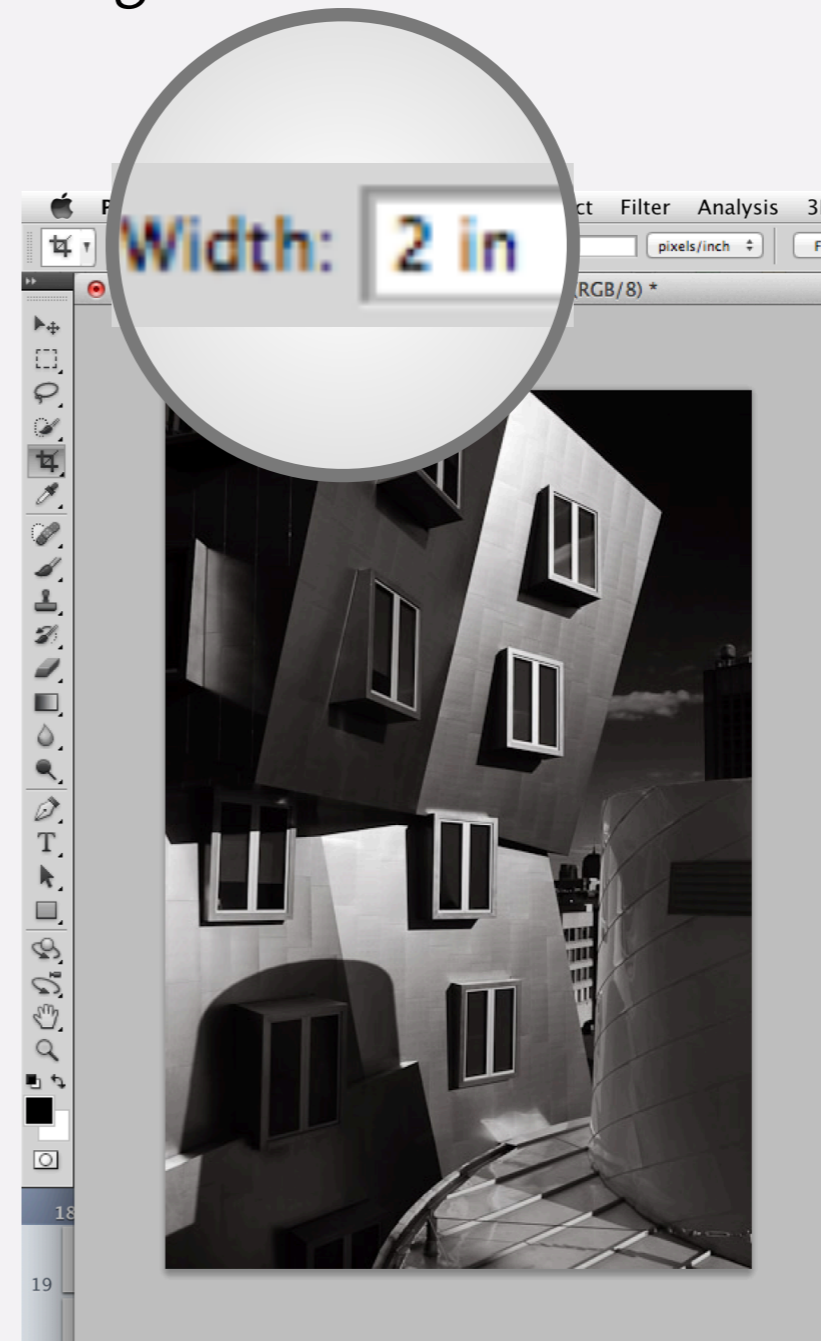
297 Negative Opinions out of 2,632

what's the essence of the problem?

not the user interface!
polished and organized



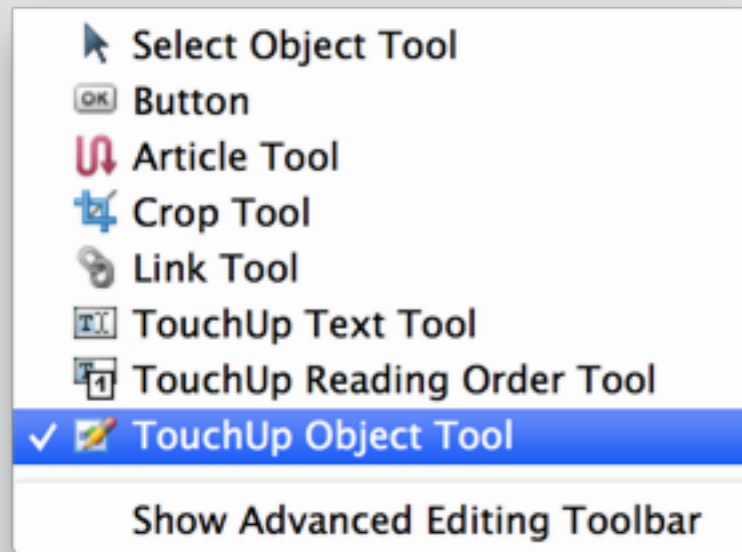
task-oriented design
no unifying concepts



complex concepts
cropping vs. resizing

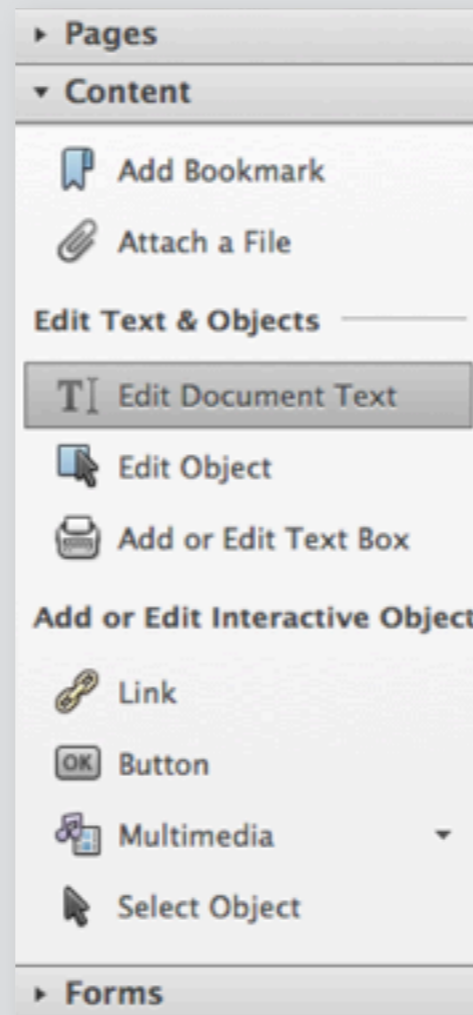
adobe fixes acrobat

Version 9 (2008)



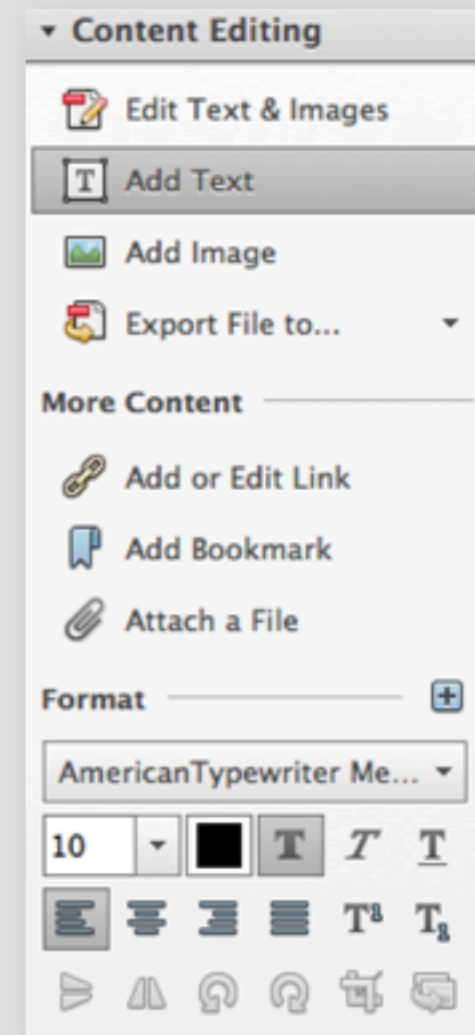
task-oriented design
no unifying concepts

Version 10 (2010)



improved interface
but still no concepts

Version 11 (2012)

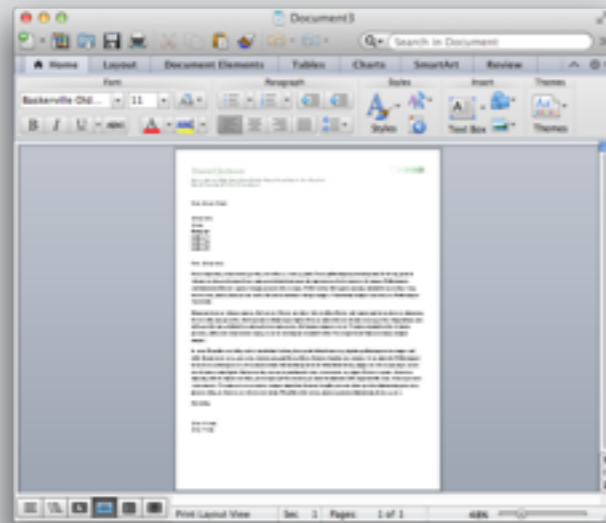


unifying concepts
text/image object

thinking
about
concepts

apps characterized by their concepts

Microsoft Word



Paragraph
Format
Style

Twitter



Tweet
Hashtag
Following

Photoshop

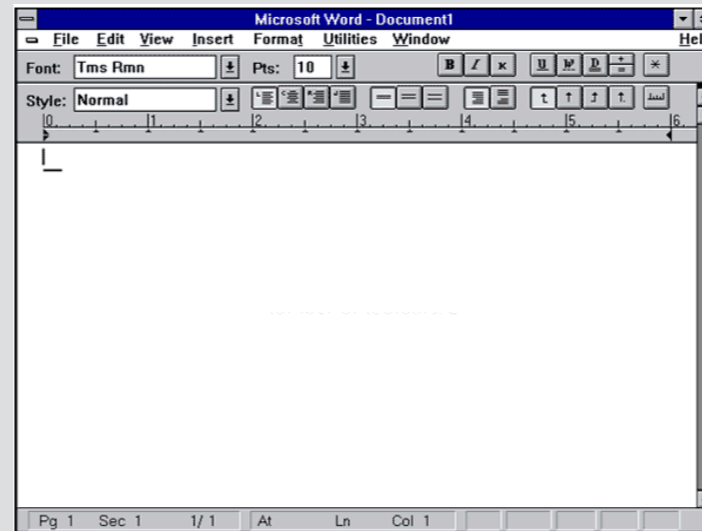


PixelMap
Layer/Mask
Adjustment

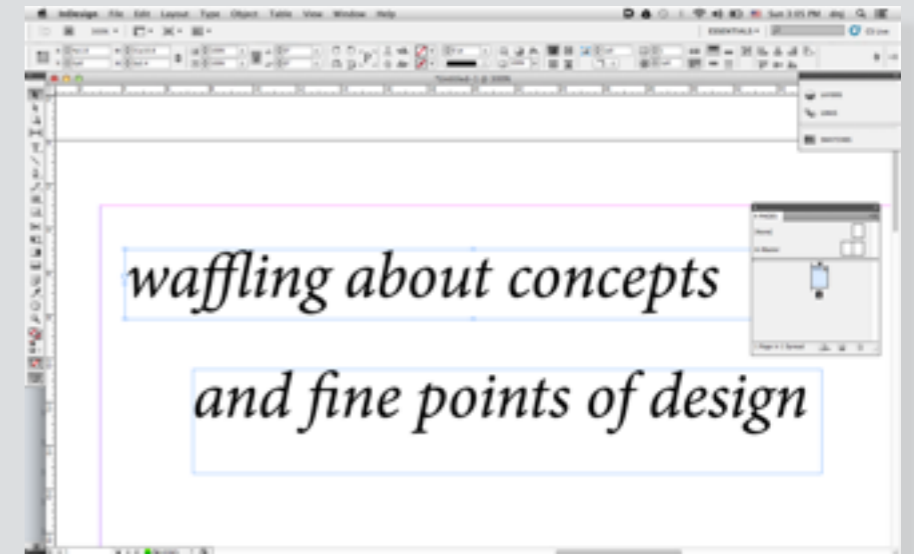
app classes characterized by concepts too



text editor
line
buffer



word processor
paragraph
format
style



desktop publishing app
stylesheet
text flow
page template

jamonh
Oct 22, 2013 7:19 PM

Just upgraded to the new Pages and can't find a way to link text boxes anymore like

<http://www.macobserver.com/tmo/article/pages-linking-text-boxes>

Am I missing something, or is it really not possible anymore?

the conventional view

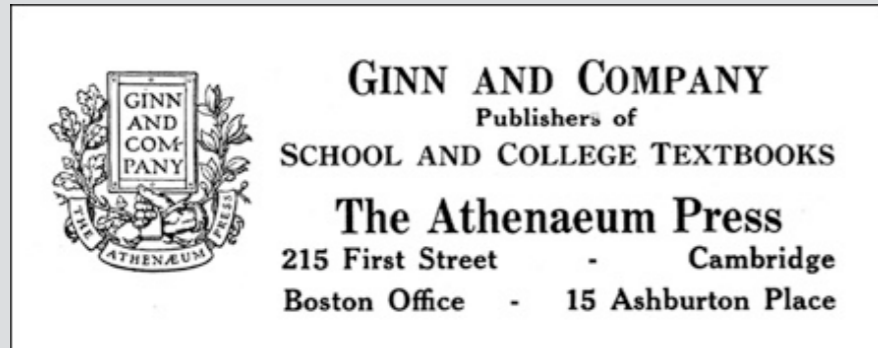
Conceptual model (computer science)

From Wikipedia, the free encyclopedia

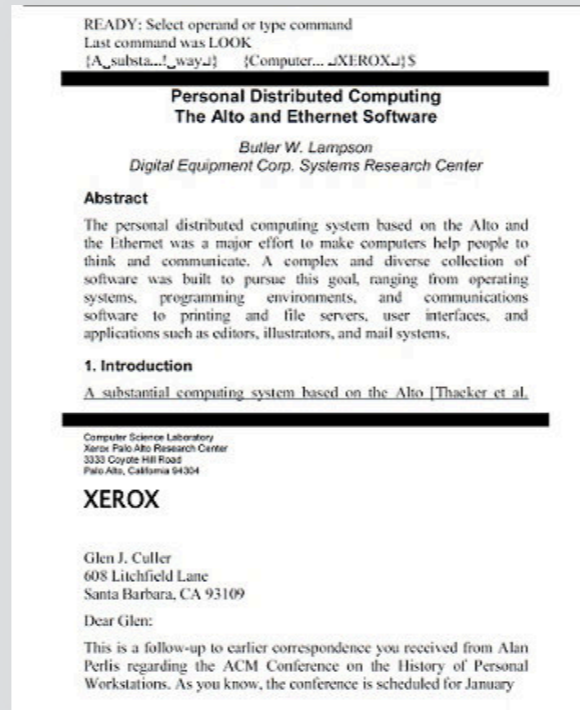
A [mental model](#) captures ideas in a [problem domain](#), while a **conceptual model** represents 'concepts' (entities) and relationships between them.

A conceptual model in the field of [computer science](#) is a special case of a general [conceptual model](#). To distinguish from other types of models, it is also known as a [domain model](#). Conceptual modeling should not be confused with other modeling disciplines such as [data modelling](#), [logical modelling](#) and

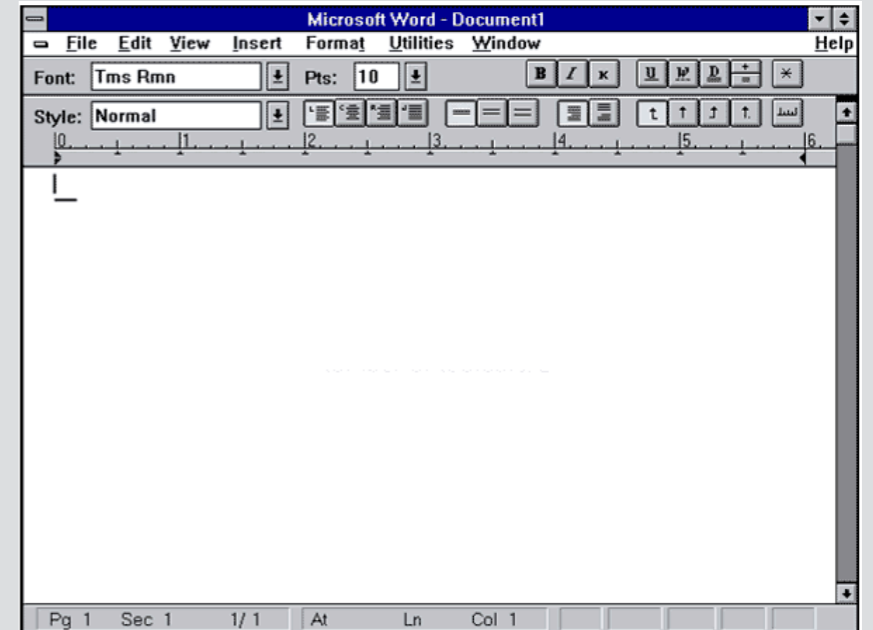
concepts are invented, not just out there



Tim Mott visits Ginn in 1974
brings idea of styles to PARC



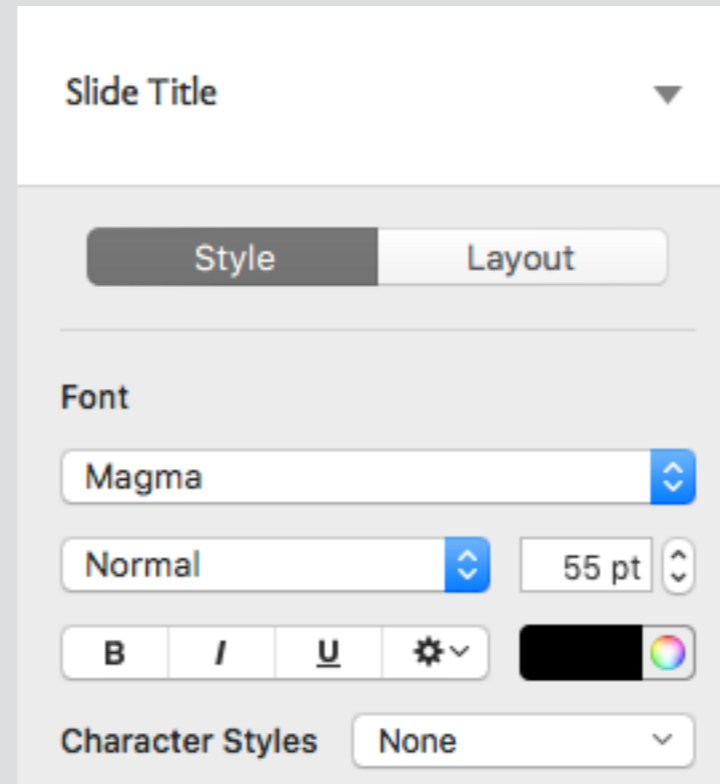
Charles Simonyi's team
implements style in
Bravo text editor



Simonyi brings style
to Microsoft in 1983

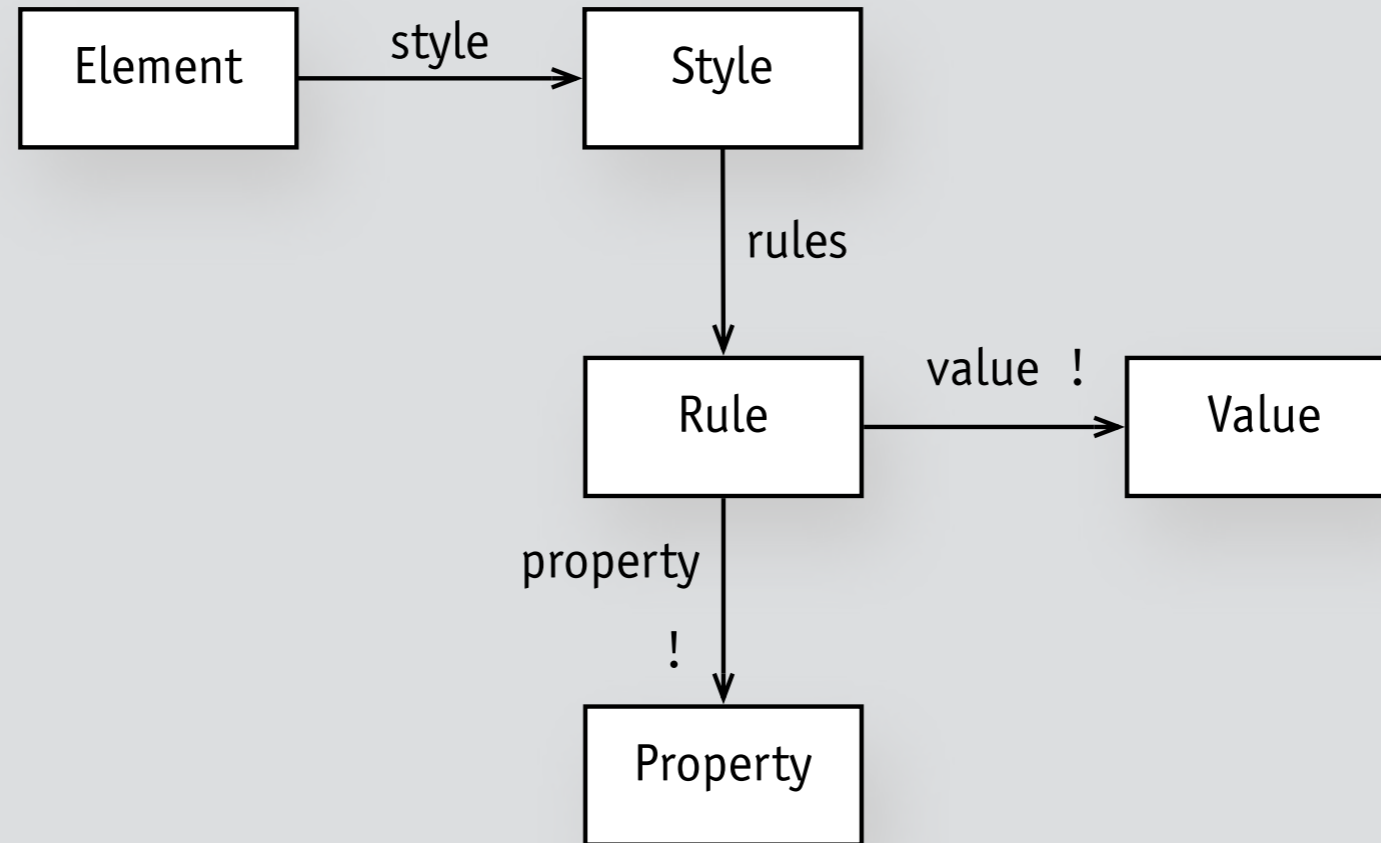
concepts have purpose

purpose of **style**: enable consistent formatting



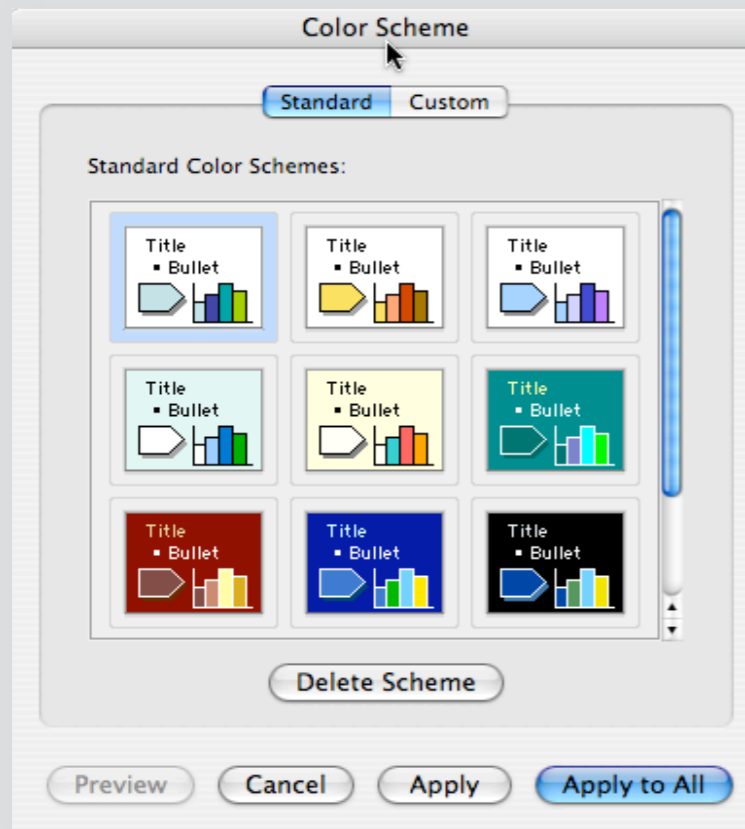
Apple Keynote
adds style concept
(2017?)

concept structure is designed not discovered

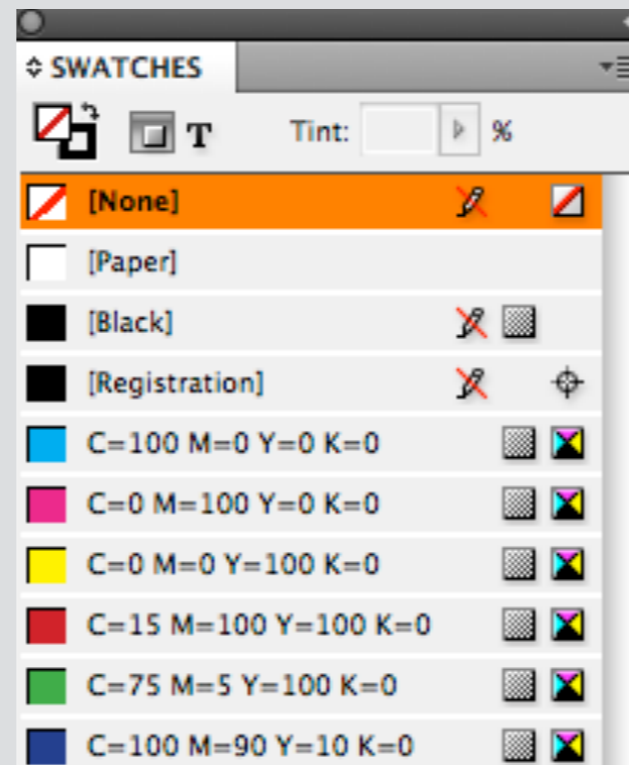


There is no problem
in computer science
that cannot be solved
by introducing another
level of indirection.
David Wheeler

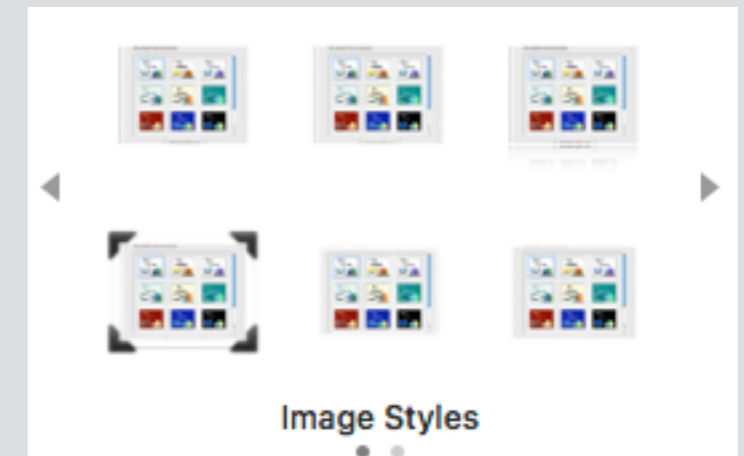
concepts are reusable



Powerpoint color schemes



Indesign swatches



Keynote image styles

explaining concepts

how to explain the style concept?

If you assign Heading to two paragraphs and then you change the style from bold to italic, both paragraphs will be changed in concert

If you create a style and assign to two elements, then when you modify the style, both elements will change...

not ontological: "a style is a mapping..."

not redundant: unlike full spec, shows how concept meets purpose

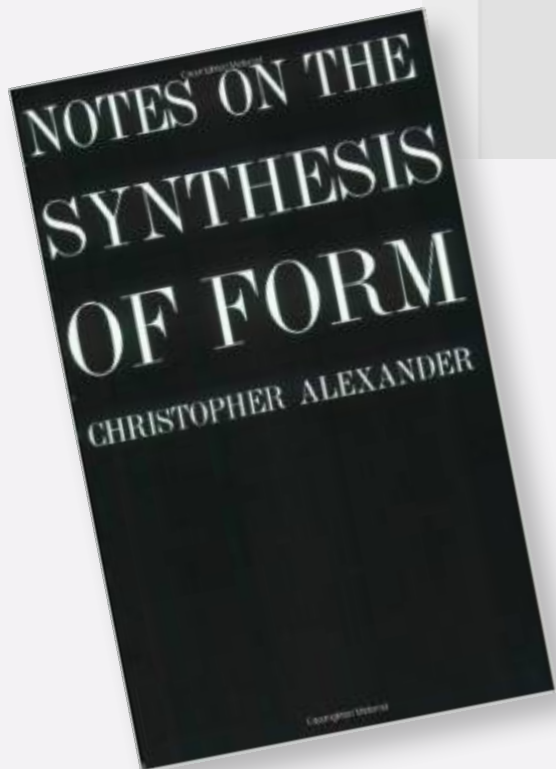
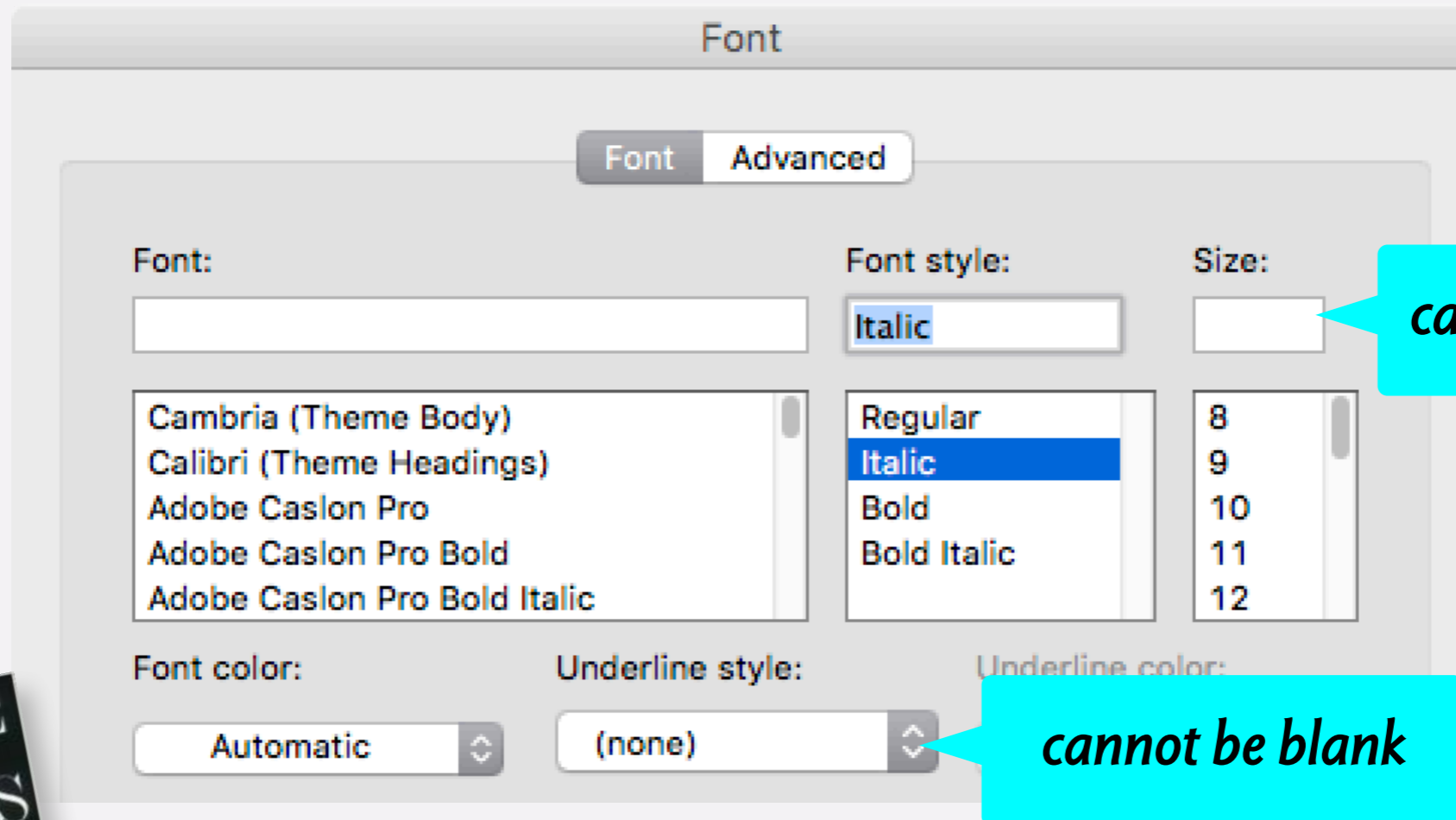


Johnson-Laird:
constructive semantics



Michael Polanyi
operational principle

when concepts don't fulfill purpose



Alexander's **misfits**:
not bugs but bad specs

concepts: modules of behavior



inventive



purposeful



behavioral



self-contained



reusable

the style concept

name

style

purpose

enable consistent formatting

structure

style: Element \rightarrow Style
value: Style \rightarrow Property \rightarrow Value

actions

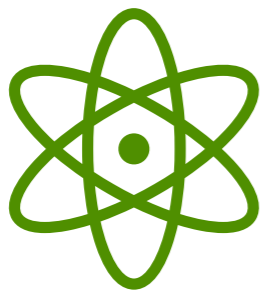
new (pv: Property \rightarrow Value) $\hat{=}$ new s | value := value + s \rightarrow pv
delete (s: Style) $\hat{=}$ style := style - Element \rightarrow s
assign (e: Element, s: Style) $\hat{=}$ style := style ++ e \rightarrow s
modify (s: Style, p: Property, v: Value) $\hat{=}$ value(s) := value(s) ++ p \rightarrow v

operational principle

if you create a new style, and assign it to two elements, and then modify the style, both elements will have the same property/value mapping

a research & teaching program

designing software with concepts



a design theory

*concept structure
& design rules
[Onward 15]*



design case studies

*Gitless
[Perez De Rosso,
Onward 13,
OOPSLA 16]*



design patterns

about 30 so far



code platform

*Deja Vu
[Perez De Rosso]*

three
design
problems

gmail
categories

gmail's categories

Primary			Social 23 new		Promotions 100+ new		+
<input type="checkbox"/>	<input type="star"/>	<input type="arrow"/>	Google	New sign-in from Chrome on Mac - New sign-in from Cr		12:30 pm	
<input type="checkbox"/>	<input type="star"/>	<input type="arrow"/>	Keith Muhammad at DeMont.	DeMontrond Auto Group - 14101 North Freeway Housto		12:19 pm	
<input type="checkbox"/>	<input type="star"/>	<input type="arrow"/>	AT&T High Speed Internet.	AT&T High Speed Internet Service Activation - Your A1		10:37 am	
<input type="checkbox"/>	<input type="star"/>	<input type="arrow"/>	Keith Muhammad at DeMont.	DeMontrond Auto Group - 14101 North Freeway Housto		Aug 26	
<input type="checkbox"/>	<input type="star"/>	<input type="arrow"/>	betterbatonrougejobs.com	Job Update -- 2015-08-26 - Looking For An Advantage W		Aug 26	

category tab settings

Categories:

[Learn more](#)

- Primary
- Social
- Promotions
- Updates
- Forums

Starred messages

- Include starred in Primary



Choose which message categories to show as inbox tabs. Other messages will appear in the Primary tab.

some reactions

Google gets it terribly, terribly wrong with Gmail tabs and makes me angry



By [Mark Wilson](#)

Published 2 years ago

Follow

71 Comments

Like 55

Share 11

g+ 37

Tweet 30

Like many Gmail users, I greeted the [news](#)

[Home](#) > [Quick Tech Tip: Disabling Gmail's Category Tabs](#)

Quick Tech Tip: Disabling Gmail's Category Tabs

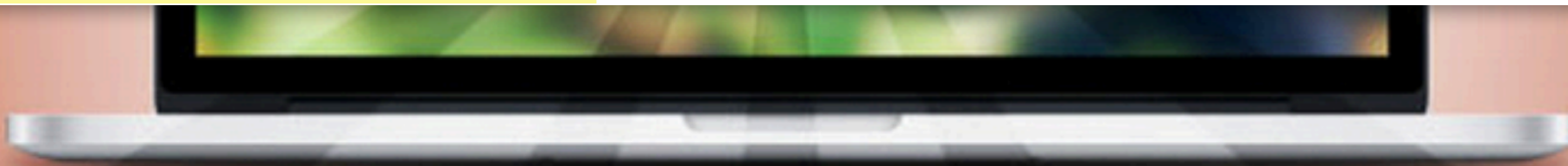
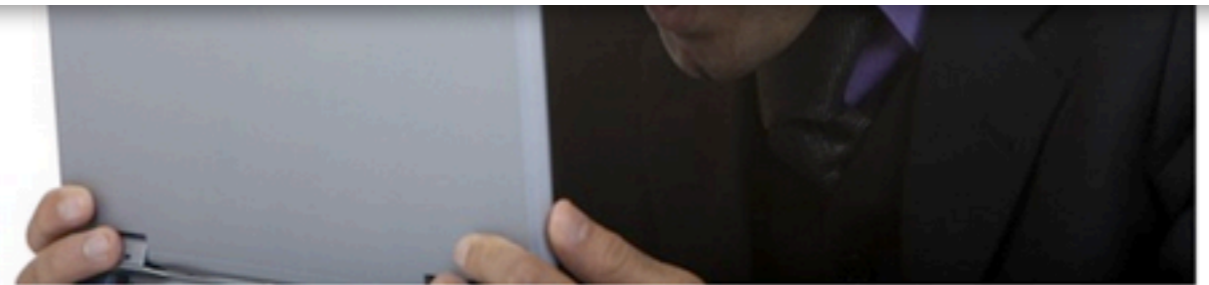
Mon, 07/29/2013 - 12:17 | [Chuck Gray](#)

in [LibraryPoint Blog](#) [Tech Tutorials](#) [Teen Blog](#) [Tech Answers](#) [Science and Technology](#) [Self-Help and Instructional](#)



Are you a Gmail user? Did you wake up a week or two ago to find that your new messages were now being automatically organized by Gmail into tabs of different, pre-determined categories? And, did you think, like me, that they were **really ugly, stupid, and unnecessary?** Here's a quick tip on how to rid yourself of them!

see that tabs were now available to me. Excitement was short-lived, however; it **quickly became apparent that this new feature is a disaster.**



how google explains labels (!)

Gmail Help 

GMAIL



FORUM

Using labels

Labels help you organize your messages into categories -- work, family, to do, read later, jokes, recipes, any category you want. Labels do all the work that folders do, but with an added bonus: you can add more than one to a message.

what you can't do

associate tabs with labels

feature available only for categories

create new categories

only new labels

use tabs outside inbox

tabs disappear when you filter on a label

fuji

aspect

ratio

my camera fuji x100s



image quality setting



aspect ratio



image size setting



non-standard ratio + raw?



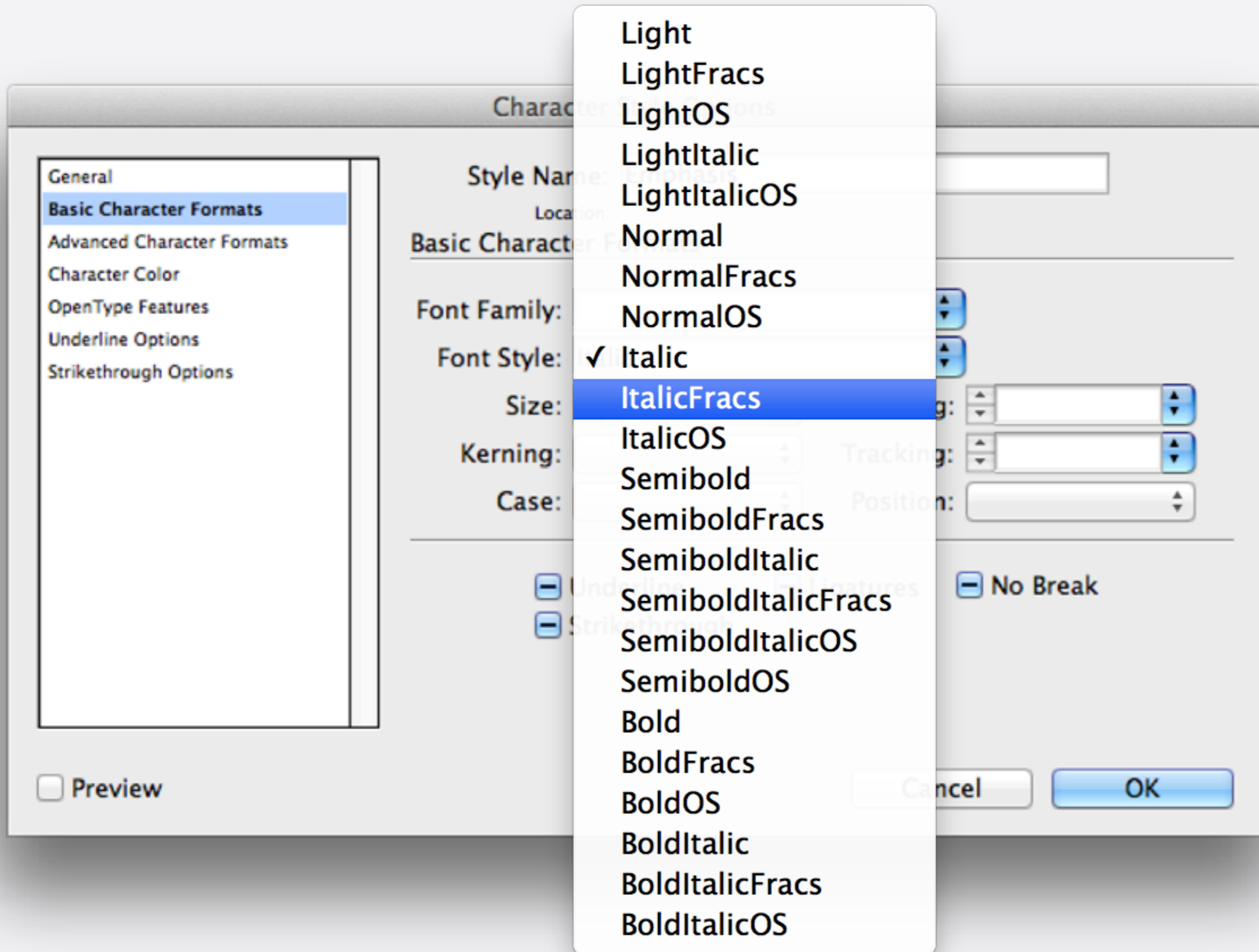
what you can't do

non-standard aspect ratio + raw
even though raw images get nice nondestructive crop!



indesign
styles

what's a font?



what you can't do

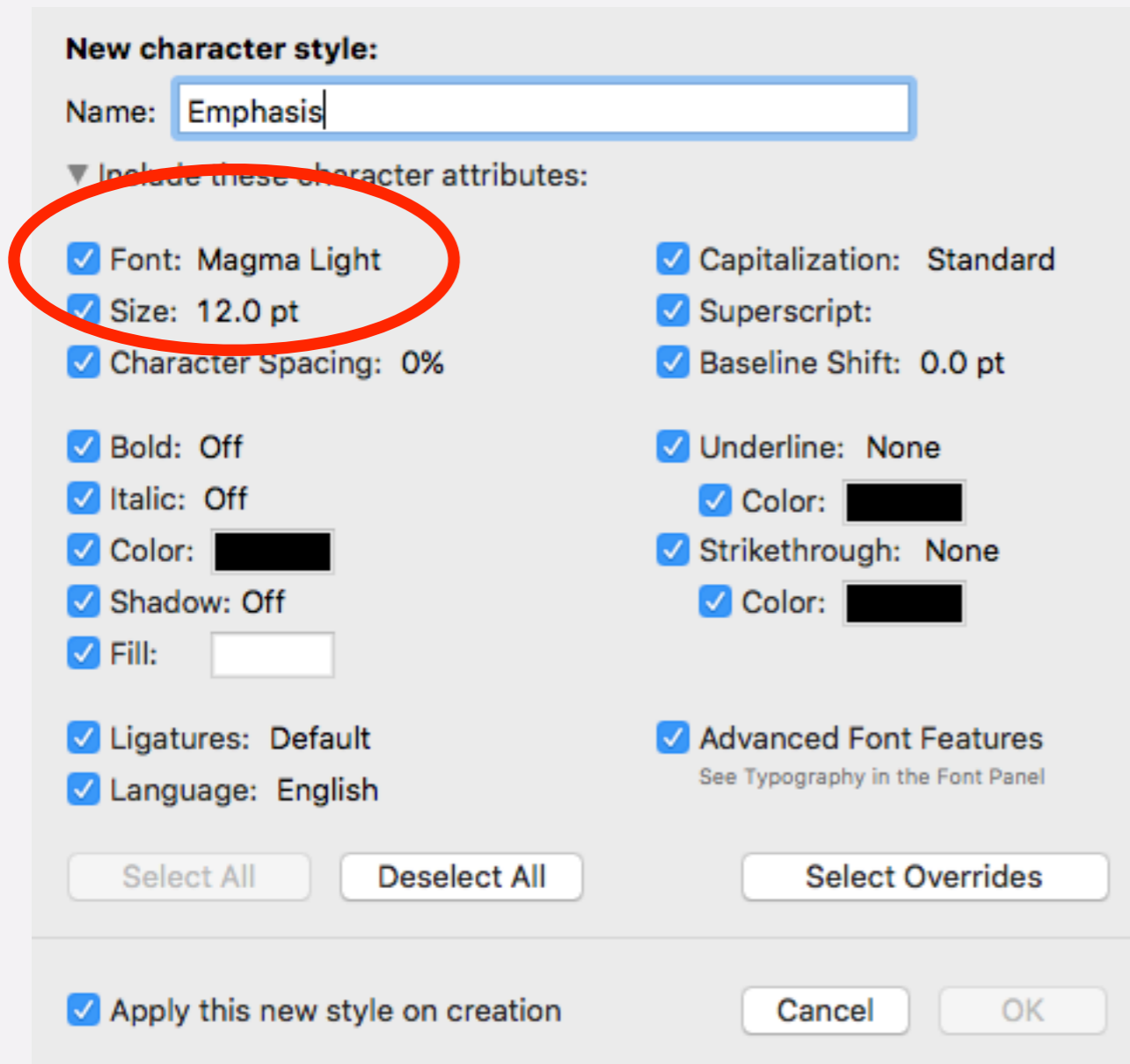
define a style that italicizes

Arno Regular to Arno Italic

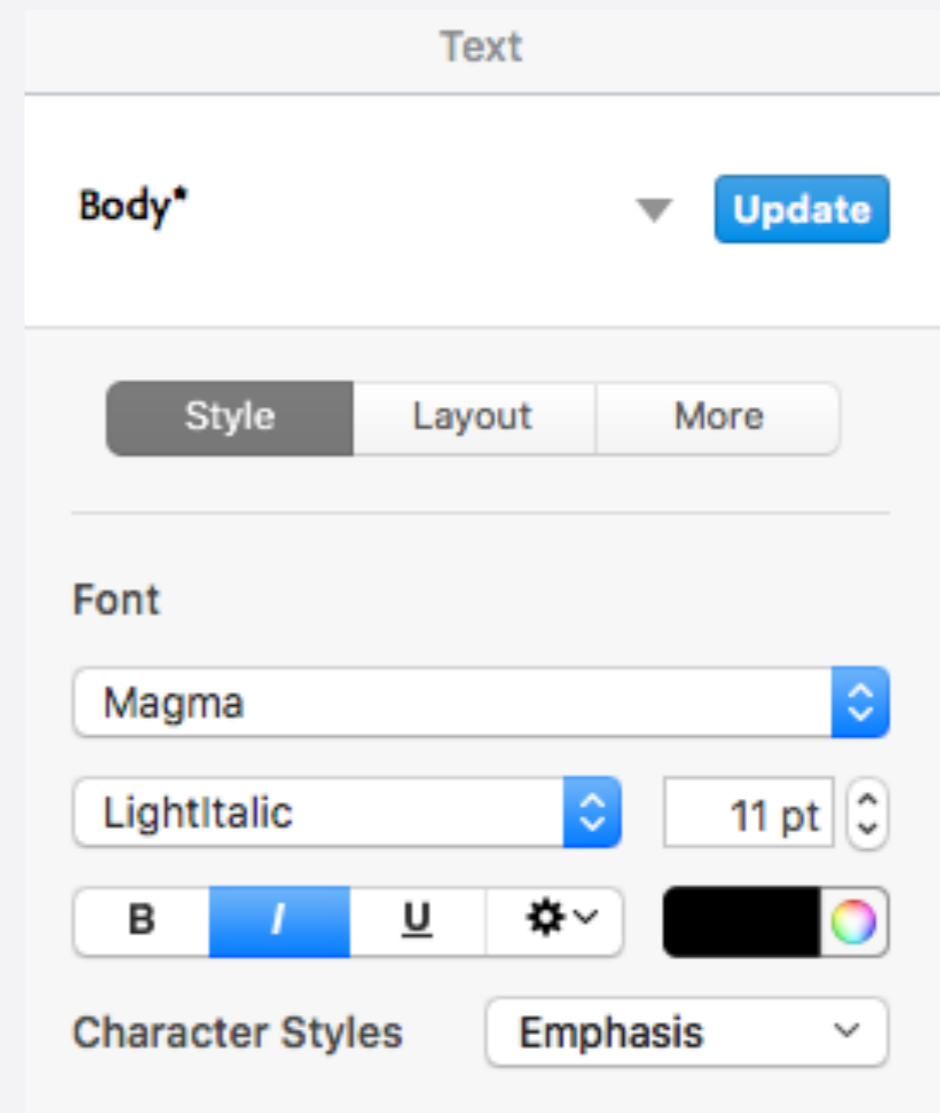
Futura Book to Futura Book Oblique

Magma Light to Magma Light Italic

introducing a concept



Keynote '09: has subfamilies



Keynote 6: gone again!

what's going on?

gmail

one purpose :: two concepts
organizing messages :: label + category

camera

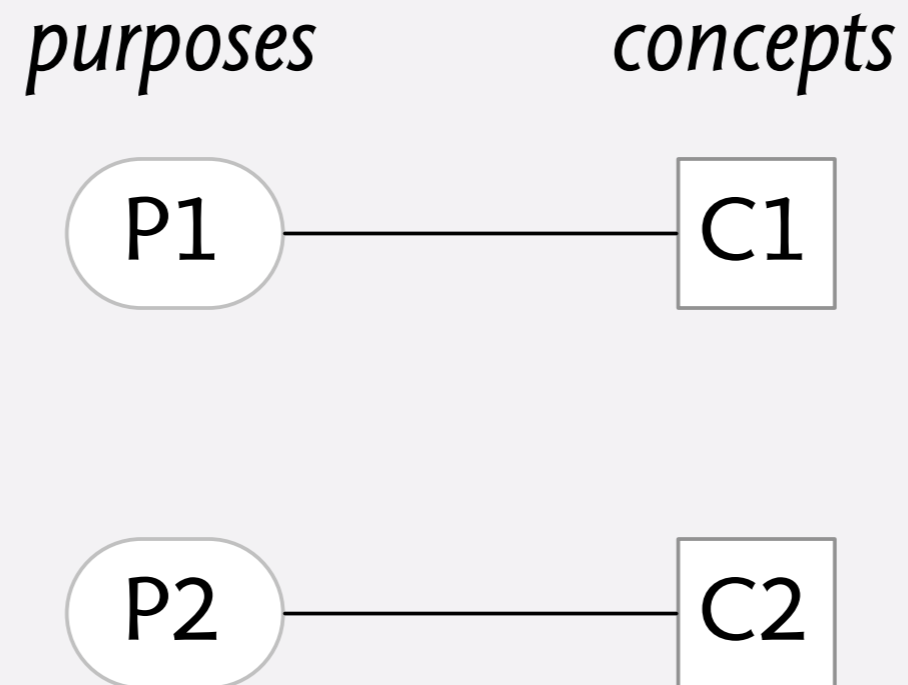
two purposes :: one concept
aspect ratio + image resolution :: image size

style

one purpose :: no concept
specify a font-independent styling :: ?

the
singularity
rule

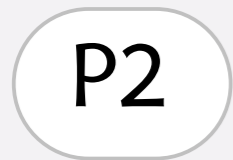
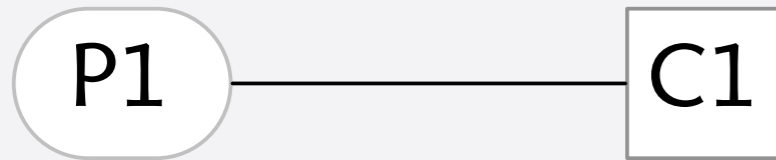
one-to-one mapping



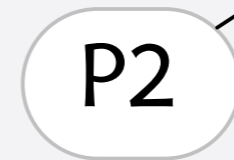
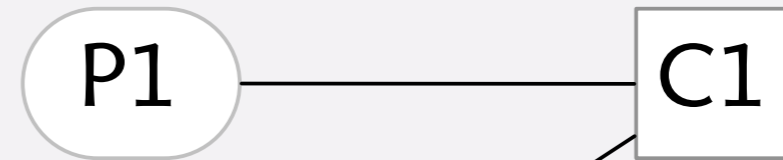
Nam Suh:
Axiomatic Design

four ways to fail

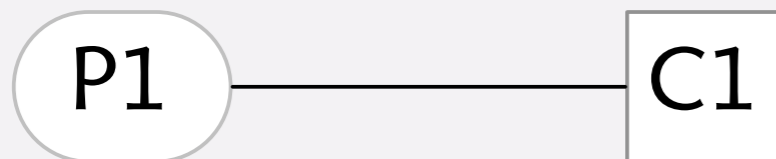
unfulfilled purpose



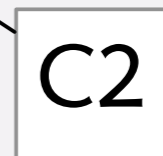
overloaded concept



unmotivated concept



redundant concepts



overloading fuji camera

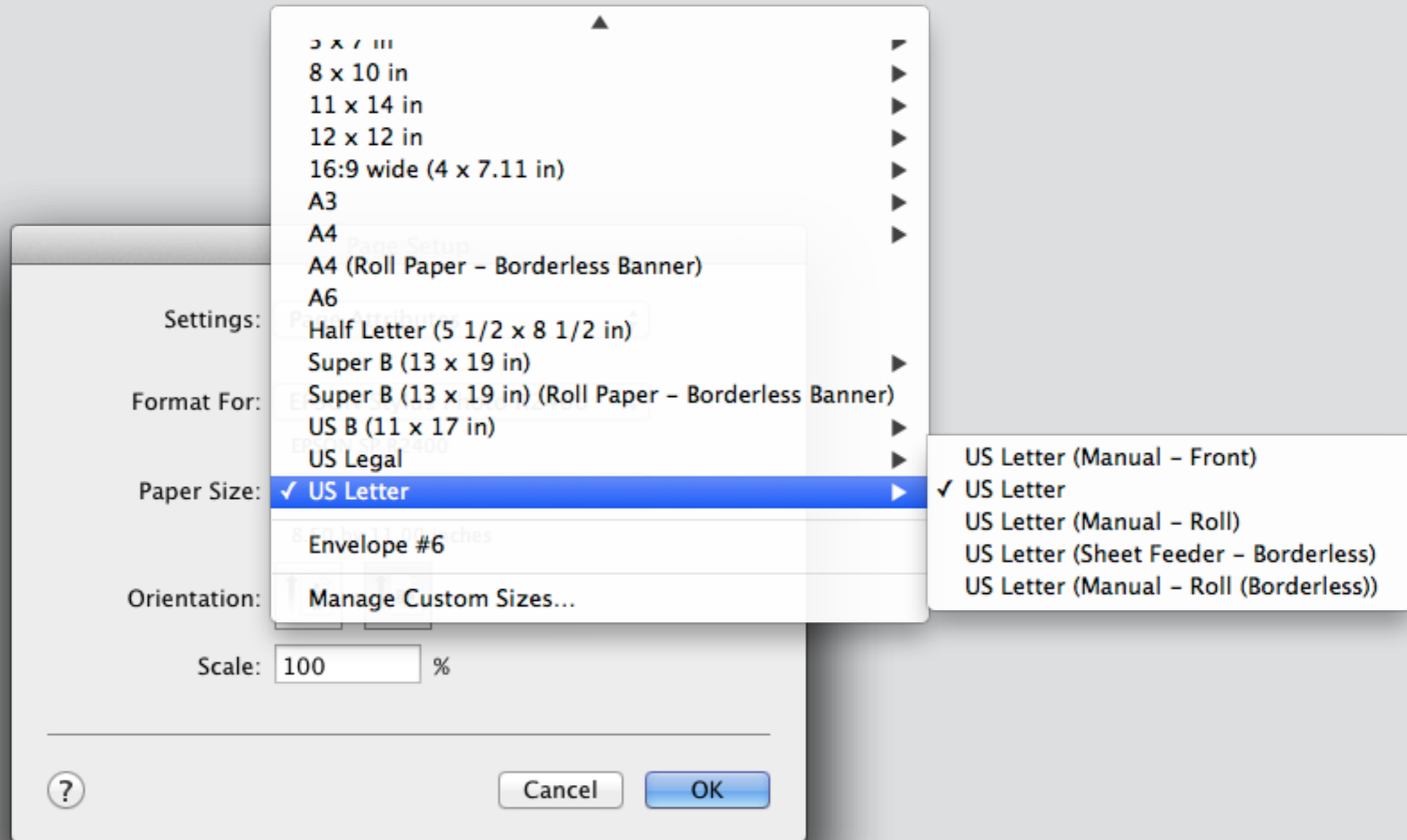
new purpose piggybacked on old concept



L	3:2	664
L	16:9	681
L	1:1	702
M	3:2	707
M	16:9	719
M	1:1	734
S	3:2	746

image size
aspect ratio piggybacked
on JPEG dimensions

overloading Epson driver



result: can't create custom size for front loading
also, page size presets in Lightroom hold feed setting

overloading email subject

new purposes emerge for old concept

To: Daniel Jackson <dnj@mit.edu>

Re: Catch me if you can in real life!

initial purpose: summarize content

To: csail-related@lists.csail.mit.edu

Re: [csail-related] turn off the lights?

emergent purpose: show sender
if you bcc a list, subject reveals to-address

thanks to Shriram Krishnamurthi

To: Daniel Jackson <dnj@mit.edu>

your trip reservation

emergent purpose: group by conversation
can't label reservations from Expedia by trip

thanks to Eunsuk Kang

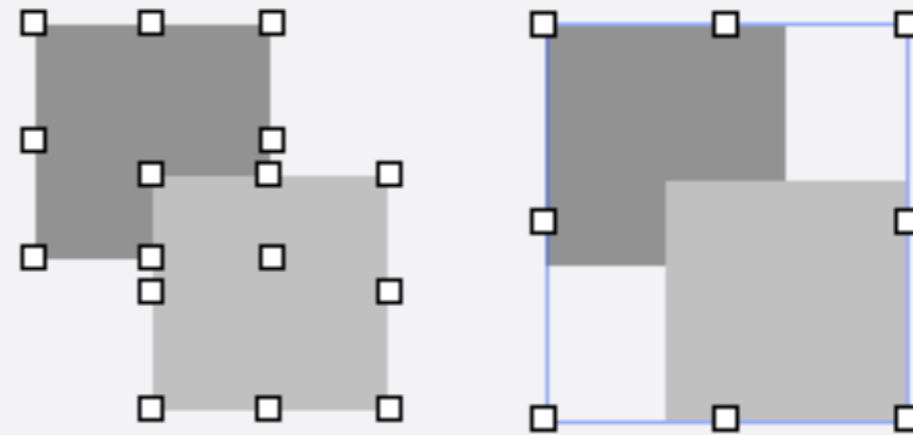
the
uniformity
rule

the uniformity rule

the operational principle should apply uniformly over states, types, arguments

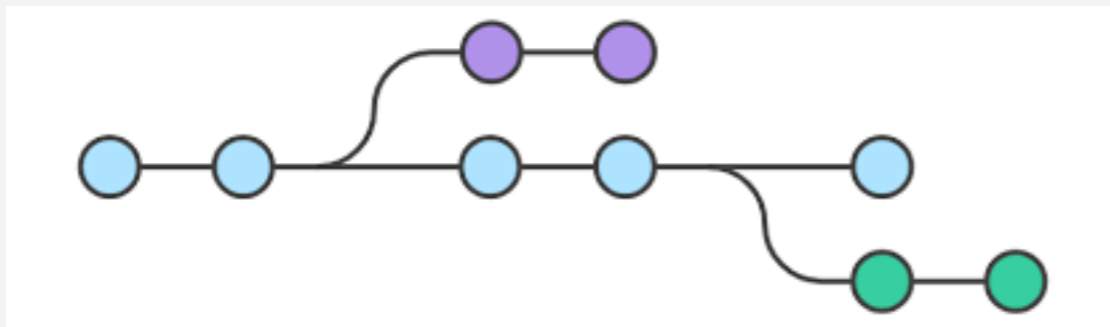
	A	B
1	item	cost
2	apples	\$4
3	bananas	\$2
4	grapes	\$6
5	kiwis	\$3
6		
7		

fx SUM B2:B5



Keynote group: ... unless object is placeholder

Numbers range: ... unless new cell is at end



Git branch: ... unless conflicts



Dropbox share: ... unless ancestor

the
genericity
rule

the genericity rule

reusing a well-known generic concept is usually preferable to inventing one

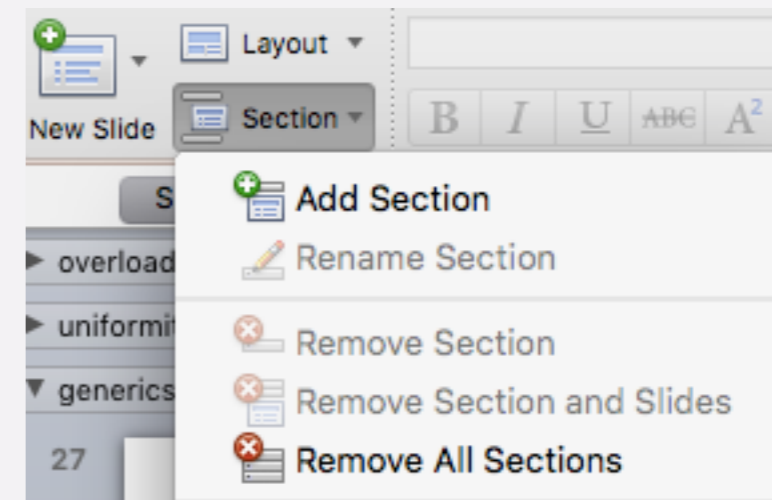
in Keynote



in Powerpoint



Powerpoint commands



the
integrity
rule

slightly surprising gmail behavior

Primary Social Promotions +

☆ me, Alyssa (12) hacking meetups javascript - Hello again Be 11:48 am

label:hacking

☆ me, Alyssa (12) Inbox meetups javascript - Hello again Ben 9:43 am

label:meetups

☆ me, Alyssa (12) Inbox hacking javascript - Hello again Ben. 9:58 am

label:hacking label:meetups

☆ me, Alyssa (12) Inbox hacking javascript - Hello again Ben. 9:58 am

🔍 No messages matched your search. Try using [search options](#) such as sender, date, size and more.

less surprising but more problematic?

This screenshot shows the Gmail inbox interface. At the top, there is a search bar with the text "Search mail". Below the search bar, there are navigation tabs for "Primary", "Social", and "Promotions". The "Primary" tab is selected. On the left side, there is a sidebar with "Compose", "Inbox" (with a red notification bubble containing the number "1"), "Starred", and "Snoozed". The main area displays a list of emails. The first email is from "Google Photos" with the subject "Ben, finish setting up your Google Photos account" and a date of "Oct 16". The second email is from "Alyssa, me 4" with the subject "Is JavaScript just Scheme with prototypes and some hacky coercions? On M..." and a date of "Jul 30".

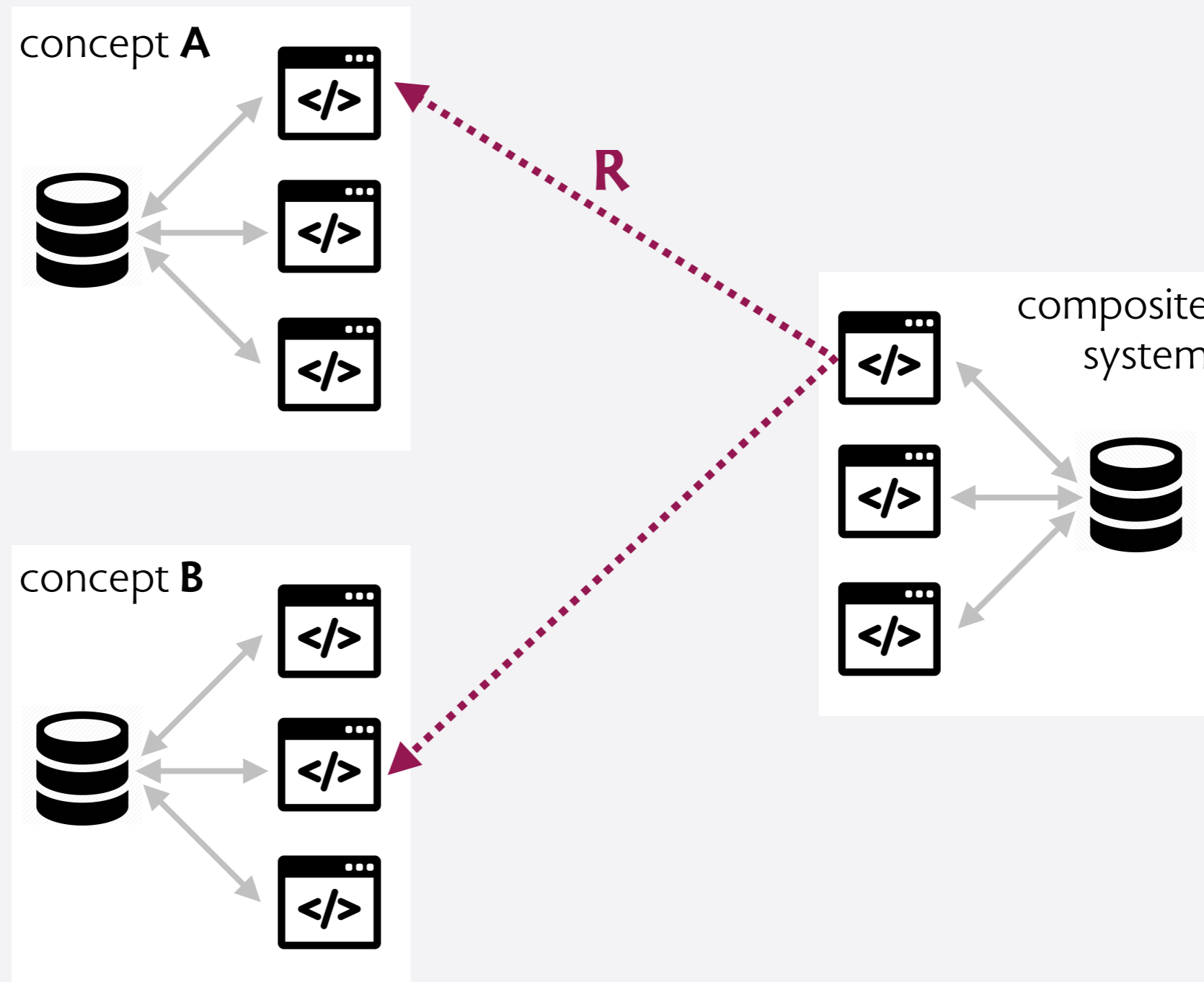
This screenshot shows a specific email thread in Gmail. The search bar at the top contains "in:sent". The email thread is titled "javascript" and has three tags: "Inbox", "hacking", and "meetups". The thread consists of four messages:

- Alyssa P. Hacker** <alyssa.pure.hacker@gmail.com> to me - Tue, May 8, 9:14 PM. Subject: "Reminds you of the old days, eh?"
- Ben Bitdiddle** <benito.bitdiddle@gmail.com> to Alyssa - Tue, May 8, 9:40 PM. Subject: "Yes, it does."
- Alyssa P. Hacker** - JavaScript makes me feel nostalgic for Scheme.
- Ben Bitdiddle** <benito.bitdiddle@gmail.com> to Alyssa - 1:15 PM (1 minute ago). Subject: "Is JavaScript just Scheme with prototypes and some hacky coercions?"

A red callout bubble points to the thread, containing the text: "can't see which messages were sent".

interpreting composite behavior

each action in composite system
interpreted as zero or more actions in each concept



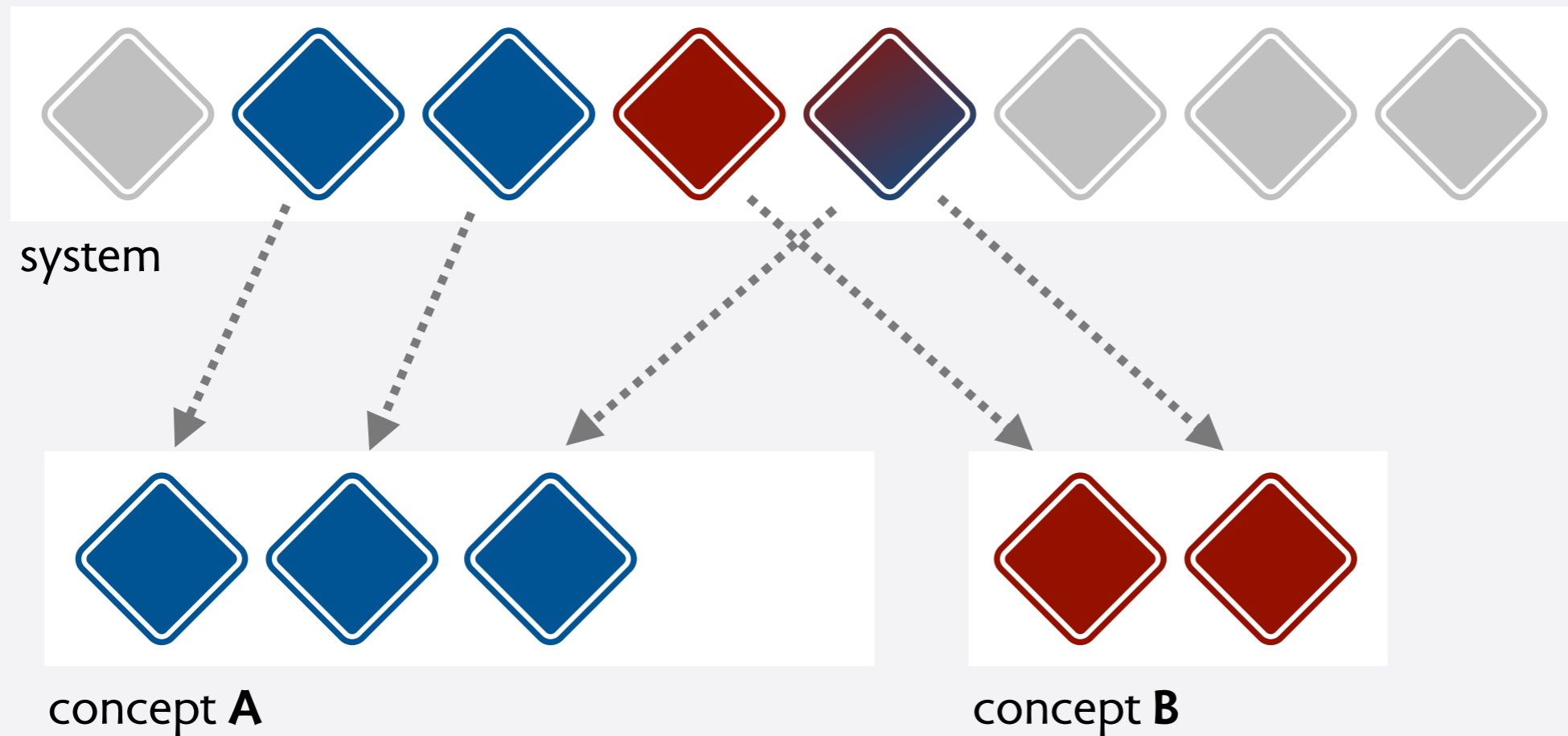
the integrity rule

when concepts are combined, each concept's behavior and OP should still apply

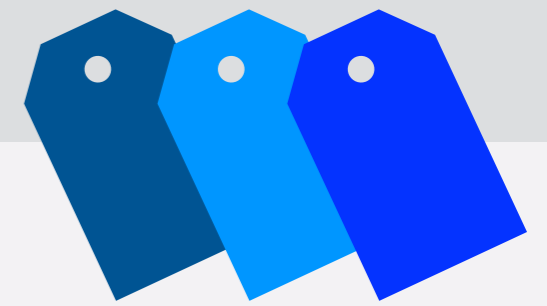
a simple criterion

projected behavior must satisfy concept spec:

$\forall c: \text{concept} \mid \forall t: \text{traces}(\text{sys}) \mid R_c(t) \in \text{traces}(c)$



the label concept



purpose

organize items for
easy retrieval

state labels: $X \rightarrow \text{Label}$

actions

mark ($x: X, p: \text{Label}$) \triangleq labels' = labels + $x \rightarrow p$

unmark ($x: X, p: \text{Label}$) \triangleq labels' = labels - $x \rightarrow p$

spec

find ($ps: \text{set Label}$): **set** $X \triangleq$ **result** = $\{x \mid ps \text{ in } x.\text{labels}\}$

operational principle

mark(x,p) then find(p): $xs \Rightarrow x \text{ in } xs$

if no mark(x,P) and then find(p): $xs \Rightarrow x \text{ !in } xs$

conversation breaks label

The screenshot shows an email inbox with a search bar at the top containing 'in:sent'. Below the search bar is a toolbar with various icons for email actions. The inbox contains four email messages. Three yellow callout boxes are overlaid on the messages, providing information about the 'sent' label. The first callout is over the first message from Alyssa P. Hacker, stating that the label is applied implicitly when a message is sent. The second callout is over the second message from Ben Bitdiddle, stating that the label is applied when the 'Sent' link is clicked. The third callout is over the fourth message from Ben Bitdiddle, stating that the label 'ms' includes messages that have never been marked.

Search: in:sent

1 of 1

javascript Inbox x hacking x meetups x

Alyssa P. Hacker <alyssa.pure.hacker@gmail.com>
to me
Reminds you of the old days, eh?

*when message m is sent
`Label.mark(m, 'sent')`
occurs implicitly*

Tue, May 8, 9:14 PM

Ben Bitdiddle <benito.bitdiddle@gmail.com>
to Alyssa
Yes, it does.

*when Sent link is clicked
`Label.find('sent'):ms`
occurs*

Tue, May 8, 9:40 PM

Alyssa P. Hacker
JavaScript makes me feel nostalgic for Scheme.

Mon, Jul 30, 1:24 PM

Ben Bitdiddle <benito.bitdiddle@gmail.com>
to Alyssa
Is JavaScript just Scheme with prototypes and some hacky c

*but ms includes
messages never marked*

1:15 PM (1 minute ago)

deja vu

reversing the process



the same concepts, again & again
post, comment, upvote, notification, ...

hard work to build
libraries often just client- or server-side
easy in a CMS, but structure hard-wired

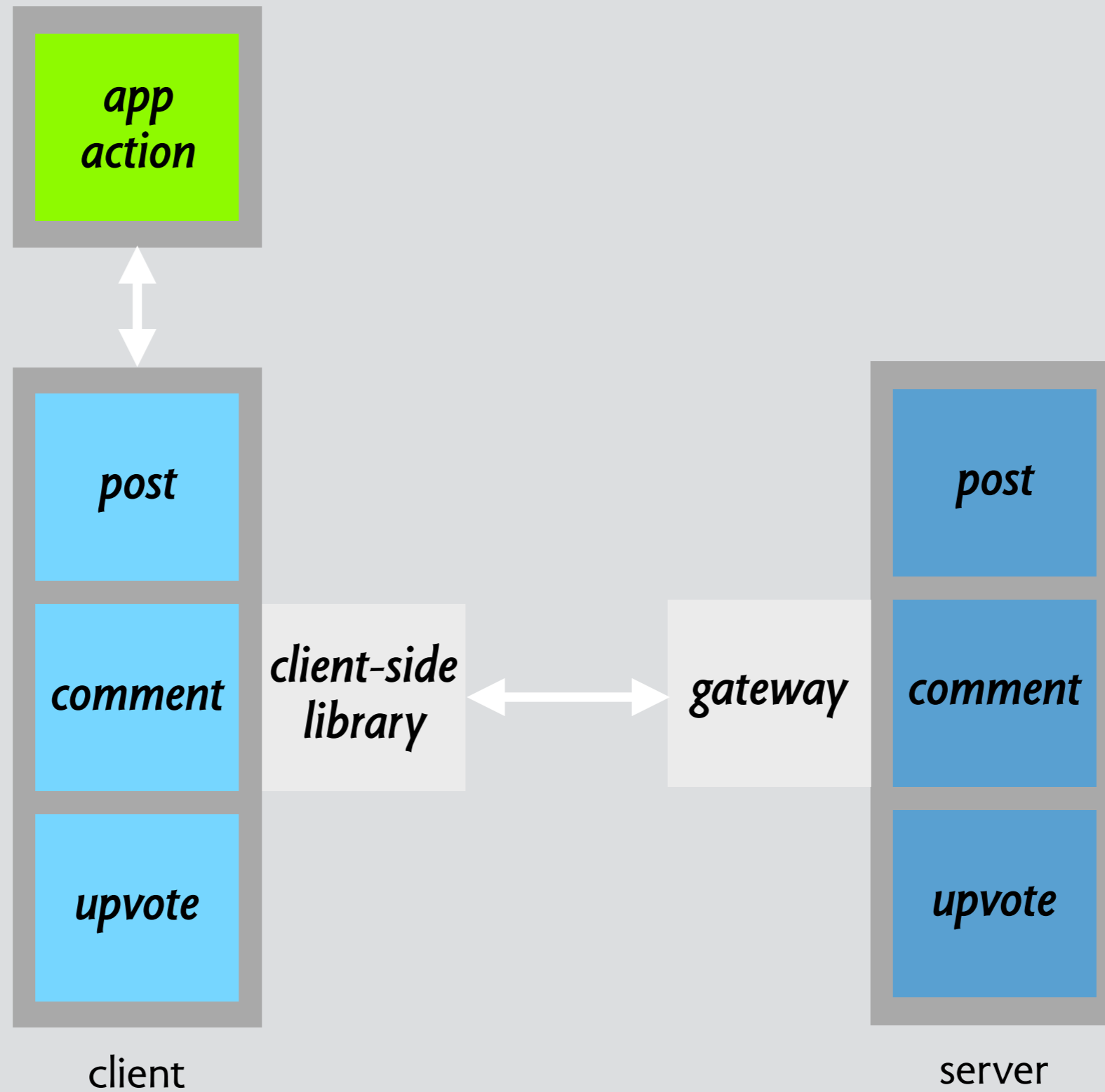


idea: concept cliches
full stack implementation

app-specific assembly
in HTML, no JS or backend code

action synchronization
build app action by joining cliché actions

architecture of deja vu



a sample app

auth

DV Hacker News Submit

ben Sign Out

▲ **SPLASH 2018** (2018.splashcon.org)

3 points by eva | comments

property

*scoring
(x2)*

▲ **Software Design Group** (sdg.csail.mit.edu)

2 points by eva | comments

▲ **Concept design** (sdg.csail.mit.edu)

1 points by alyssa | comments

▲ **Déjà Vu** (sdg.csail.mit.edu)

1 points by ben | comments

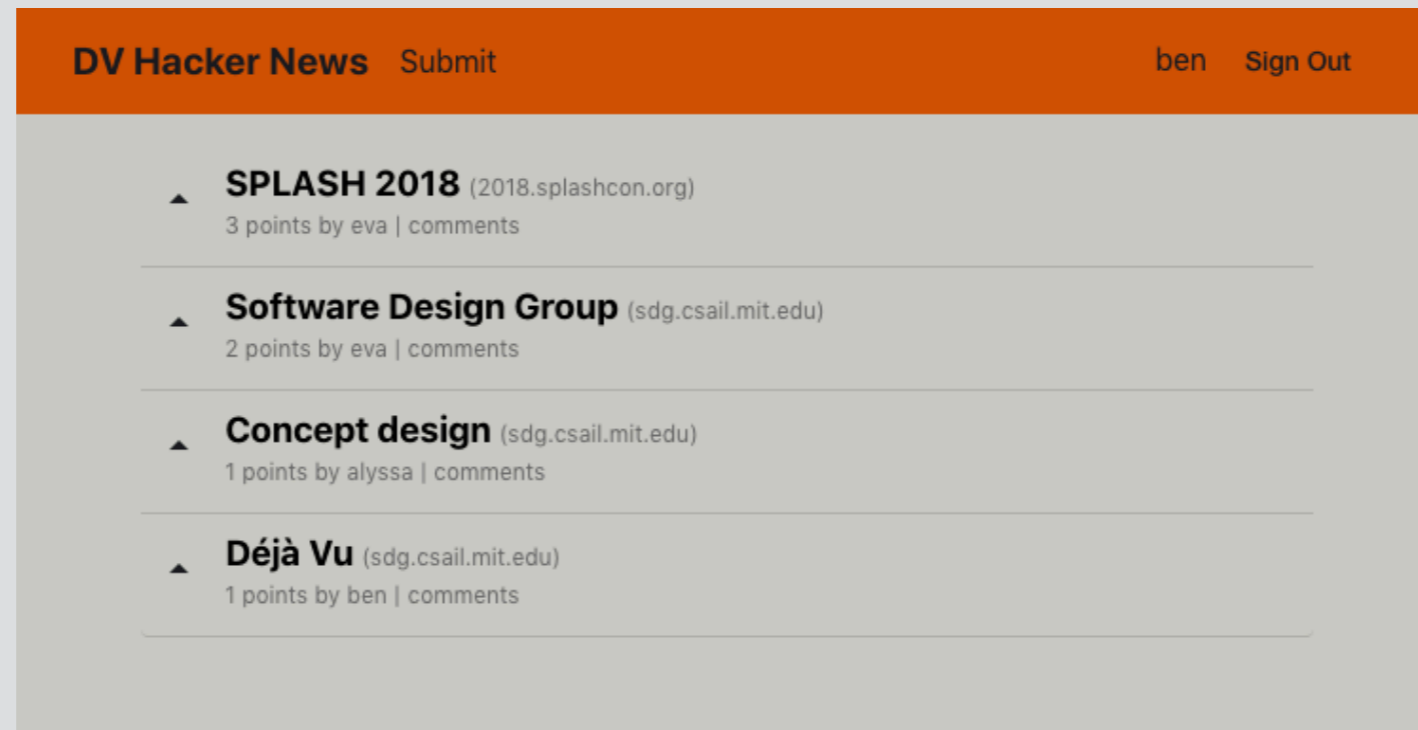
comment

```
{
  "name": "hackernews",
  "usedCliches": {
    "authentication": {},
    "comment": {},
    "property": {...},
    "scoringposts": {"name": "scoring"}
    "scoringcomments": {"name": "scoring"}
  },

```

```
"routes": [
  { "route": "", "action": "home" },
  { "route": "news", "action": "home" },
  { "route": "post", "action": "post-detail" },
  { "route": "login", "action": "login" },
  { "route": "submit", "action": "submit-post" }
]
```

home action



The screenshot shows the DV Hacker News interface. At the top, there is an orange navigation bar with "DV Hacker News" and "Submit" on the left, and "ben" and "Sign Out" on the right. Below the navigation bar, there is a list of four posts, each with a small upward-pointing triangle icon to its left. The posts are: "SPLASH 2018 (2018.splashcon.org)" with 3 points by eva and a link to comments; "Software Design Group (sdg.csail.mit.edu)" with 2 points by eva and a link to comments; "Concept design (sdg.csail.mit.edu)" with 1 point by alyssa and a link to comments; and "Déjà Vu (sdg.csail.mit.edu)" with 1 point by ben and a link to comments.

```
<dv.action name="home">
  <hackernews.navbar />
  <div class="main">
    <scoringposts.show-targets-by-score
      noTargetsText="No posts yet"
      showAscending=false
      showScores=false
      showTarget=<hackernews.show-post post=$target id=$id />
    </scoringposts.show-targets-by-score>
  </div>
</dv.action>
```

submit post action

DV Hacker News Submit ben Sign Out

Title *

Url *

Submit

```
<dv.action name="submit-post">
<hackernews.navbar />
<div class="main"> <dv.tx>
  <dv.gen-id />
  <property.create-object
    id=dv.gen-id.id
    initialValue={ author: hackernews.navbar.user.username }
    showExclude=["author"]
    buttonLabel="submit"
    newObjectSavedText="Post"
  </property.create-object>
  <scoringposts.create-score
    targetId=dv.gen-id.id
    value=0
    hidden=true />
  <authentication.authenticate id=hackernews.navbar.user hidden=true />
  <dv.link href="/item" params={ id: dv.gen-id.id } />
</dv.tx> </div> </dv.action>
```

generate id

transaction

id used

set param

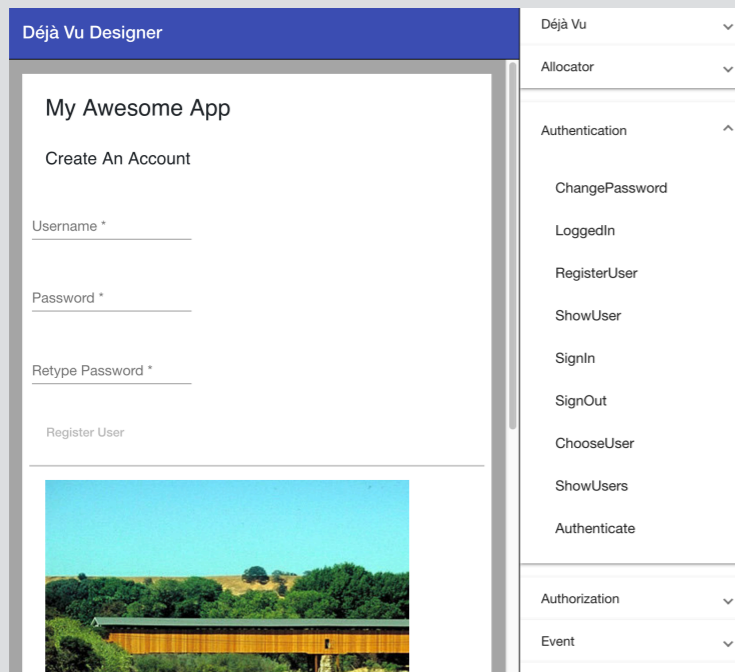
id used

redirect

rebuilding class projects

app	Authentication	Authorization	Passkey	Transfer	Rating	Follow	Geolocation	Comment	Event	Label	Group	Task	Scoring	Property	Chat
Accord	1	1	0	0	1	0	0	0	0	0	1	0	1	2	0
ChoreStar	2	2	0	1	1	0	0	0	0	0	0	1	0	0	0
MapMIT	1	1	0	0	0	0	2	0	1	0	1	0	0	1	0
Rendezvous	1	1	0	0	0	0	2	1	1	1	1	0	0	1	0
SweetSpots	1	1	0	0	1	1	1	1	0	1	0	0	0	1	0
Potluck	1	1	0	1	0	0	0	0	1	0	1	0	0	1	0
GroceryShip	1	1	0	2	1	0	0	0	1	0	0	1	0	2	0
Lingua	1	1	0	0	0	0	0	1	0	1	0	0	1	1	1
LiveScorecard	1	1	2	0	0	0	0	0	1	1	2	1	1	1	0

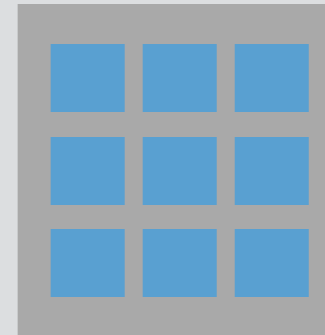
deja vu plans



WYSIWYG designer
(Barry McNamara)



security: stop
request forgeries



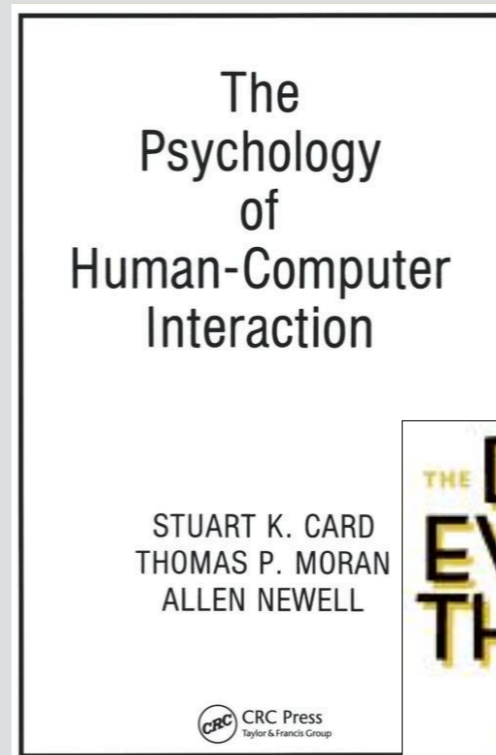
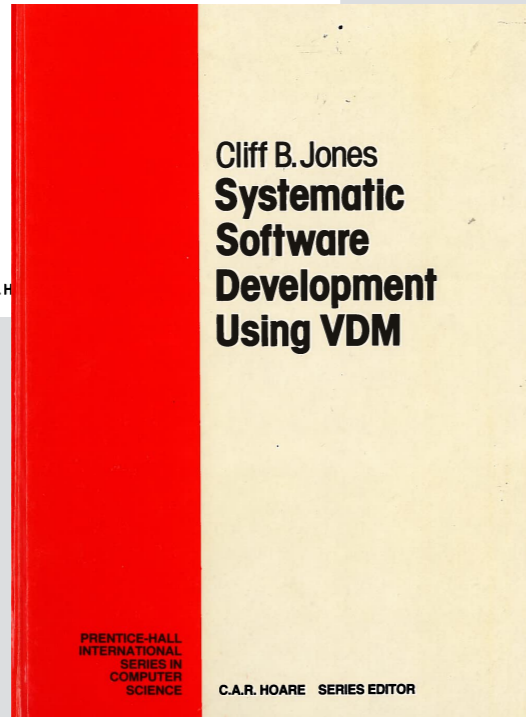
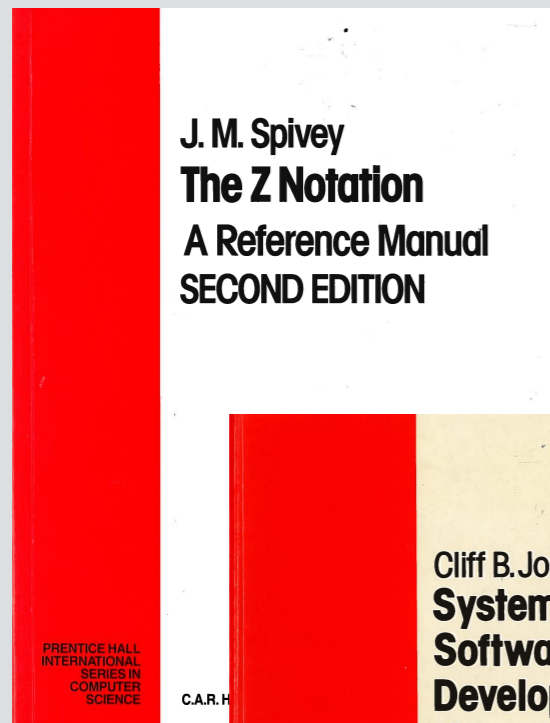
cliche library
for social apps
(Maryam Archie)



make it easier
to author cliches
(Czarina Lao)

closing
thoughts

bringing two fields together



user-centered design: conceptual model should be designed
formal methods: software defined by its behavior
both originating around 1974

putting the “thinking” into “design thinking”



theory of usability: collections of heuristics
design thinking: focused on empirical evaluation
see Natasha Jen, *Design Thinking is Bullsh*t*

patterns

128 INDOOR SUNLIGHT*



614

. . . according to SOUTH FACING OUTDOORS (105), the building is placed in such a way as to allow the sun to shine directly into it, across its gardens. From INTIMACY GRADIENT (127), you have some idea of the overall distribution of public and private rooms within the building. This pattern marks those rooms and areas along the intimacy gradient which need the sunlight most, and helps to place them so that the indoor sunlight can be made to coincide with the rooms in the INTIMACY GRADIENT which are most used.

❖ ❖ ❖

If the right rooms are facing south, a house is bright and sunny and cheerful; if the wrong rooms are facing south, the house is dark and gloomy.

Everyone knows this. But people may forget about it, and get confused by other considerations. The fact is that very few things have so much effect on the feeling inside a room as the sun shining into it. If you want to be sure that your house, or building, and the rooms in it are wonderful, comfortable places, give this pattern its due. Treat it seriously; cling to it tenaciously; insist upon it. Think of the rooms you know which do have sunshine in them, and compare them with the many rooms you know that don't.

From the pattern SOUTH FACING OUTDOORS (105), the building gets an orientation toward the south. Now the issue is the particular arrangement of rooms along this south edge. Here are some examples: (1) a porch that gets the evening sun late in the day; (2) a breakfast nook that looks directly into a garden which is sunny in the morning; (3) a bathing room arranged to get full morning sun; (4) a workshop that gets full southern exposure during the middle of the day; (5) an edge of a living room where the sun falls on an outside wall and warms a flowering plant.

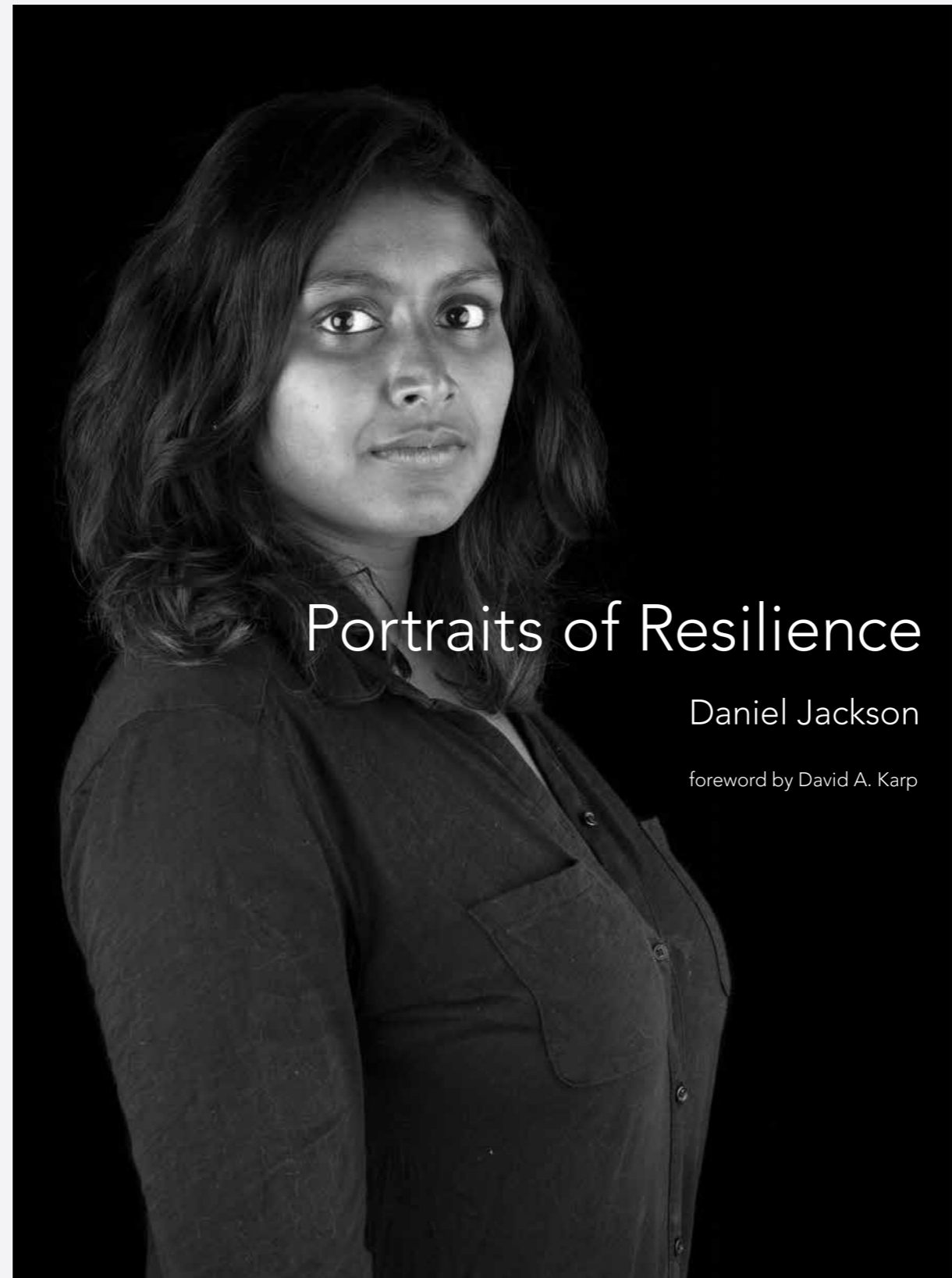
The key diagram for this pattern summarizes the relations between parts of the house and the morning, the afternoon and

615

concepts: more like Alexander's patterns?

<https://tinyurl.com/conceptproject>
to be notified about release of book & platform

a different project



<http://portraitsofresilience.com>