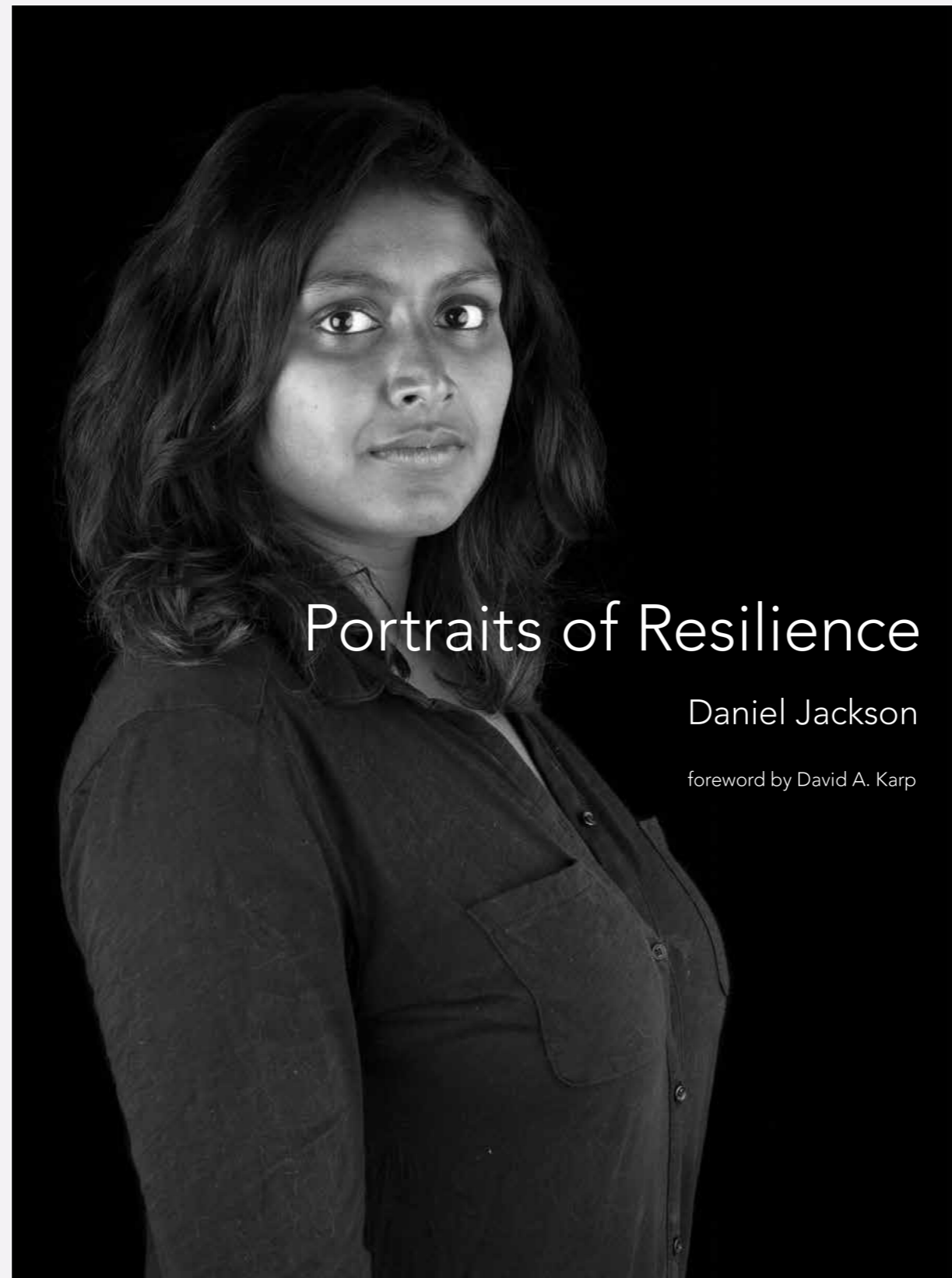


a new way to  
think about  
specifications

**Daniel Jackson · CSAIL, MIT**

ABZ · June 7, 2018

# a different project



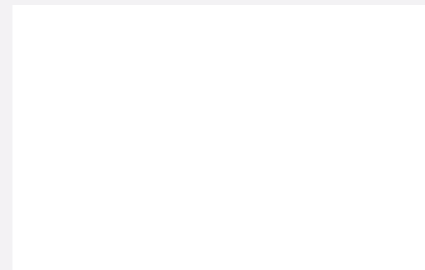
<http://portraitsofresilience.com>

how bugs  
led us astray

# the software problem



**need**  
the motivation for  
building the system



**implementation**  
the mechanisms  
of the system

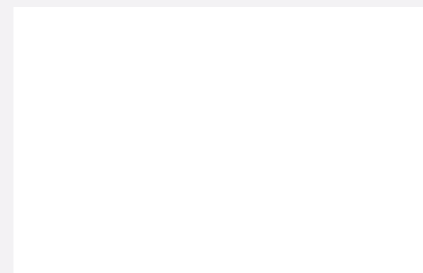
# separating concerns



**need**  
the motivation for  
building the system

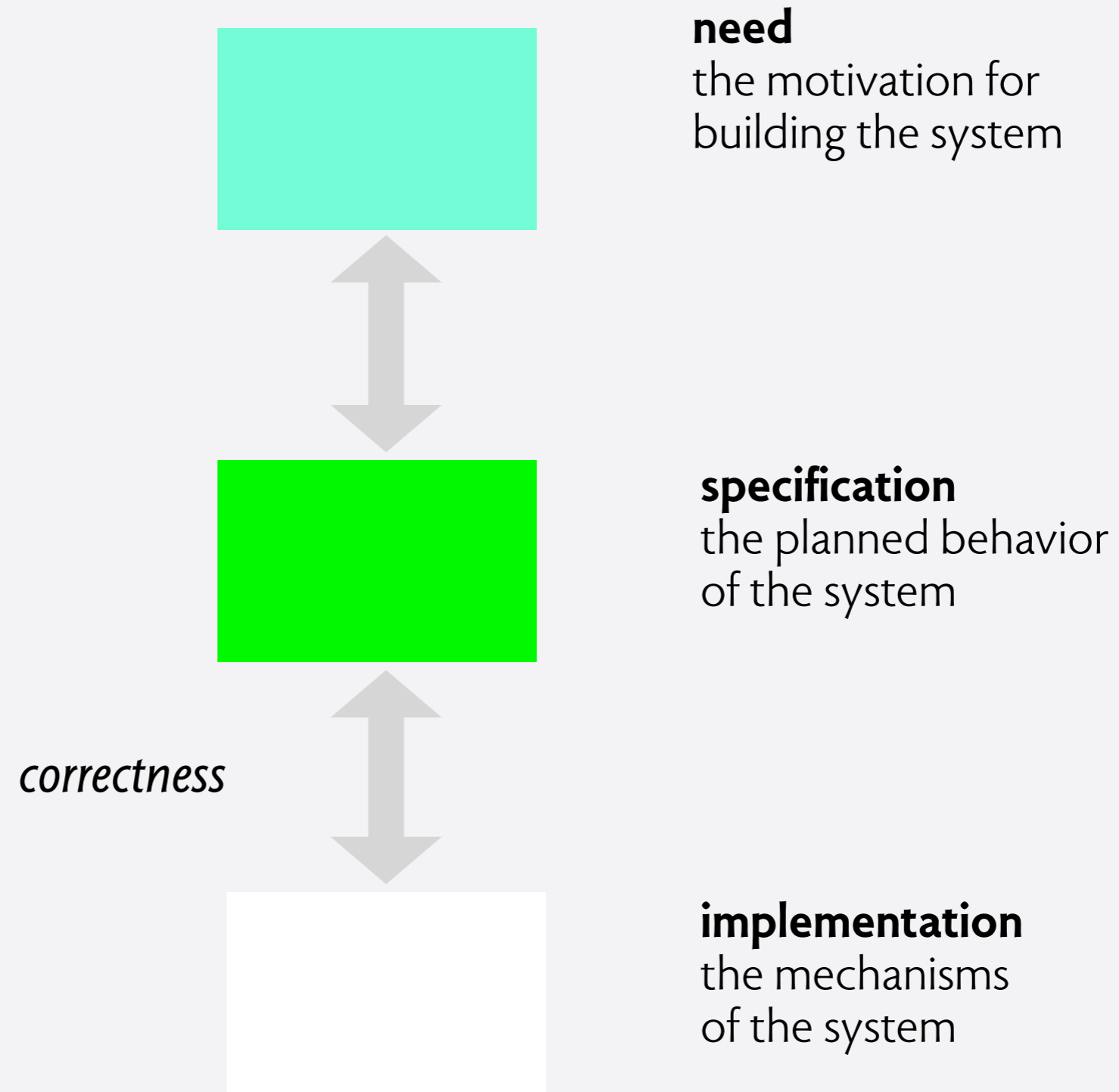


**specification**  
the planned behavior  
of the system

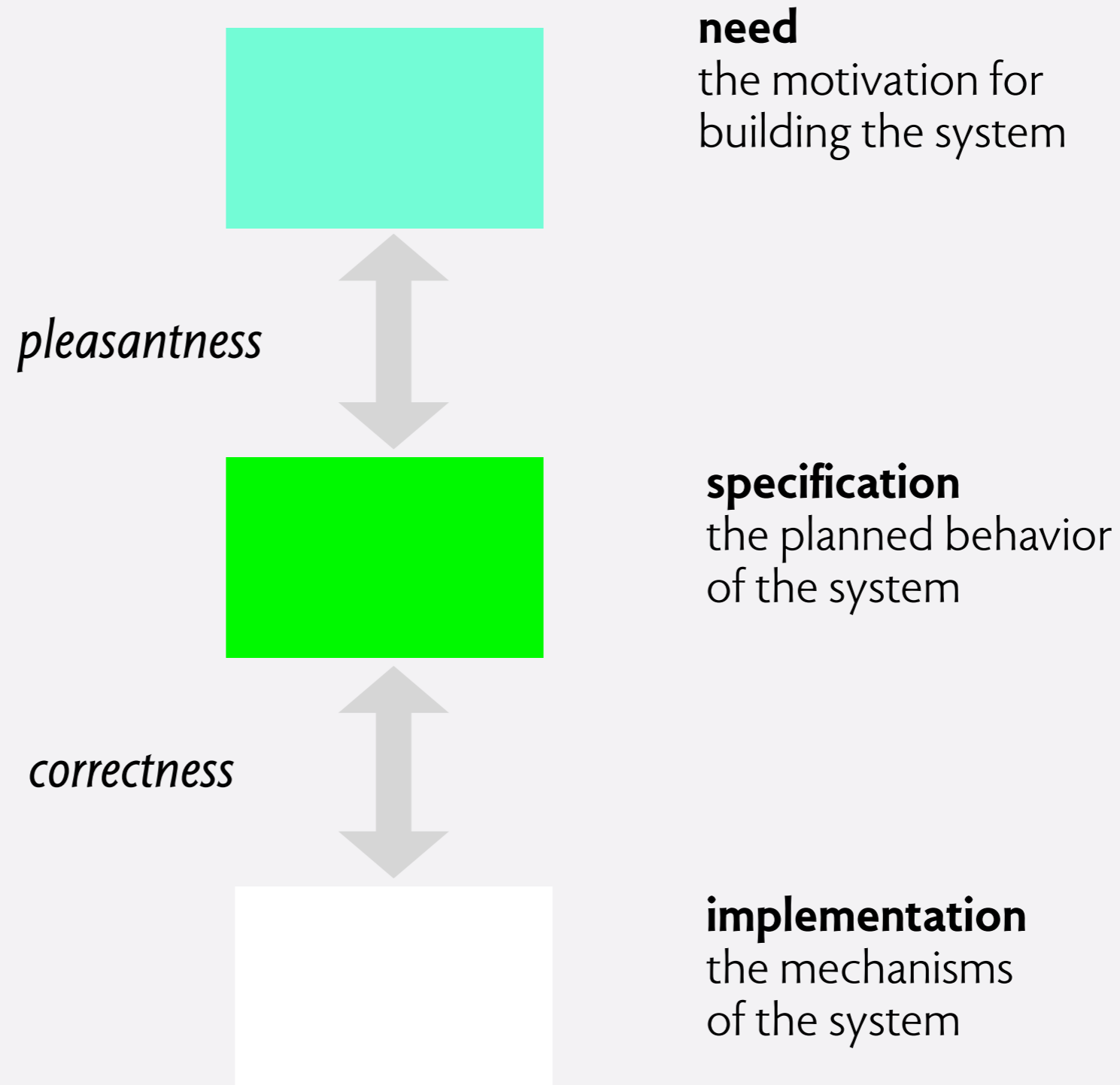


**implementation**  
the mechanisms  
of the system

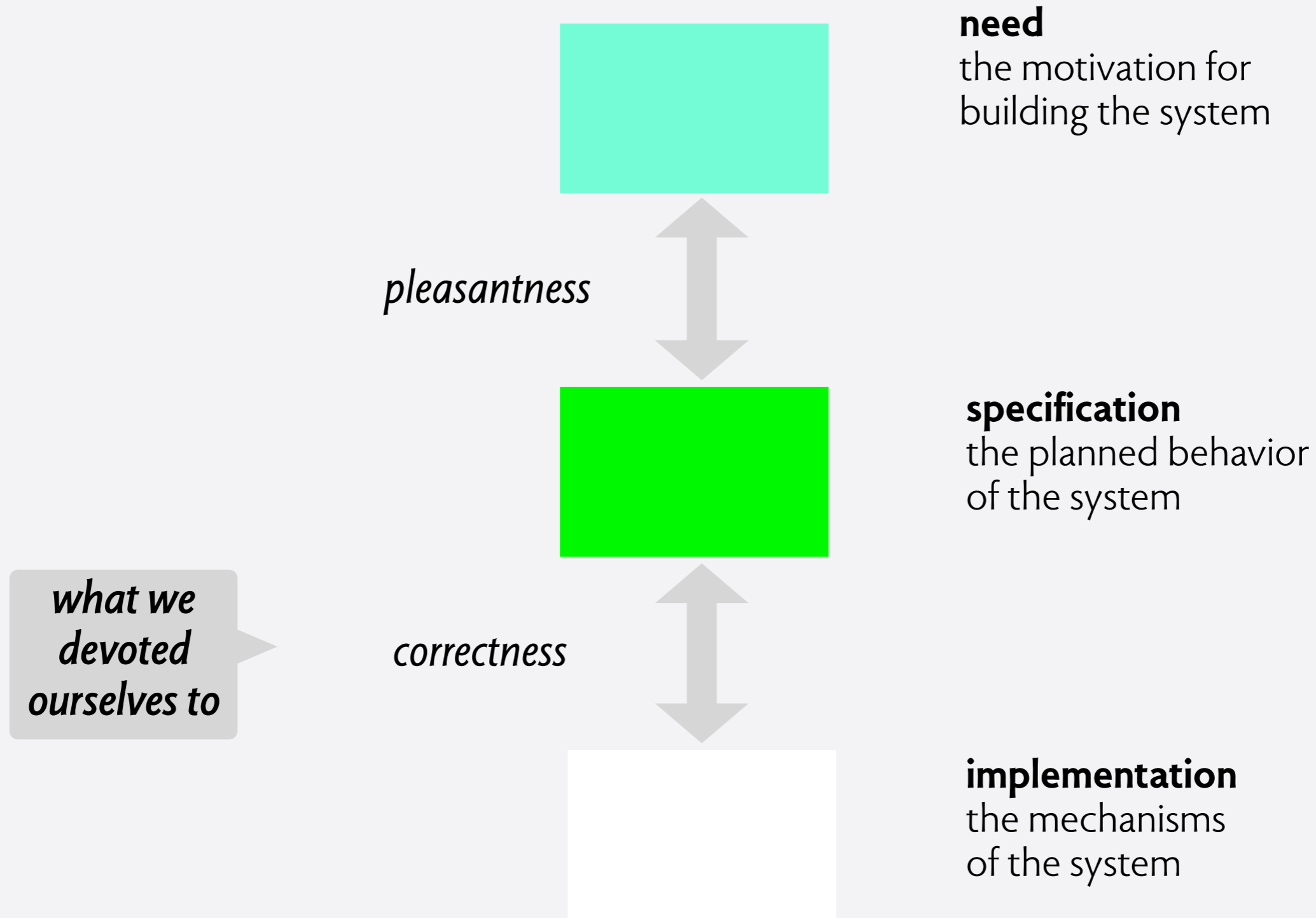
# separating concerns



# separating concerns

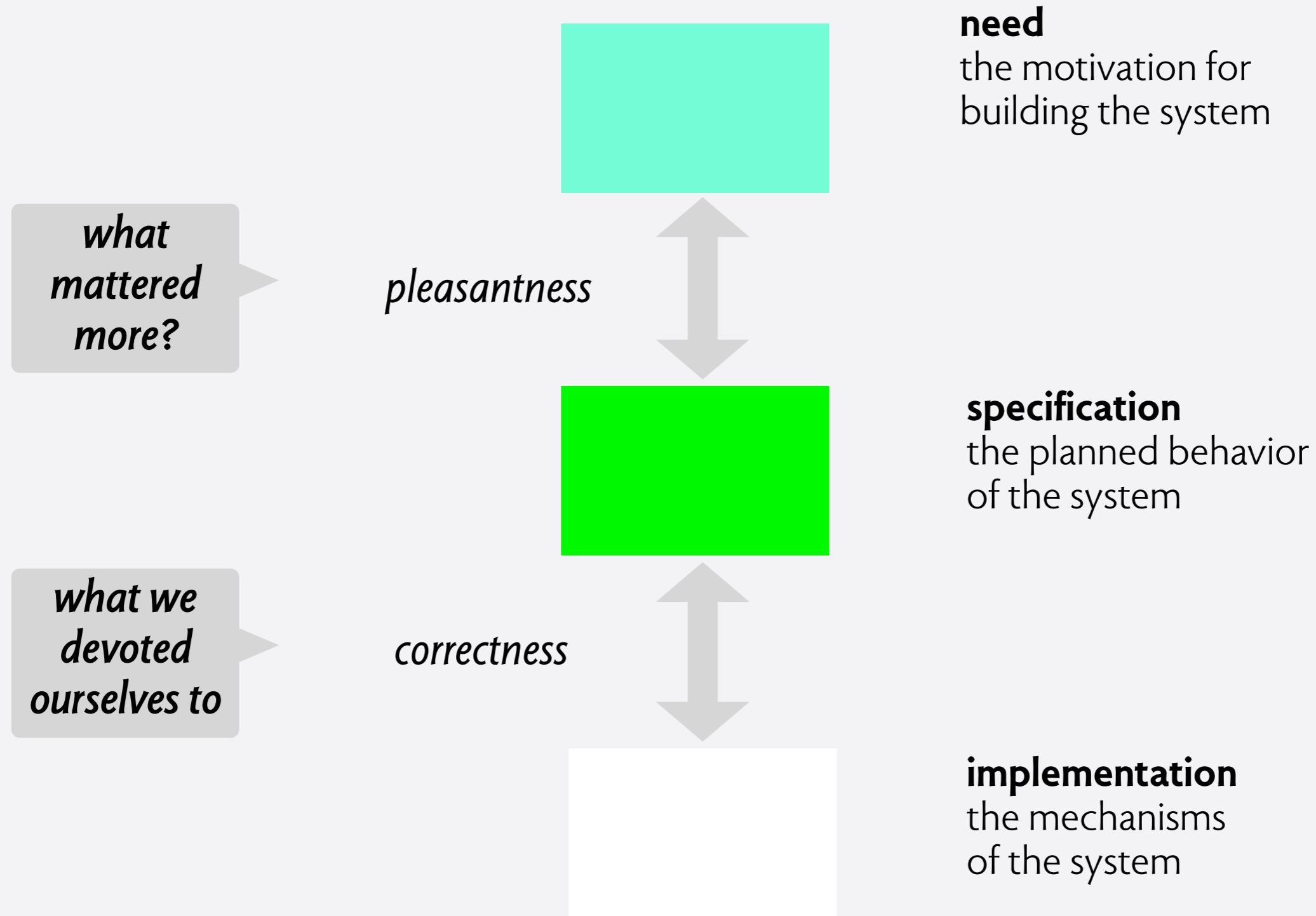


# separating concerns

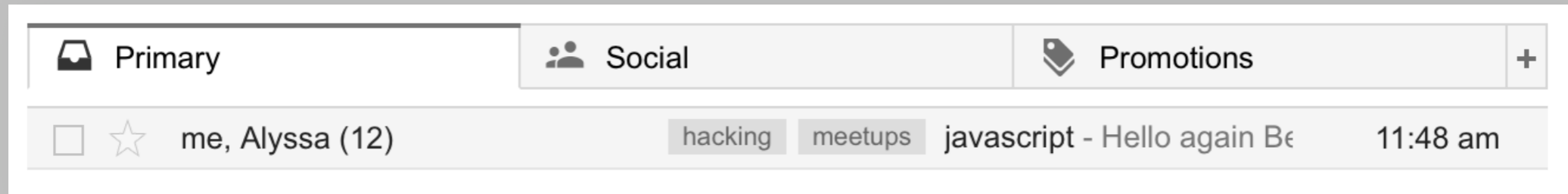




# separating concerns



# correct $\Rightarrow$ useful ?



# correct $\Rightarrow$ useful ?

Primary Social Promotions +

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

label:hacking

More

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

# correct $\Rightarrow$ useful ?

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

# correct $\Rightarrow$ useful ?

Primary Social Promotions +

☆ me, Alyssa (12) hacking meetups javascript - Hello again Ben 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.

correct  $\Rightarrow$  useful ?

# correct ⇒ useful ?

1-2 of 2

[Empty Trash now](#) (messages that have been in Trash more than 30 days will be automatically deleted)

<input type="checkbox"/>		me, Alyssa (13)	<span>hacking</span> <span>meetups</span> <span>todo</span>	javascript - Hello a	11:48 am
<input type="checkbox"/>		<b>Andy from Google</b>	<span>Updates</span>	<b>Ben, welcome to your new Googl</b>	<b>9:01 am</b>

# correct $\Rightarrow$ useful ?

A screenshot of an email inbox interface. At the top, there are control buttons: a selection checkbox, a refresh icon, and a "More" dropdown menu. To the right, it shows "1-2 of 2" with navigation arrows, a keyboard icon, and a settings gear. Below this is a blue notification: "Empty Trash now (messages that have been in Trash more than 30 days will be automatically deleted)". The inbox contains two messages:

<input type="checkbox"/>		me, Alyssa (13)	<span>hacking</span> <span>meetups</span> <span>todo</span>	javascript - Hello a	11:48 am
<input type="checkbox"/>		Andy from Google	<span>Updates</span>	Ben, welcome to your new Googl	9:01 am

A screenshot of an email search interface. A search bar contains the text "label:todo" and a blue search button with a magnifying glass icon. To the right are icons for a grid view, a notification bell, and a profile circle with the letter 'B'. Below the search bar are control buttons: a selection checkbox, a refresh icon, and a "More" dropdown menu. To the right are a keyboard icon and a settings gear. At the bottom, the text reads: "There are no conversations with this label."



# correct $\Rightarrow$ useful ?

☐ ▾ ↻ More ▾ 1-2 of 2 < > 🗃️ ▾ ⚙️ ▾

[Empty Trash now](#) (messages that have been in Trash more than 30 days will be automatically deleted)

☐	🗑️	me, Alyssa (13)	hacking	meetups	todo	javascript - Hello a	11:48 am
☐	🗑️	<b>Andy from Google</b>	Updates	<b>Ben, welcome to your new Googl</b>			9:01 am

label:todo ▾ 🔍 🗃️ 🔔 B

☐ ▾ ↻ More ▾ 🗃️ ▾ ⚙️ ▾

There are no conversations with this label.

label:todo label:trash ▾ 🔍 🗃️ 🔔 B

☐ ▾ ↻ More ▾ 1-1 of 1 < > 🗃️ ▾ ⚙️ ▾

☐	🗑️	me, Alyssa	Trash	hacking	meetups	todo	javascript -	10:11 am
---	----	------------	-------	---------	---------	------	--------------	----------

# correct $\Rightarrow$ useful ?

☐ ▾ ↻ More ▾ 1-2 of 2 < > 🗃️ ▾ ⚙️ ▾

[Empty Trash now](#) (messages that have been in Trash more than 30 days will be automatically deleted)

☐	🗑️	me, Alyssa (13)	hacking	meetups	todo	javascript - Hello a	11:48 am
☐	🗑️	Andy from Google	Updates	Ben, welcome to your new Googl			9:01 am

label:todo ▾ 🔍 🗃️ 🔔 B

☐ ▾ ↻ More ▾ 🗃️ ▾ ⚙️ ▾

There are no conversations with this label.

label:todo label:trash ▾ 🔍 🗃️ 🔔 B

☐ ▾ ↻ More ▾ 1-1 of 1 < > 🗃️ ▾ ⚙️ ▾

☐	🗑️	me, Alyssa	Trash	hacking	meetups	todo	javascript -	10:11 am
---	----	------------	-------	---------	---------	------	--------------	----------

label:todo OR label:meetup ▾ 🔍 🗃️ 🔔 B

☐ ▾ ↻ More ▾ 🗃️ ▾ ⚙️ ▾

🔍 Some messages in Trash or Spam match your search. [View messages.](#)

# correct $\Rightarrow$ useful ?

correctness & pleasantness  
are not independent

☐ ▾ ↻ More ▾ 1-2 of 2 < > 🗃️ ▾ ⚙️ ▾

[Empty Trash now](#) (messages that have been in Trash more than 30 days will be automatically deleted)

☐	🗑️	me, Alyssa (13)	hacking	meetups	todo	javascript - Hello a	11:48 am
☐	🗑️	<b>Andy from Google</b>	Updates	<b>Ben, welcome to your new Googl</b>			9:01 am

label:todo ▾ 🔍 🗃️ 🔔 B

☐ ▾ ↻ More ▾ 🗃️ ▾ ⚙️ ▾

There are no conversations with this label.

label:todo label:trash ▾ 🔍 🗃️ 🔔 B

☐ ▾ ↻ More ▾ 1-1 of 1 < > 🗃️ ▾ ⚙️ ▾

☐	🗑️	me, Alyssa	Trash	hacking	meetups	todo	javascript -	10:11 am
---	----	------------	-------	---------	---------	------	--------------	----------

label:todo OR label:meetup ▾ 🔍 🗃️ 🔔 B

☐ ▾ ↻ More ▾ 🗃️ ▾ ⚙️ ▾

🔍 Some messages in Trash or Spam match your search. [View messages.](#)

# correct $\Rightarrow$ useful ?

A screenshot of the Gmail web interface. The browser address bar shows 'mail.google.com'. The search bar contains 'in:sent' and a search icon. Below the search bar, there are navigation buttons: a square icon, a refresh icon, and a 'More' dropdown. To the right, it says '1-1 of 1' with left and right arrow buttons, a keyboard icon, and a settings gear icon. The main content area shows a search result for 'To: Alyssa P. Hacker (2)' with tags 'Inbox', 'hacking', and 'javascript - Yes, it does. On'. The time is '9:40 pm'. On the left sidebar, there is a red 'COMPOSE' button and a list of folders: 'Inbox', 'Starred', 'Sent Mail', and 'Drafts'. At the bottom of the main area, it says '0 GB (0%) of 15 GB used' with a 'Manage' link, and 'Last account activity: 26 minutes ago' with a 'Details' link.

A screenshot of the Gmail web interface showing the details of an email. The browser address bar shows 'mail.google.com'. The search bar contains 'in:sent'. Below the search bar, there are navigation buttons: a back arrow, a download icon, a warning icon, a trash icon, a 'Move to Inbox' button, a tag icon, a 'More' dropdown, left and right arrow buttons, a keyboard icon, and a settings gear icon. The main content area shows the email title 'javascript' with tags 'Inbox x' and 'hacking x'. There are icons for download, print, and share. The email is from 'Alyssa P. Hacker' with the subject 'Reminds you of the old days, eh?' and the time '9:14 PM (33 minutes ago)'. Below it, there is a reply from 'Ben Bitdiddle <benito.bitdiddle@gmail.com>' to 'Alyssa' with the time '9:40 PM (7 minutes ago)'. The reply text is 'Yes, it does.' On the left sidebar, there is a red 'COMPOSE' button and a list of folders: 'Inbox', 'Starred', 'Sent Mail', 'Drafts', 'Trash', and 'Categories'.

correct  $\Rightarrow$  safe ?



Airbus A320, Warsaw 1993

correct  $\Rightarrow$  safe ?

airborne  $\Leftrightarrow$  disabled

**requirement**



Airbus A320, Warsaw 1993

# correct $\Rightarrow$ safe ?

$\neg$ WheelPulse  $\Leftrightarrow$  disabled

**specification**

airborne  $\Leftrightarrow$  disabled

**requirement**



Airbus A320, Warsaw 1993

# correct $\Rightarrow$ safe ?

airborne  $\Leftrightarrow \neg$ WheelPulse

**environment**

$\neg$ WheelPulse  $\Leftrightarrow$  disabled

**specification**

airborne  $\Leftrightarrow$  disabled

**requirement**

$\wedge$

$\Rightarrow?$



Airbus A320, Warsaw 1993



# correct $\Rightarrow$ secure ?

From: "TIG" <[help@MIT.EDU](mailto:help@MIT.EDU)>  
Date: October 13, 2008 11:04:08 AM EDT  
To: "Daniel Jackson" <[dnj@csail.mit.edu](mailto:dnj@csail.mit.edu)>  
Subject: your password

We recently ran a password checker to evaluate passwords of all CSAIL users, and your password was readily broken. Please choose a new password ASAP...

# correct $\Rightarrow$ secure ?

From: "TIG" <[help@MIT.EDU](mailto:help@MIT.EDU)>  
Date: October 13, 2008 11:04:08 AM EDT  
To: "'Daniel Jackson'" <[dnj@csail.mit.edu](mailto:dnj@csail.mit.edu)>  
Subject: your password

We recently ran a password checker to evaluate passwords of all CSAIL users, and your password was readily broken. Please choose a new password ASAP...

my password:

sergeantpepper1967

# correct $\Rightarrow$ secure ?

From: "TIG" <[help@MIT.EDU](mailto:help@MIT.EDU)>  
Date: October 13, 2008 11:04:08 AM EDT  
To: "'Daniel Jackson'" <[dnj@csail.mit.edu](mailto:dnj@csail.mit.edu)>  
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my password:

sergeantpepper1967

8 char limit: passwd utility silently truncated rest

# correct $\Rightarrow$ secure ?

From: "TIG" <[help@MIT.EDU](mailto:help@MIT.EDU)>  
Date: October 13, 2008 11:04:08 AM EDT  
To: "'Daniel Jackson'" <[dnj@csail.mit.edu](mailto:dnj@csail.mit.edu)>  
Subject: your password

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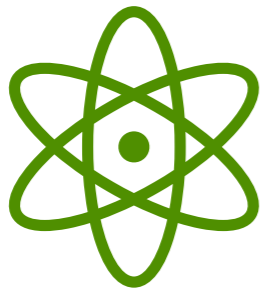
8 char limit: passwd utility silently truncated rest

*Aydal [2009]*

*Analyzed Tokeneer for security  
Found 9 anomalous scenarios  
eg, new configuration file silently  
ignored if one exists on disk*

# a research program

explore software design  
what makes a good spec



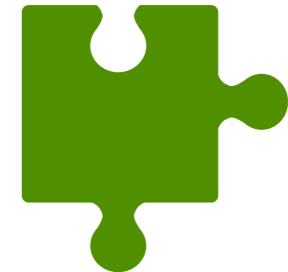
a design theory



design case studies



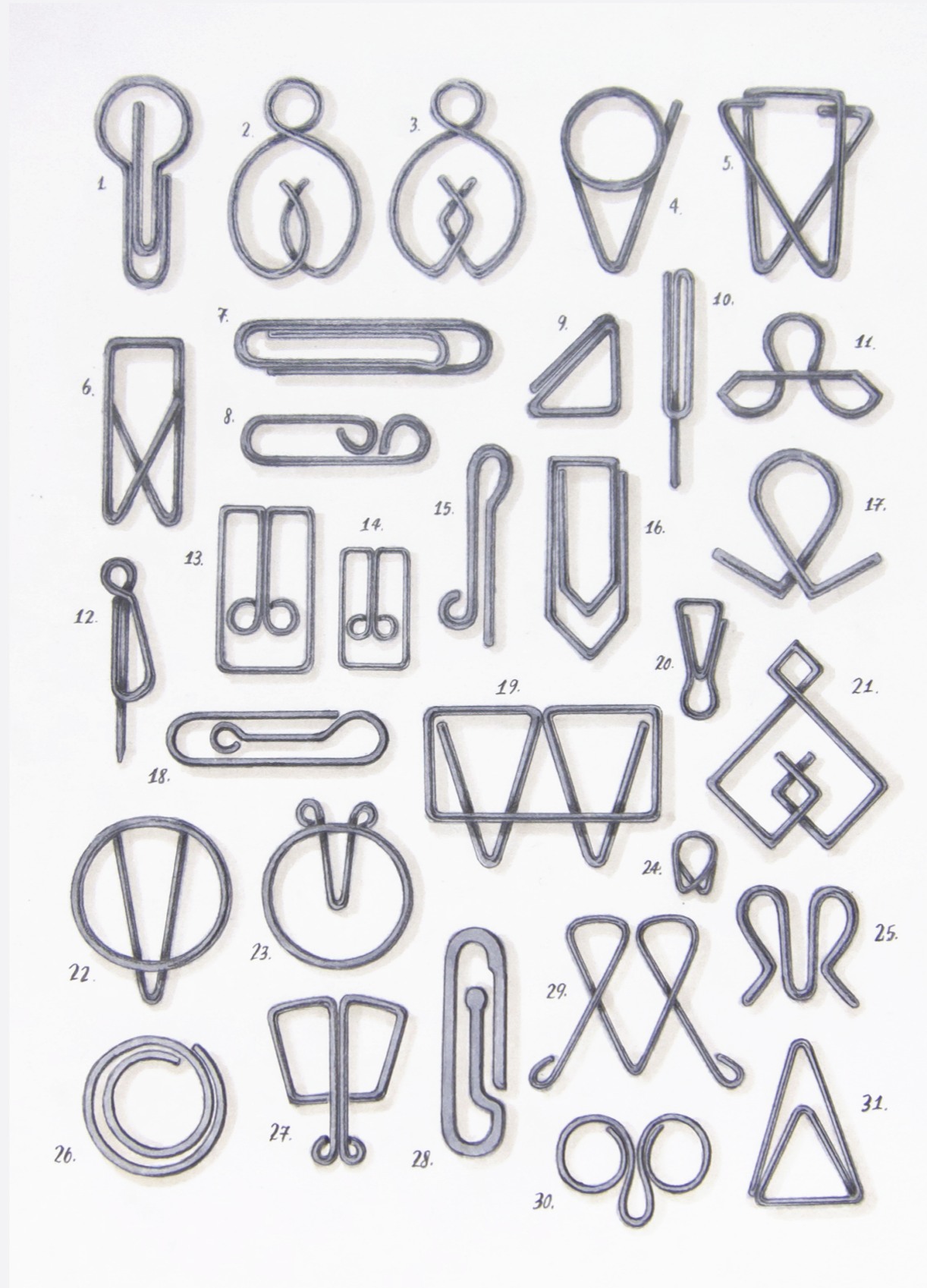
design patterns



code platform

how is  
design  
done?

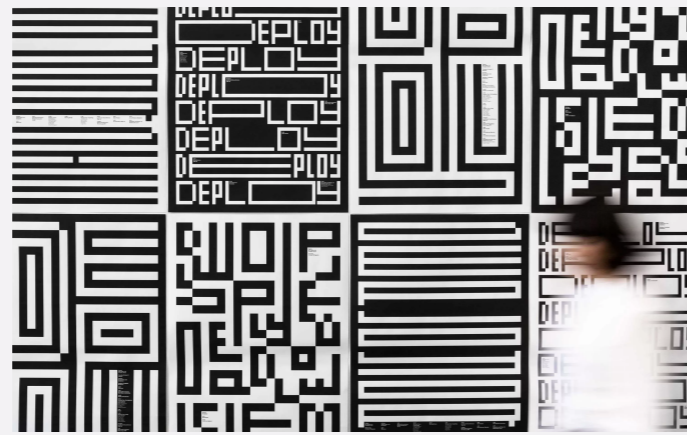
# simple design



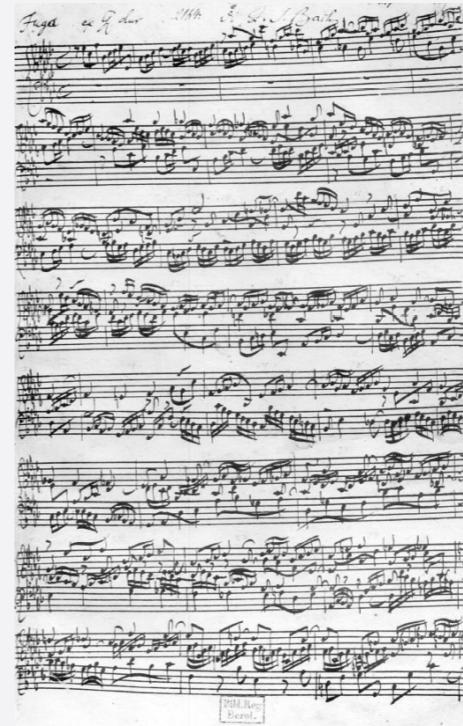
# complicated design



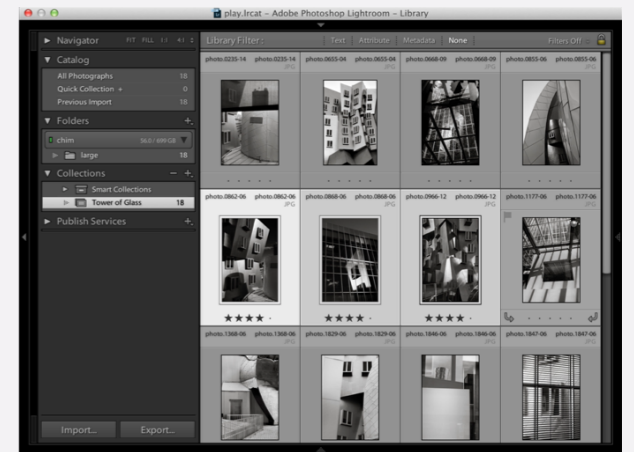
architecture



graphic design



music



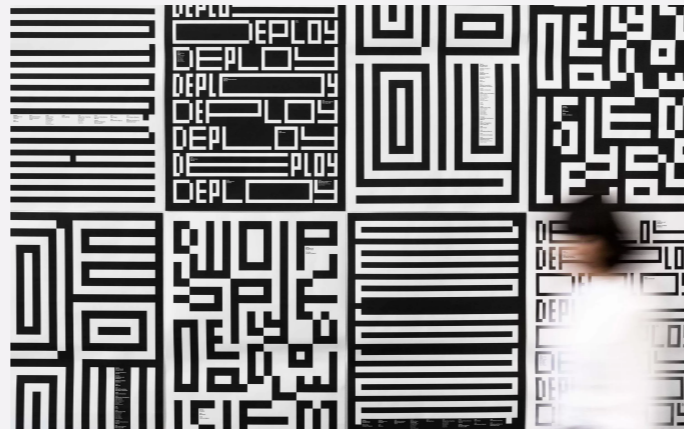
software



# core concepts: a universal design strategy



architecture



graphic design

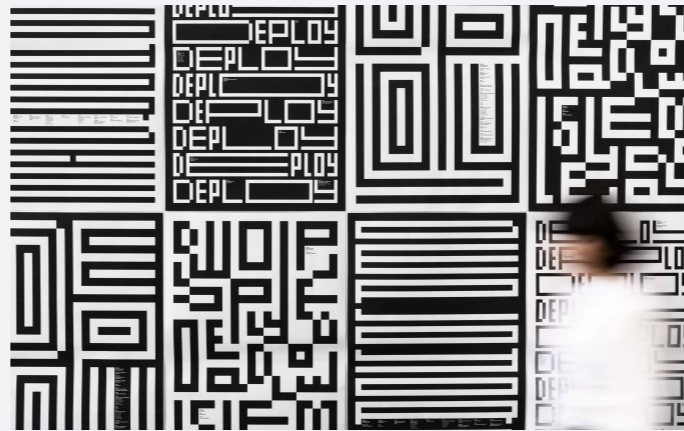


music

# core concepts: a universal design strategy



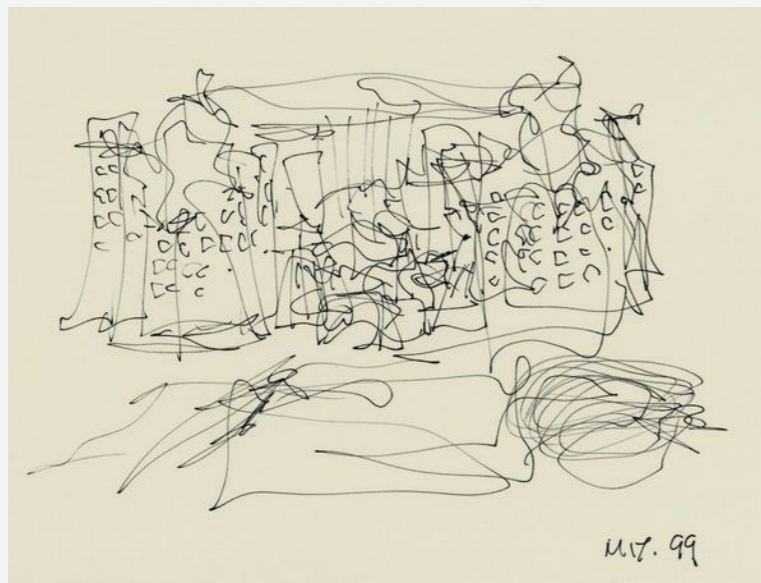
architecture



graphic design



music

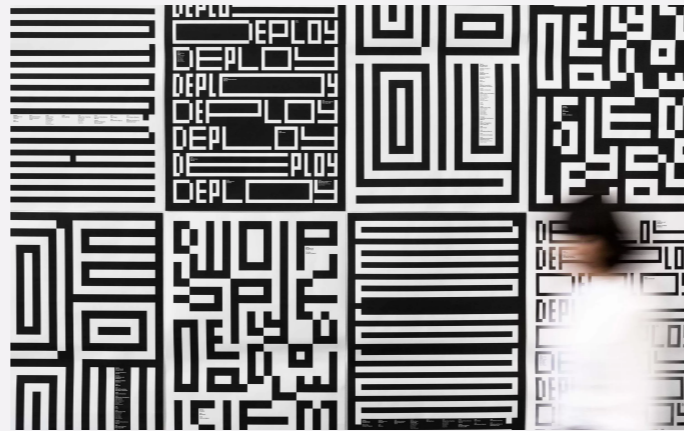


massing

# core concepts: a universal design strategy



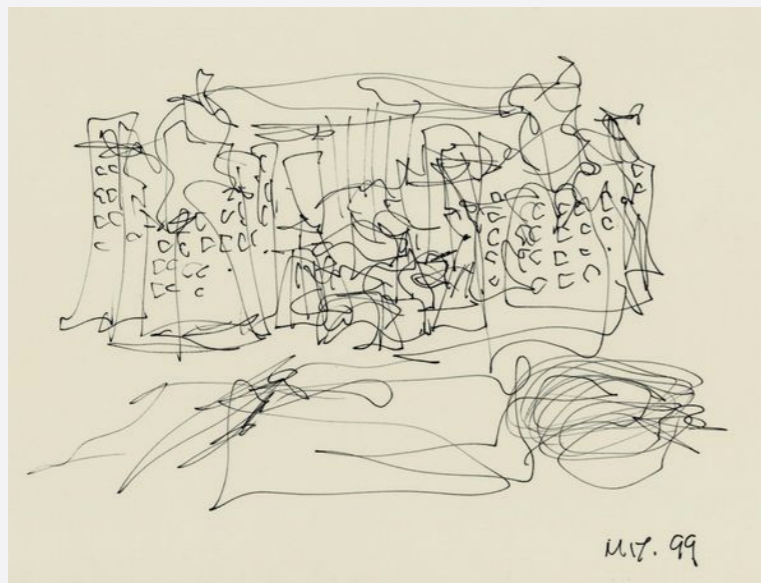
architecture



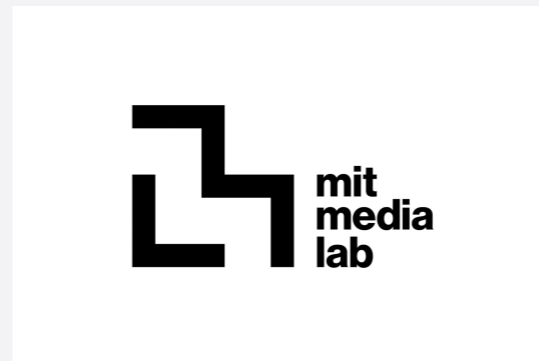
graphic design



music



massing

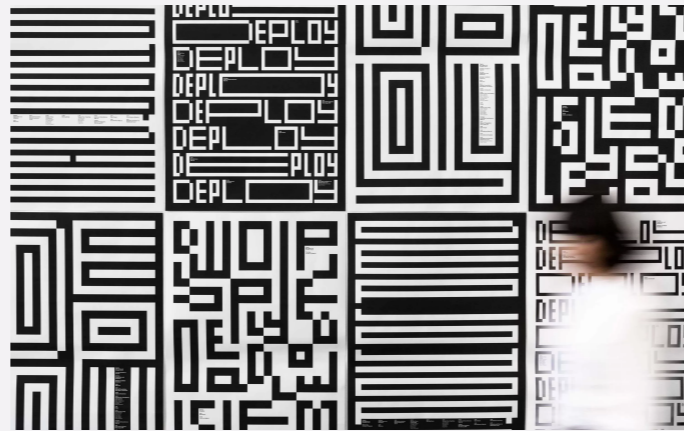


identity

# core concepts: a universal design strategy



architecture



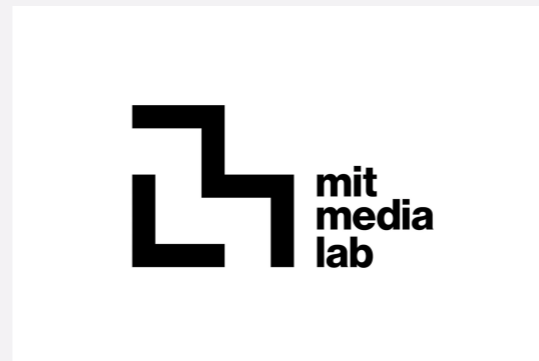
graphic design



music



massing



identity



motif

# core concepts for software



core concepts:  
**song, playlist**



core concepts:  
**buffer**



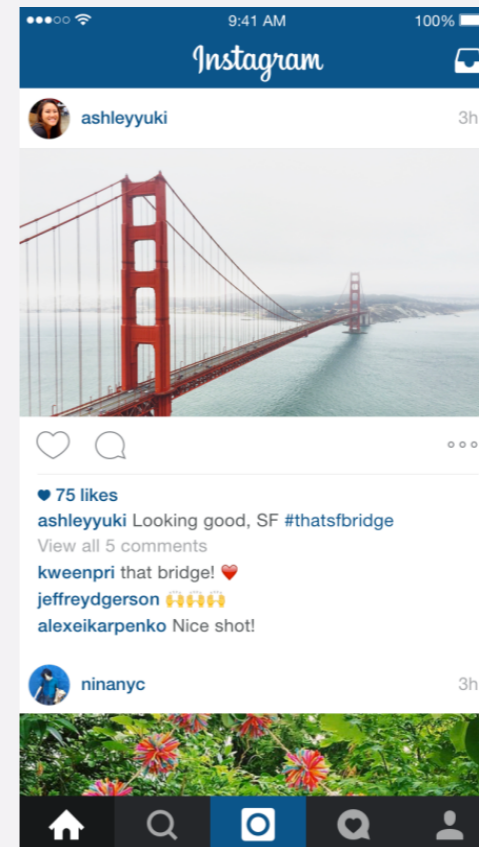
core concepts:  
**paragraph, styles**



core concepts:  
**paragraph, styles, linkedBox, page**



core concepts:  
**post, group, call**



core concepts:  
**photo, follow, like**



core concepts:  
**pixel map, layer/mask**



core concepts:  
**message, channel, mention**

concept  
basics

what is a concept?

what is a concept?



# what is a concept?



**inventive**

# what is a concept?



**inventive**



**purposeful**

# what is a concept?



**inventive**



**purposeful**



**behavioral**

# what is a concept?



**inventive**



**purposeful**



**behavioral**



**self-contained**

# what is a concept?



**inventive**



**purposeful**



**behavioral**



**self-contained**



**reusable**

# what is a concept?



**inventive**

*so not just modeling*



**purposeful**

*so not an action*



**behavioral**

*so not an entity*



**self-contained**

*so not a feature or an abstract type*



**reusable**

*so not a feature*



**inventive**



**purposeful**



**behavioral**



**self-contained**



**reusable**

# *trash*



**inventive**

first in Apple Lisa (1982)  
not really about the GUI  
(despite Apple vs Msft, 1994)



**purposeful**

purpose is:  
to undo deletions!



**behavioral**

to delete a file, move to trash;  
can restore from there; to  
make space, empty trash



**self-contained**

synergistic with file system  
but concept requires  
only set of objects



**reusable**

messages (Gmail)  
photos (iPhoto)  
posts (WordPress)  
notes (Evernote)



## *trash*

## *reservation*



**inventive**

first in Apple Lisa (1982)  
not really about the GUI  
(despite Apple vs Msft, 1994)

for restaurants, started in 19th  
century (tables and rooms)



**purposeful**

purpose is:  
to undo deletions!

purpose is:  
efficient allocation  
of resources



**behavioral**

to delete a file, move to trash;  
can restore from there; to  
make space, empty trash

select resource to reserve;  
request reservation;  
make use of resource



**self-contained**

synergistic with file system  
but concept requires  
only set of objects

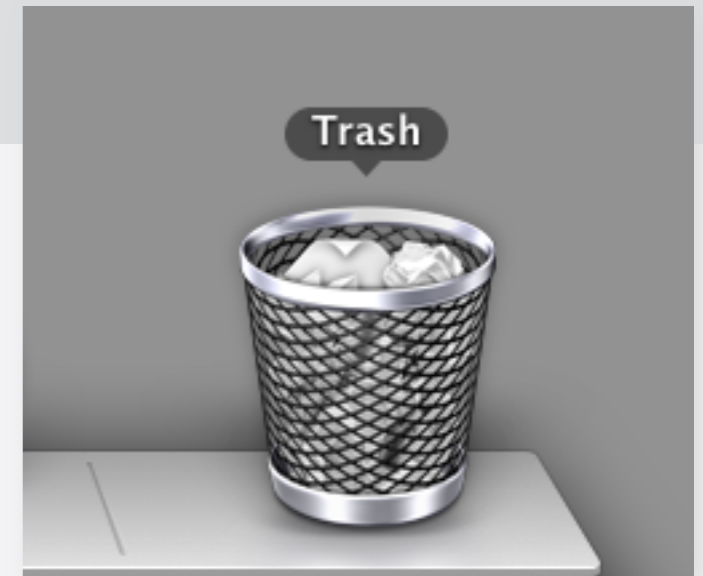


**reusable**

messages (Gmail)  
photos (iPhoto)  
posts (WordPress)  
notes (Evernote)

restaurant tables  
airplane seats  
medical appointments  
...

# the trash concept

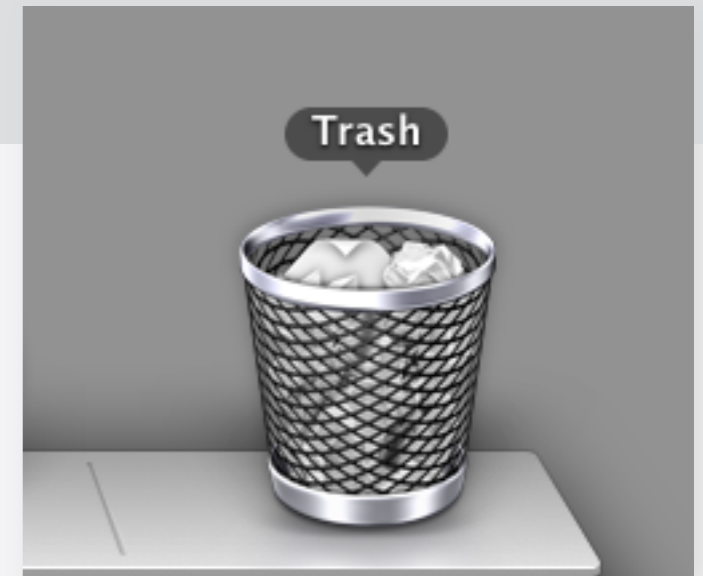


# the trash concept

purpose

spec

operational principle

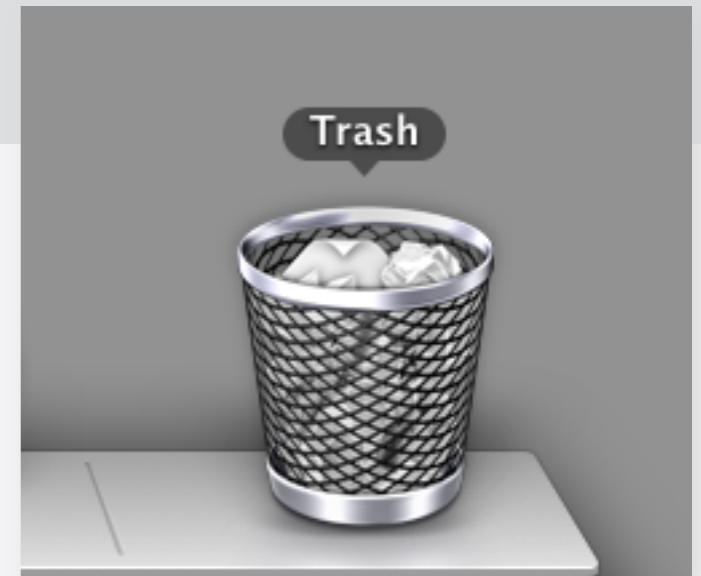


# the trash concept

purpose allow undo of deletion

spec

operational principle



# the trash concept

purpose

allow undo of  
deletion

spec

**state** all, deleted: **set** X

**actions**

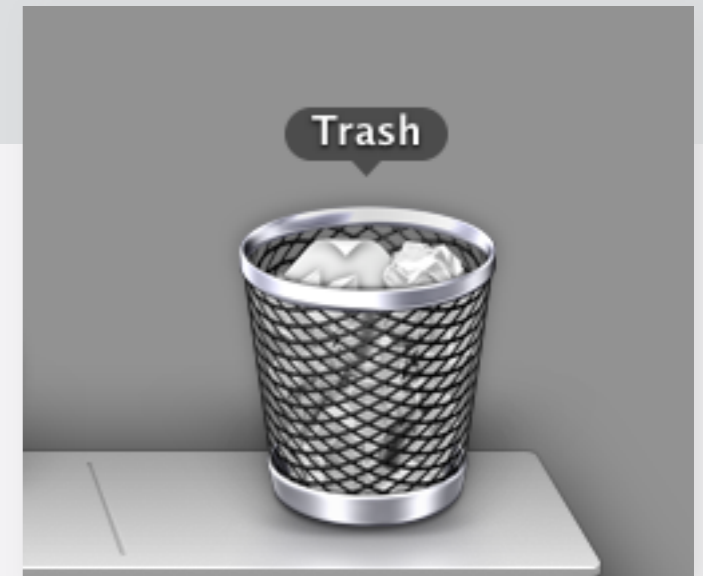
new (): X  $\hat{=}$  **result !in** all and all' = all + **result**

del (x: X)  $\hat{=}$  deleted' = deleted + x

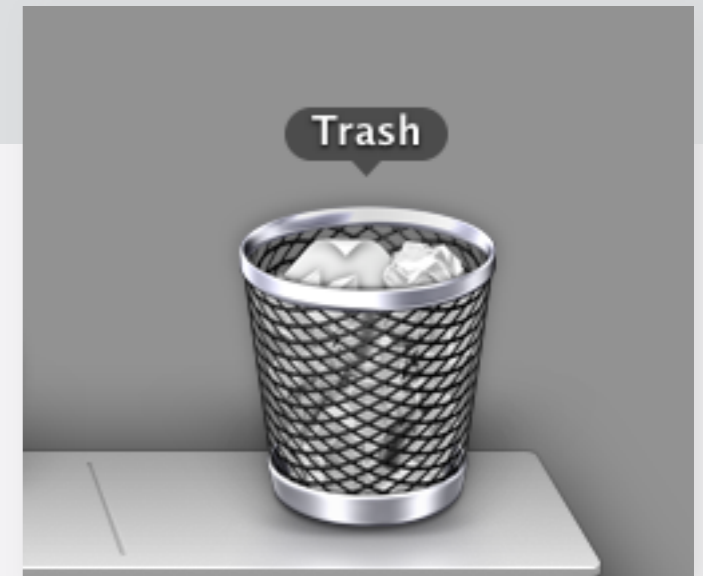
empty ()  $\hat{=}$  **no** deleted' **and** all' = all - deleted

showAll () : **set** X  $\hat{=}$  **result** = all

operational principle



# the trash concept



purpose allow undo of deletion

**state** all, deleted: **set** X

**actions**

new (): X  $\hat{=}$  **result !in** all and all' = all + **result**

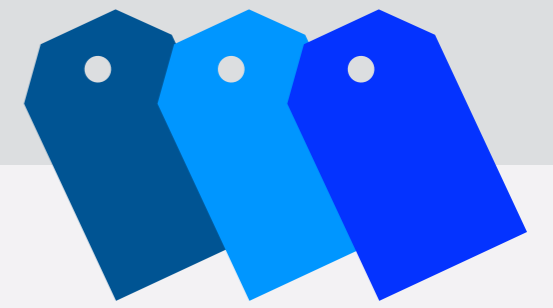
del (x: X)  $\hat{=}$  deleted' = deleted + x

empty ()  $\hat{=}$  **no** deleted' **and** all' = all - deleted

spec showAll () : **set** X  $\hat{=}$  **result** = all

operational principle del(x) ... **not** empty() ... showAll():xs  $\Rightarrow$  x **in** xs  
del(x) ... empty() ... showAll():xs  $\Rightarrow$  x **not in** xs

# the label concept

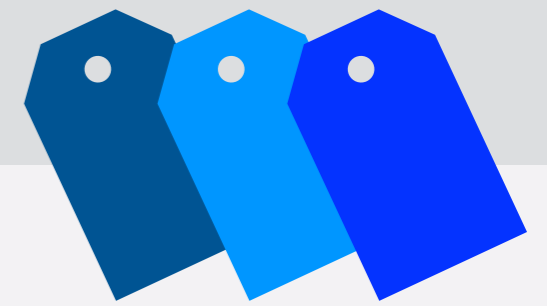


purpose

spec

operational principle

# the label concept



purpose

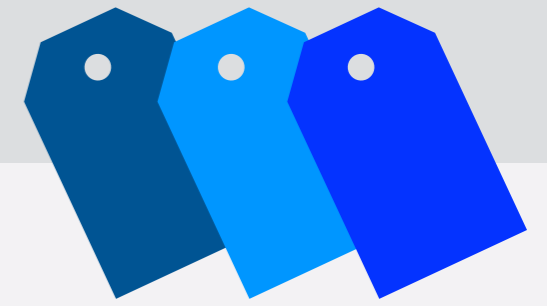
organize items for  
easy retrieval

spec

operational principle



# 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 -  $x \rightarrow p$

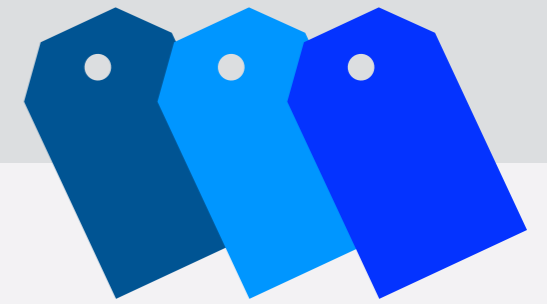
find ( $ps: \text{set Label}$ ): **set**  $X \triangleq$  **result** = { $x \mid ps \text{ in } x.\text{labels}$ }

spec

show ( $x: X$ ): **set**  $\text{Label} \triangleq$  **result** =  $x.\text{labels}$

operational principle

# 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 -  $x \rightarrow p$

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

spec

show ( $x: X$ ):  $\mathbf{set} \text{Label} \triangleq \mathbf{result} = x.\text{labels}$

operational principle

mark( $x,p$ ) ... **not** unmark( $x,p$ ) ... search( $p$ ): $xs \Rightarrow x \mathbf{in} xs$

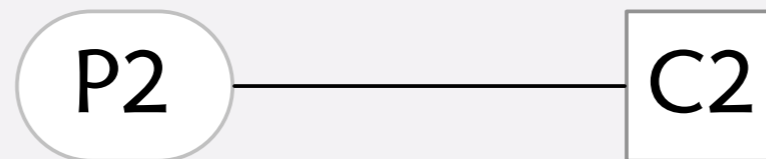
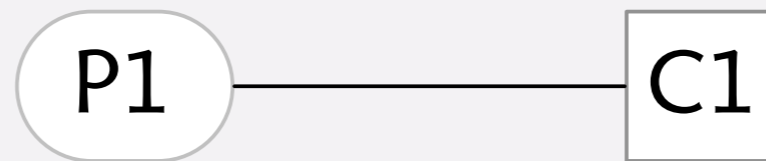
**not** mark( $x,p$ ) ... search( $p$ ): $xs \Rightarrow x \mathbf{not in} xs$

the  
singularity  
rule

# one-to-one mapping

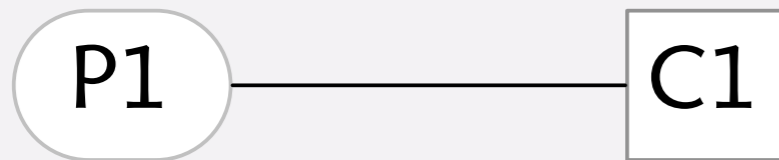
*purposes*

*concepts*

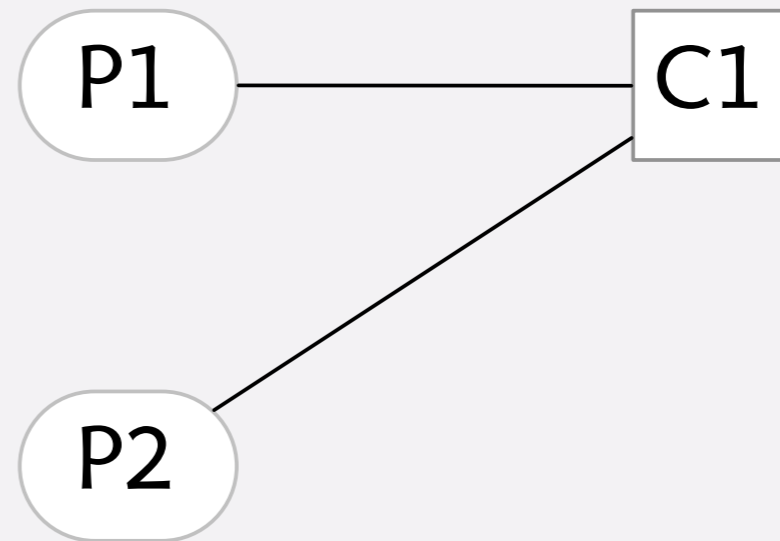


# four ways to fail

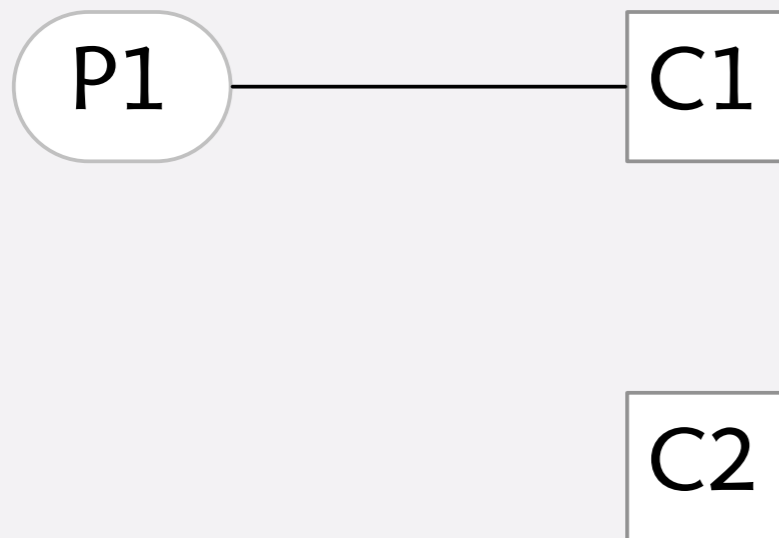
unfulfilled purpose



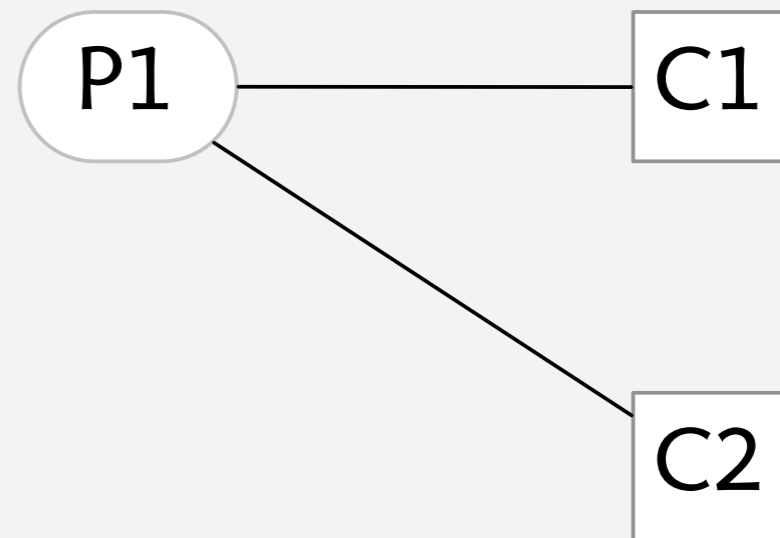
overloaded concept



unmotivated concept



redundant concepts



# my camera fuji x100s



# image quality setting

# image quality setting





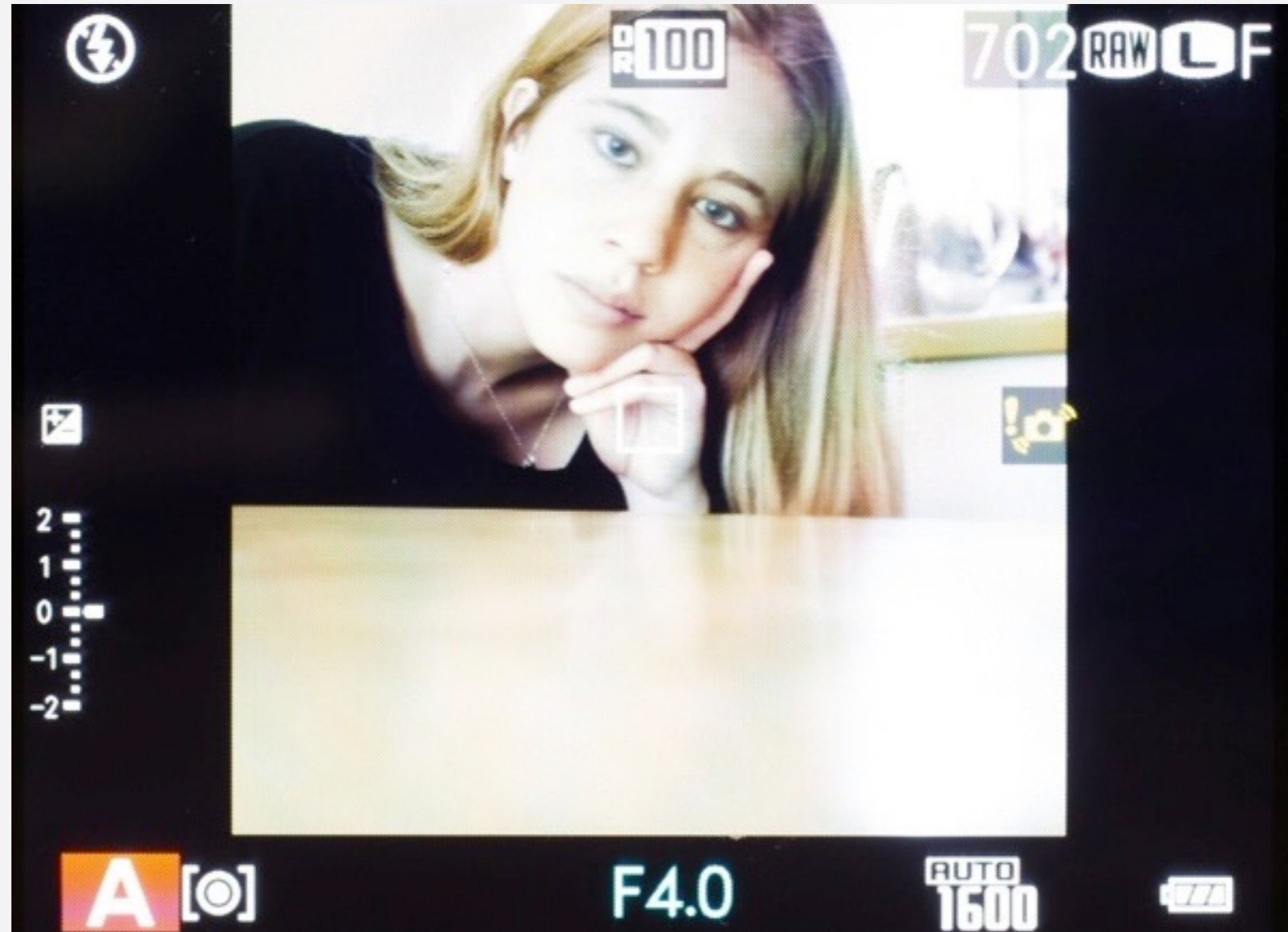
# image quality setting



# aspect ratio



# aspect ratio



# image size setting

# image size setting



# image size setting



# 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!

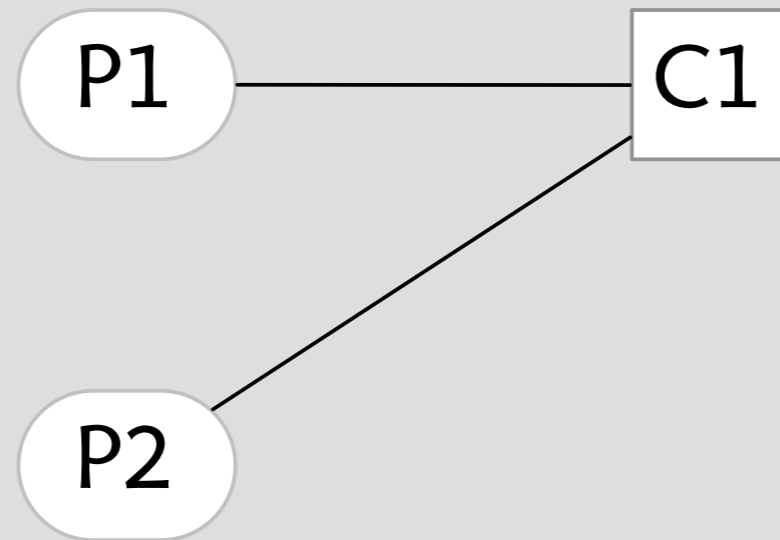
# what you can't do

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



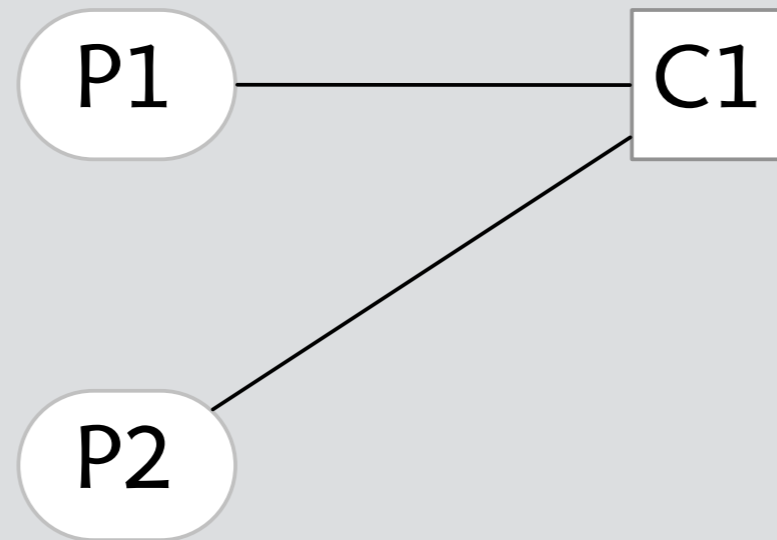
# overloaded concepts

No one can serve two masters. Either you will hate the one and love the other, or you will be devoted to the one and despise the other. [Matthew 6:24]



# overloaded concepts

No one can serve two masters. Either you will hate the one and love the other, or you will be devoted to the one and despise the other. [Matthew 6:24]



4 forms of overloading:

**piggybacking** new purpose hacked onto old concept

**false convergence** two purposes looked the same

**emergent purpose** second purpose emerged with use

**denial** designer believes second purpose unnecessary

# piggybacking fuji camera

new purpose hacked onto old concept

# piggybacking fuji camera

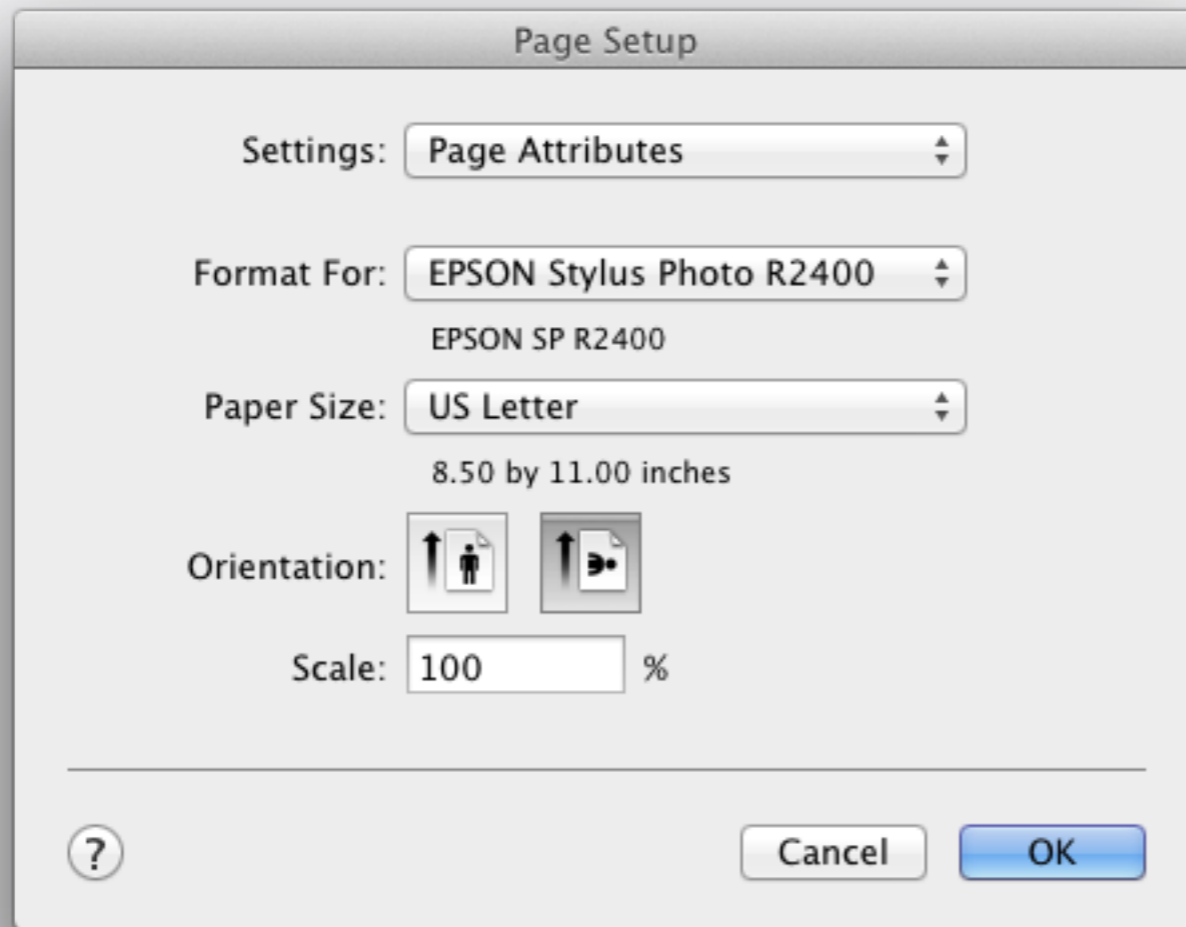
new purpose hacked onto old concept

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

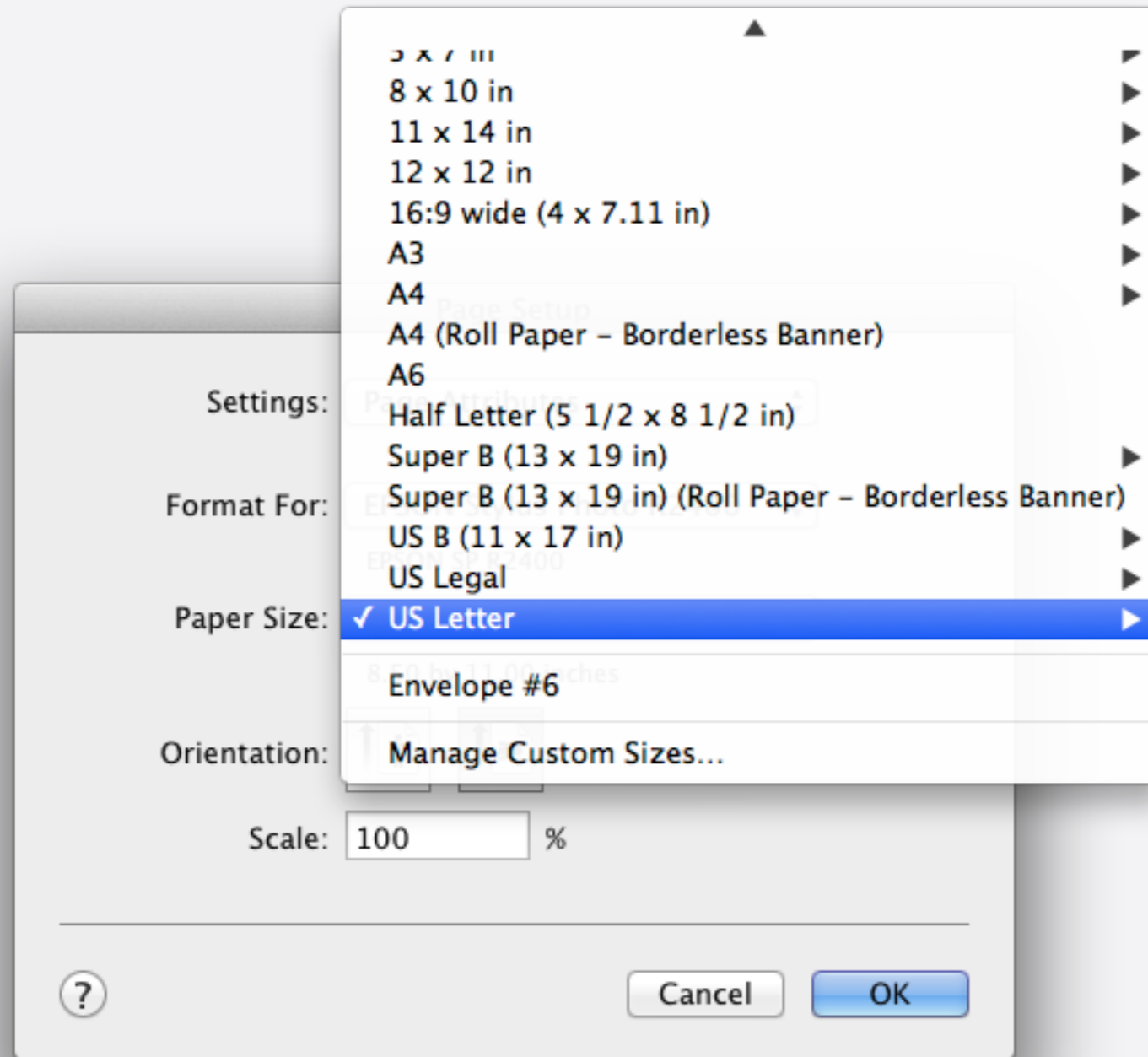
piggybacking **epson driver**

# piggybacking epson driver

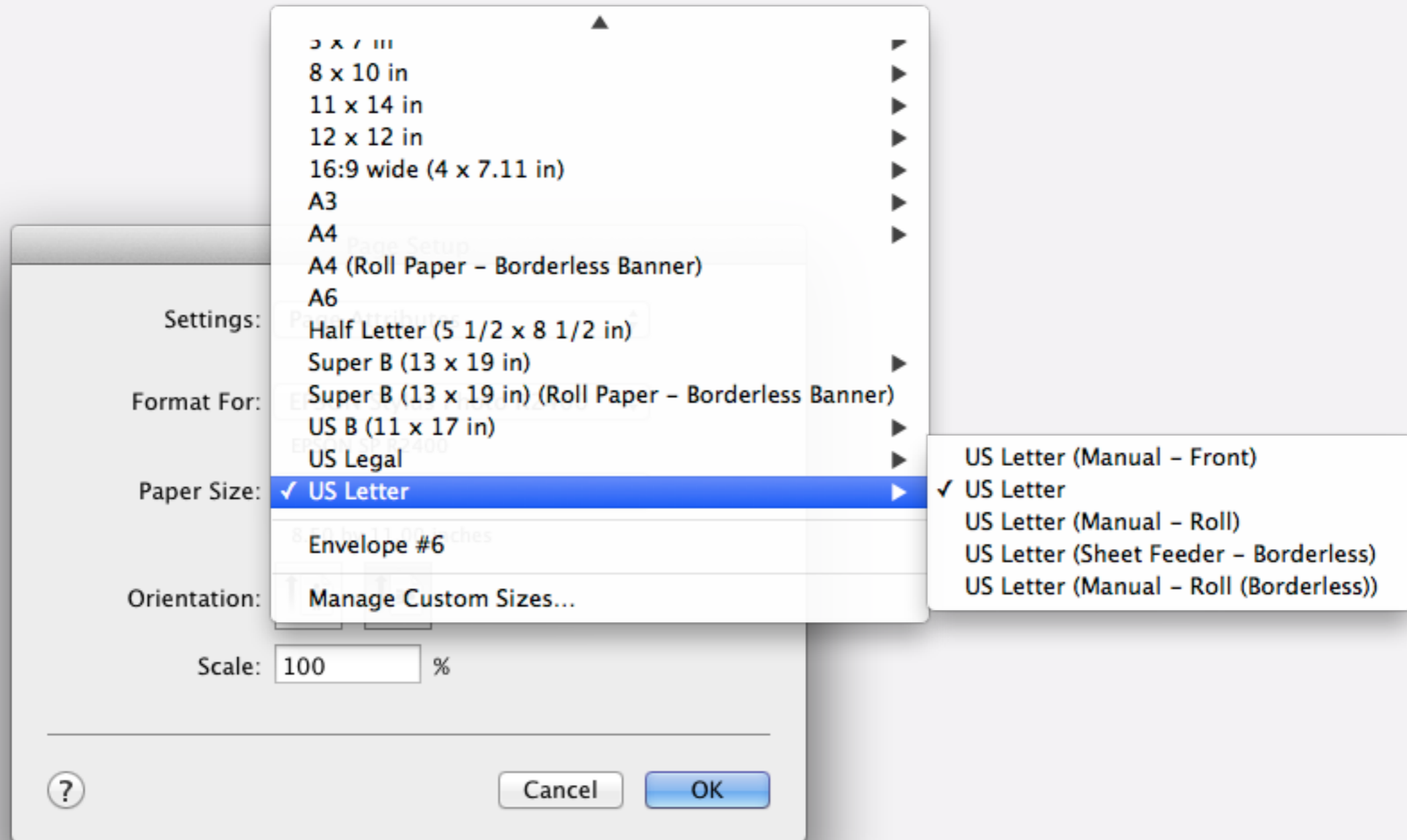




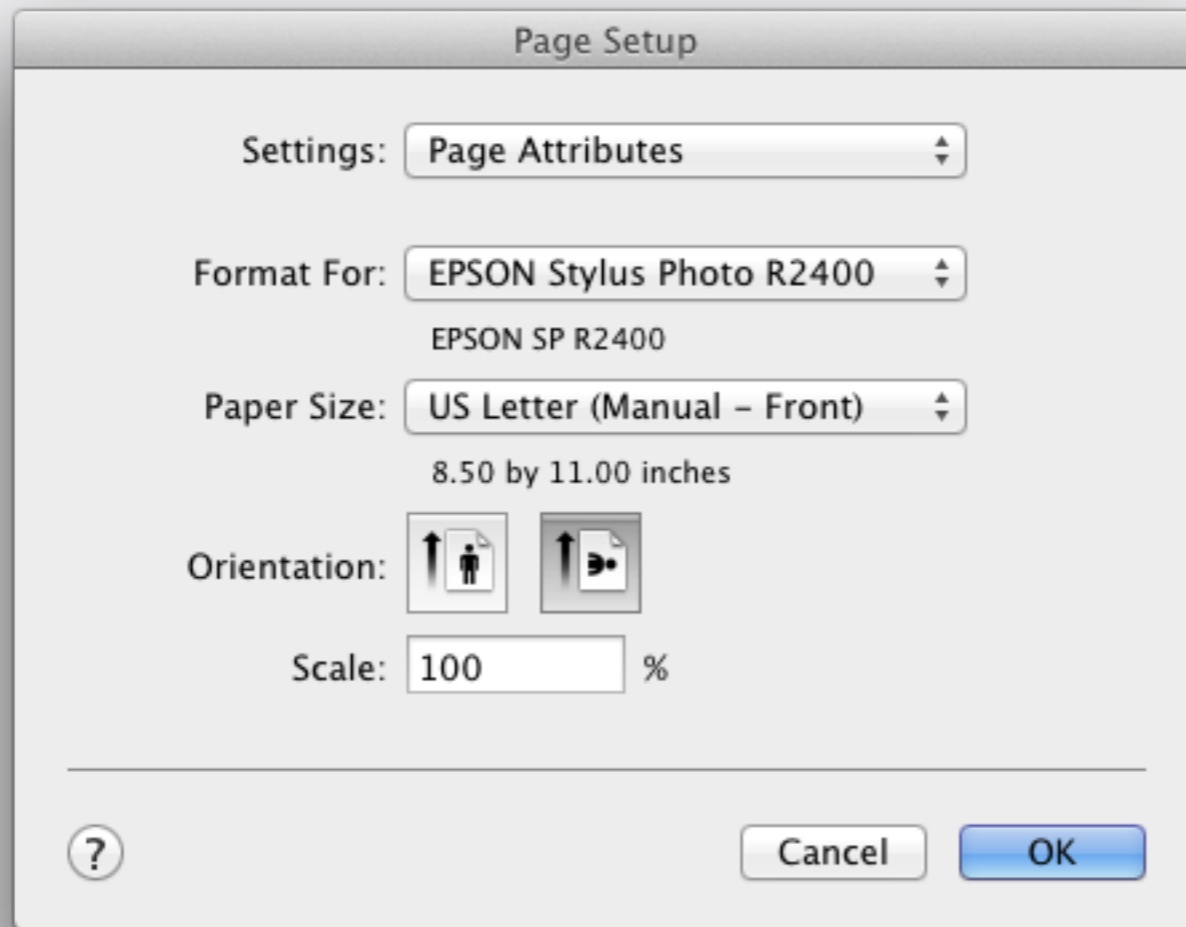
# piggybacking epson driver



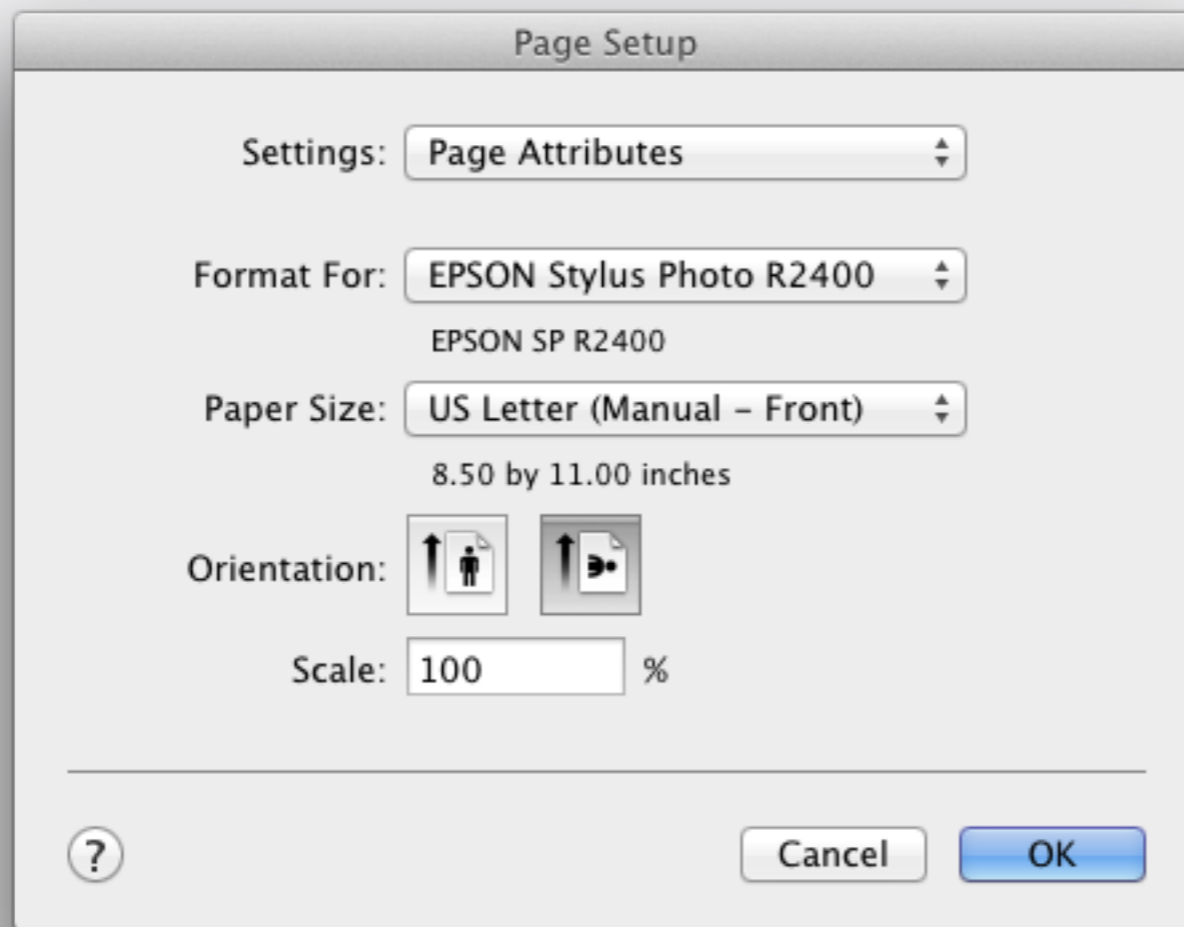
# piggybacking epson driver



# piggybacking epson driver



# piggybacking epson driver



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

# false convergence facebook friend

two purposes looked the same



filter incoming posts  
control access to my posts  
**distinct purposes**

2011: Facebook added  
subscribe/follow

# emergent purpose email subject

users find second purpose for concept

# emergent purpose email subject

users find second purpose for concept

To: Daniel Jackson <dnj@mit.edu>

Re: Catch me if you can in real life!

initial purpose: summarize content

# emergent purpose email subject

users find second purpose for 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



# emergent purpose email subject

users find second purpose for 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?

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To: Daniel Jackson <dnj@mit.edu>

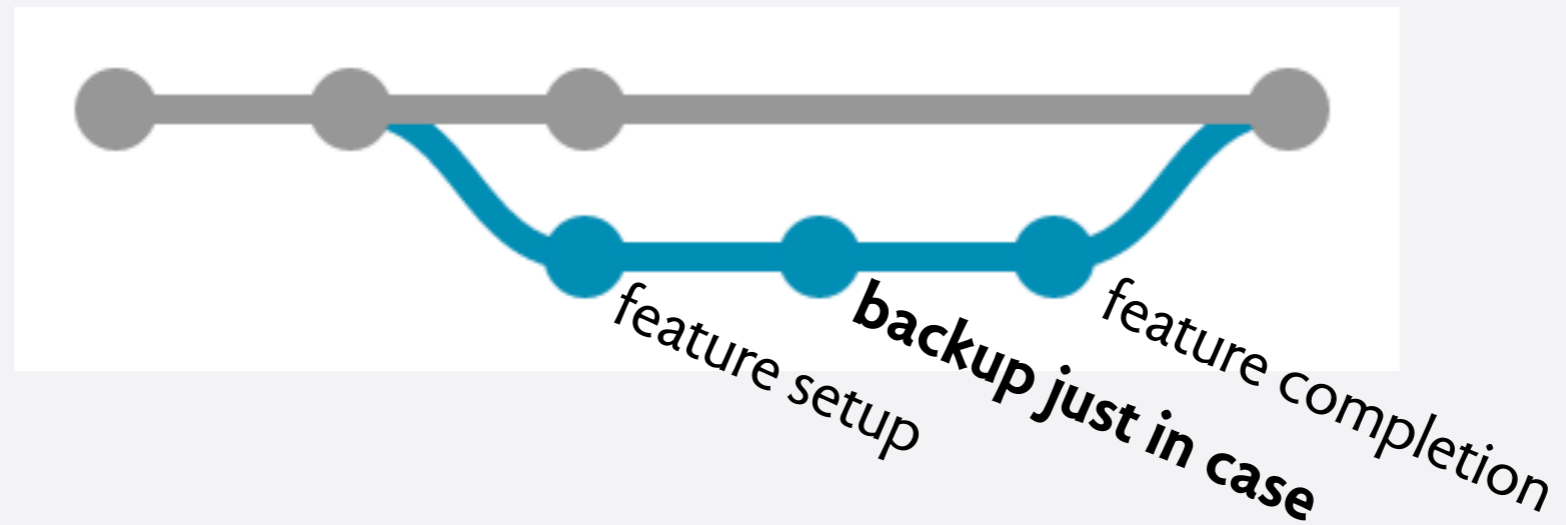
your trip reservation

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

thanks to Eunsuk Kang

# denial commit

designer believes second purpose unnecessary



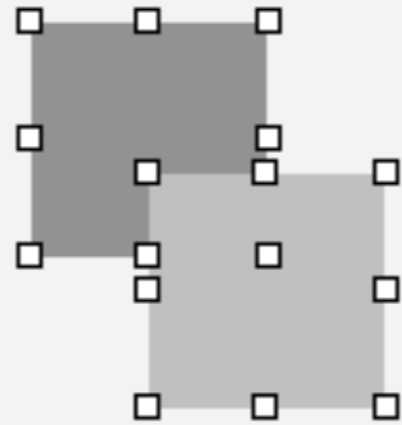
the  
uniformity  
rule

# what makes a usable concept?

operational principle is uniform  
always the same actions, irrespective of context

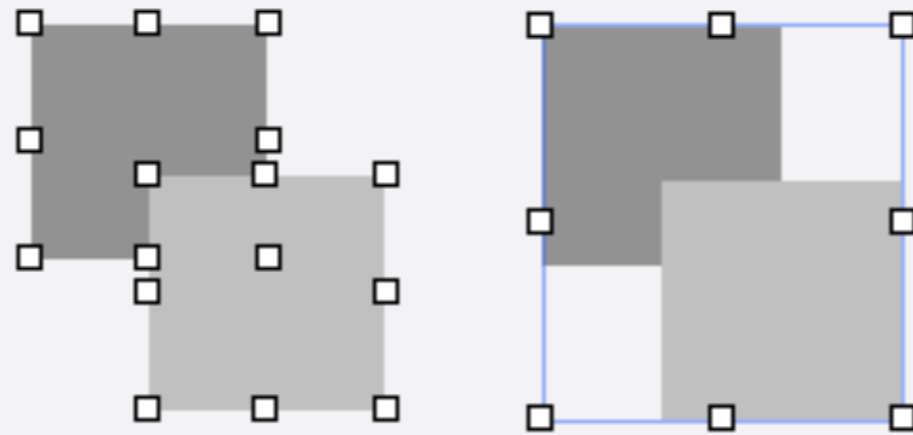
# what makes a usable concept?

operational principle is uniform  
always the same actions, irrespective of context



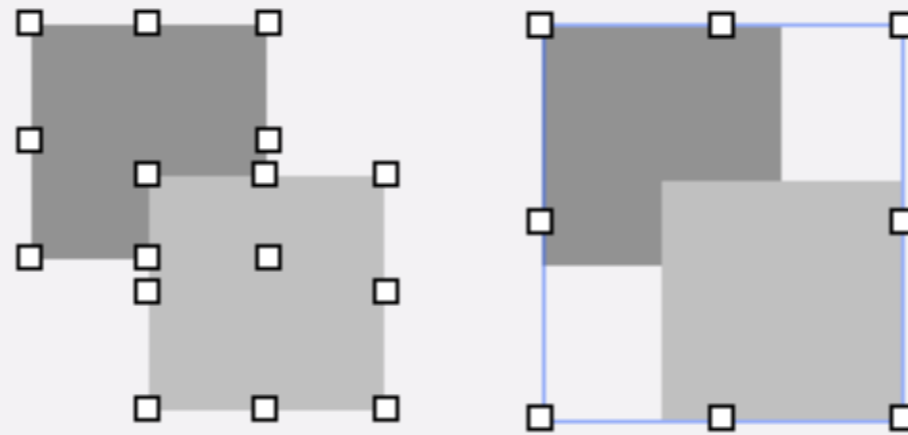
# what makes a usable concept?

operational principle is uniform  
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# what makes a usable concept?

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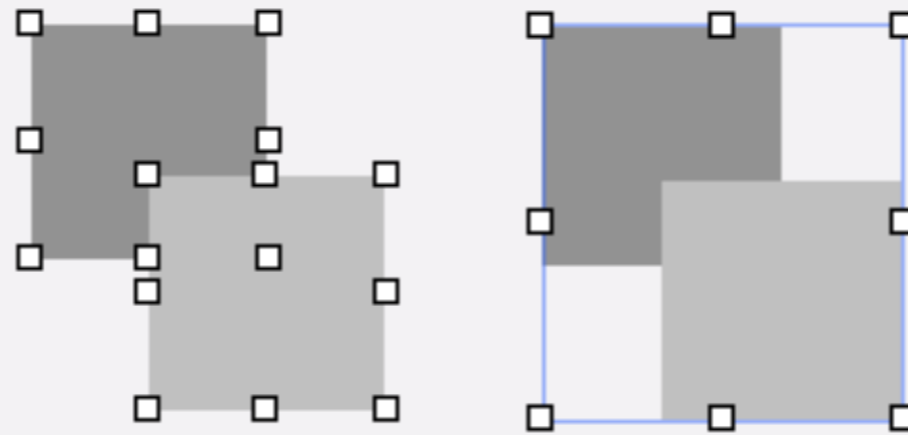
*concept:* **Group** (Keynote)

*purpose:* treat set as one

*OP:* ... `select(objs); group(); mutate()`

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*concept:* **Group** (Keynote)

*purpose:* treat set as one

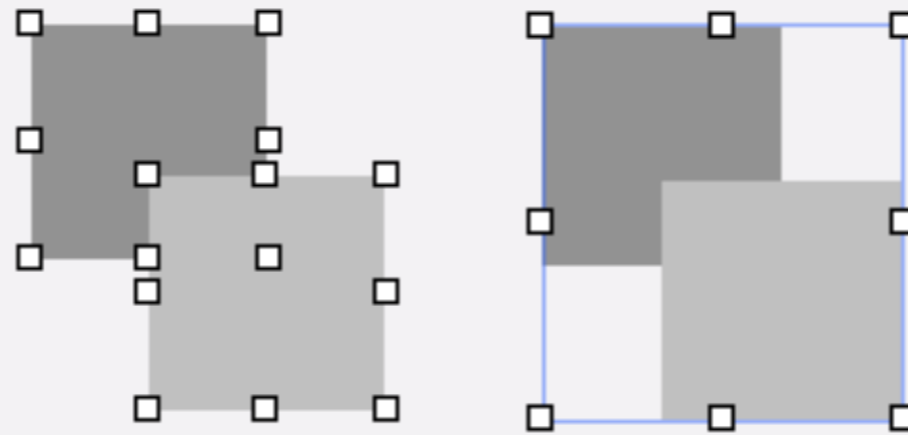
*OP:* ... select(objs); group(); mutate()

quantified over state & args



# what makes a usable concept?

operational principle is uniform  
always the same actions, irrespective of context



*concept:* **Group** (Keynote)

*purpose:* treat set as one

*OP:* ... select(objs); group(); mutate()

quantified over state & args

**unless** objs contains a text body object

# non-uniformity range

A screenshot of a spreadsheet interface. The spreadsheet has two columns: 'item' and 'cost'. The 'cost' column is highlighted in blue. A formula bar at the bottom shows the formula '=SUM(B2:B5)'. The data is as follows:

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

A screenshot of a spreadsheet interface. The spreadsheet has two columns: 'item' and 'cost'. The 'cost' column is highlighted in blue. A formula bar at the bottom shows the formula '=SUM(B2:B5)'. The data is as follows:

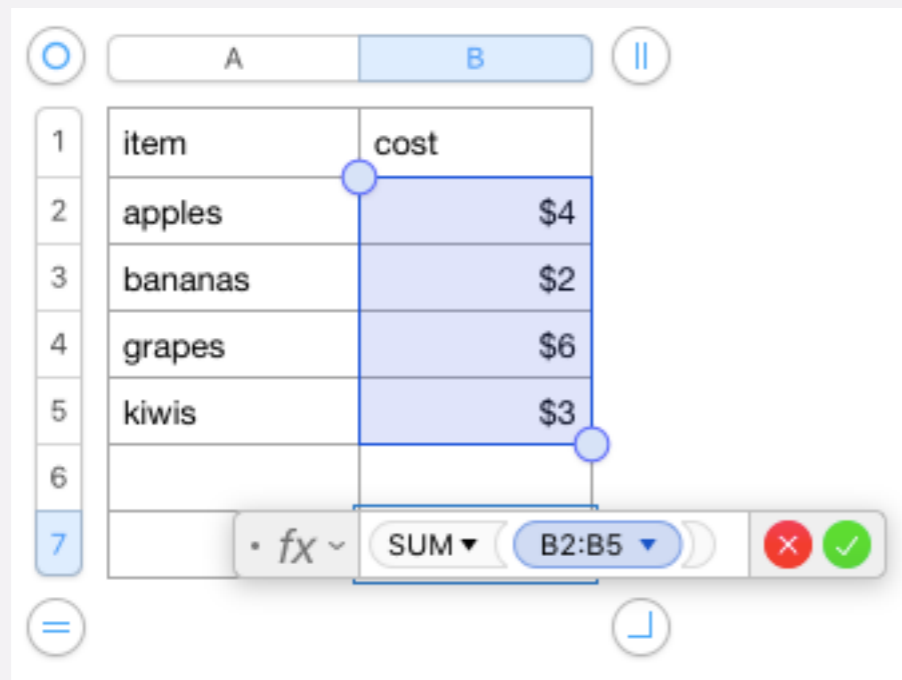
	A	B
1	item	cost
2	apples	\$4
3	bananas	\$2
4	cherries	
5	grapes	\$6
6	kiwis	\$3
7		
8		\$15

# non-uniformity range

concept: **Range** (Numbers)

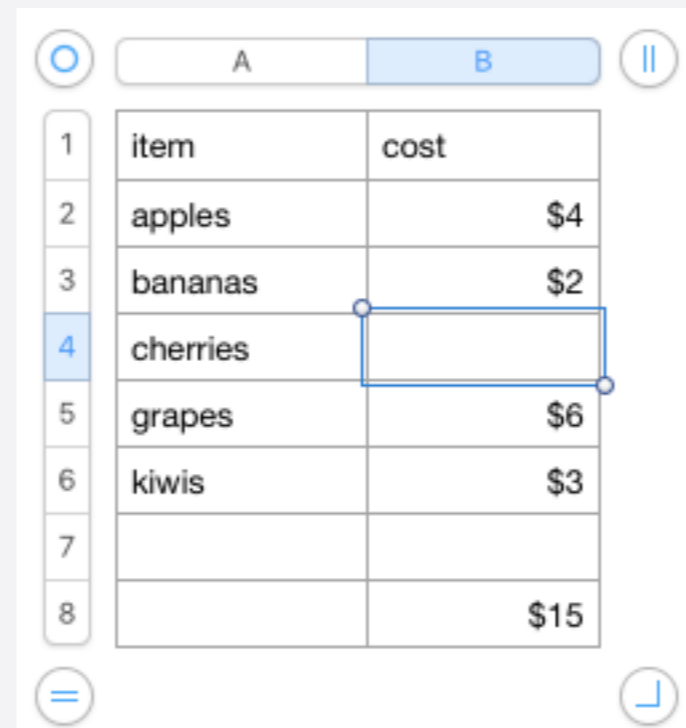
purpose: define formula over adjustable group of cells

OP: ... define(f, c, R) ... new(rc, dir): nc ... enter(nc,v) ... show(c)



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

• fx SUM B2:B5



	A	B
1	item	cost
2	apples	\$4
3	bananas	\$2
4	cherries	
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6	kiwis	\$3
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8		\$15

# non-uniformity range

concept: **Range** (Numbers)

purpose: define formula over adjustable group of cells

OP: ... define(f, c, R) ... new(rc, dir): nc ... enter(nc,v) ... show(c)

**unless** range cell rc is at top of range and dir is above or...

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

• fx SUM B2:B5

	A	B
1	item	cost
2	apples	\$4
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5	grapes	\$6
6	kiwis	\$3
7		
8		\$15

# non-uniformity conversation

The screenshot shows an email client interface with a sidebar on the left, a central message list, and a right-hand pane for the selected message. The sidebar lists mailboxes: 'Inbox' (selected), 'Flagged' (188), 'Drafts' (21), 'Sent', and 'Trash' (91). Under 'Smart Mailboxes', there is a 'csail imap' mailbox with sub-folders like '@SaneBlackHole', '@SaneLater', and 'imap'. The 'imap' folder is expanded to show sub-folders: '\_Archive', 'Admin', 'Personal', 'Photography', 'Projects', 'Accenture', 'Alloy', 'Alloy for CACM', 'Concept Design', 'Dependability', 'Dependencies', 'Discussions', 'Misc Research', 'MJ Discussions', and 'Object Sheets'. The central message list is sorted by date and shows a list of messages. The selected message is from 'Santiago Perez De Rosso' with the subject 'a question about DV'. The right-hand pane shows the content of this message, including a reply from 'Santiago Perez De Rosso' and a quote from 'Daniel Jackson'.

Inbox (59 messages)

Mailboxes: Inbox, Drafts (21), Sent, Flagged

Network Offline

Sort by Date

Found in Sent - csail imap Mailbox

**Daniel Jackson** <dnj@mit.edu> Yesterday at 2:00 PM (DJ)

Re: a question about DV

To: Santiago Perez De Rosso <sperezde@csail.mit.edu>

ready to chat on Skype when you are...

[See More from Santiago Perez De Rosso](#)

☆ **Santiago Perez De Rosso** <sperezde@csail.mit.edu> Yesterday at 1:57 PM (SD)

Re: a question about DV

To: Daniel Jackson <dnj@mit.edu>

On Thu, May 31, 2018 at 10:38 AM Daniel Jackson <dnj@mit.edu> wrote:  
But unmark is already a user action.  
You mean that deletion is associated also with an unmark? That would be a neat solution.

Yes, but I don't even think about deletion at all. The item could still exist somewhere else but for Label it makes no difference whether it does or not. As far as Label is concerned you don't "delete an item", you unmark it.

[See More](#)

Found in Sent - csail imap Mailbox

☆ **Daniel Jackson** <dnj@mit.edu> Yesterday at 1:38 PM (DJ)

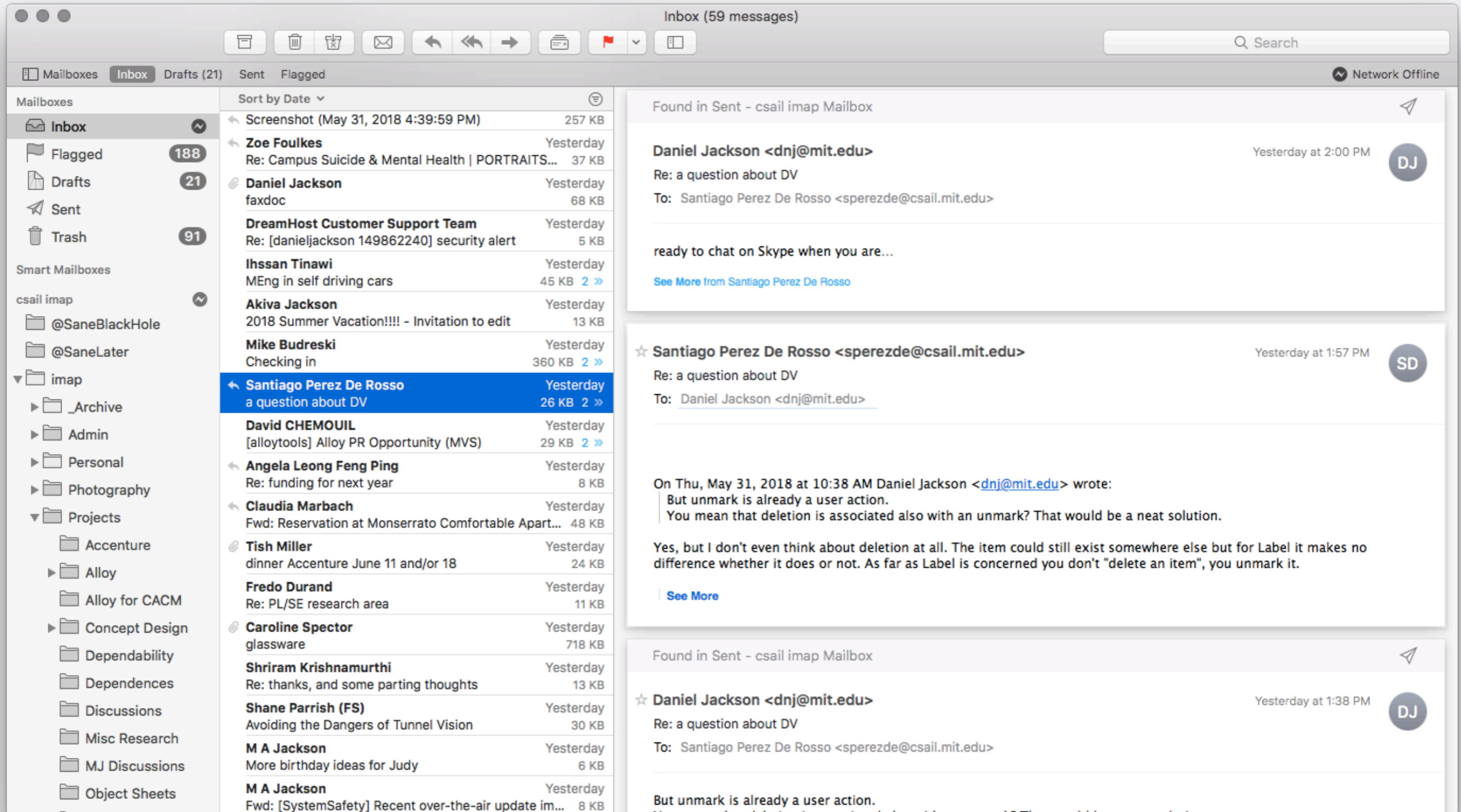
Re: a question about DV

To: Santiago Perez De Rosso <sperezde@csail.mit.edu>

But unmark is already a user action.  
You mean that deletion is associated also with an unmark? That would be a neat solution.

action applied to every message in conversation

# non-uniformity conversation



action applied to every message in conversation **unless** message in other folder or action is reply ...

# kinds of non-uniformity

Keynote grouping **unless** objs contains a text body object

Fuji aspect ratio setting **unless** set to raw only mode

Dropbox share folder **unless** folder is ancestor or descendant of shared folder

Git branch **unless** working directory contains uncommitted file or...

Twitter mention **unless** mention includes first character of tweet

# kinds of non-uniformity

*varies  
over type*

Keynote grouping **unless** objs contains a text body object

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*varies  
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*varies  
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Git branch **unless** working directory contains uncommitted file or...

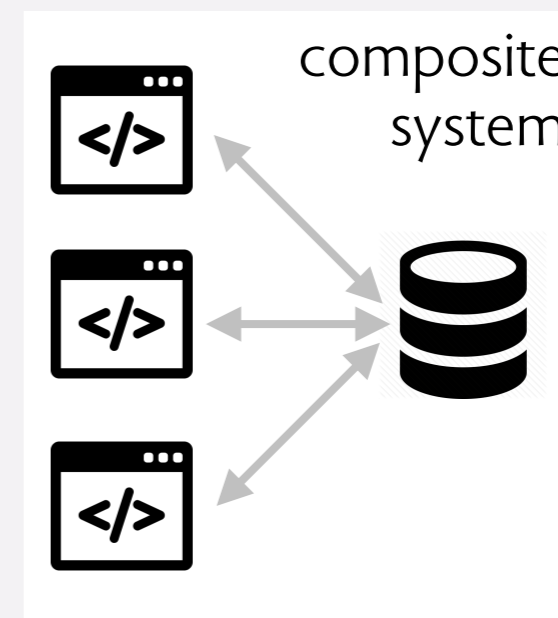
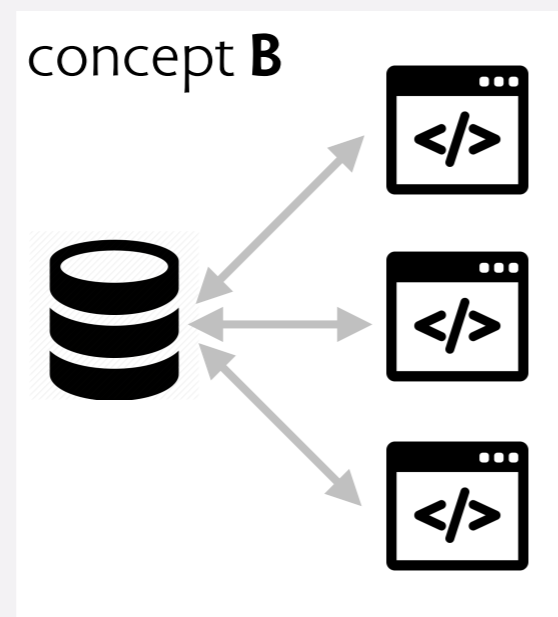
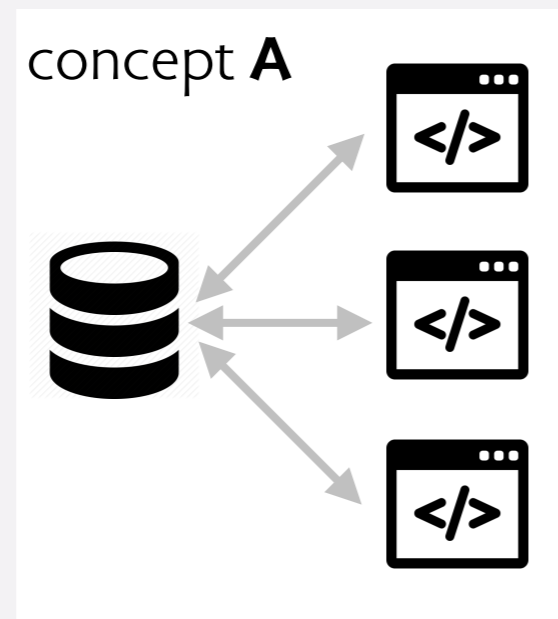
*varies  
over arg*

Twitter mention **unless** mention includes first character of tweet

the  
integrity  
rule

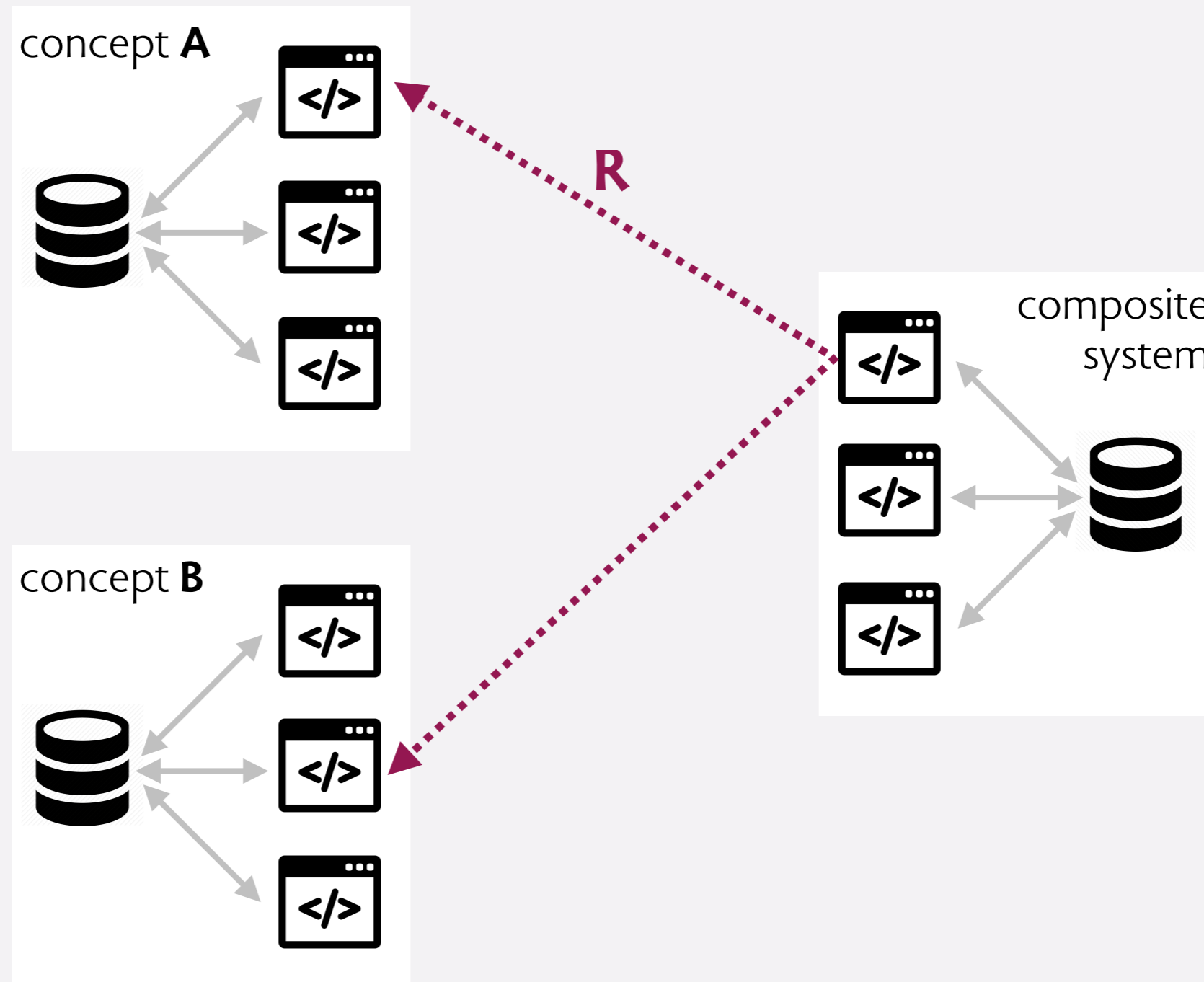
# interpreting composite behavior

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



# interpreting composite behavior

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



# example gmail



in:sent



Gmail



More

1-1 of 1



COMPOSE



To: Alyssa P. Hacker (2)

Inbox

hacking

javascript - Yes, it does. On

9:40 pm

0 GB (0%) of 15 GB used  
[Manage](#)

[Terms](#) - [Privacy](#)

Last account activity: 26 minutes ago  
[Details](#)

Inbox

Starred

Sent Mail

Drafts

Trash

Categories

Social

Promotions

Updates

Forums

hacking

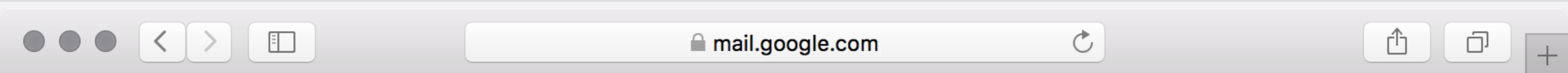
meetups

todo

More



# example gmail



in:sent

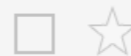


Gmail



More

1-1 of 1



To: Alyssa P. Hacker (2)

Inbox

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COMPOSE

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More

0 GB (0%) of 15 GB used  
[Manage](#)

[Terms](#) - [Privacy](#)

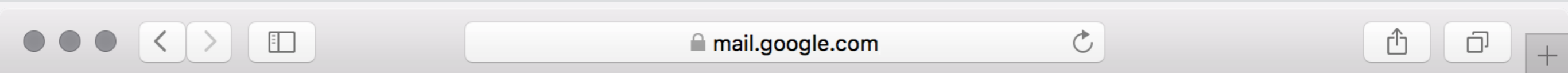
Last account activity: 26 minutes ago  
[Details](#)

action is **Label.show( $p$ ): $ms$**   
where  $p$  is the label *sent*  
and  $ms$  is the set of two messages listed





# example gmail



in:sent



Gmail

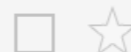


More

1-1 of 1



COMPOSE



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Inbox

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javascript - Yes, it does. On

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0 GB (0%) of 15 GB used  
[Manage](#)

[Terms](#) - [Privacy](#)

Last account activity: 26 minutes ago  
[Details](#)

action is **Label.show**( $p$ ): $ms$   
where  $p$  is the label *sent*  
and  $ms$  is the set of two messages listed

prior sending of msg  $m$  was an instance of  
action **Label.mark**( $m, p$ )  
where  $p$  is the label *sent*

- Inbox
- Starred
- Sent Mail**
- Drafts
- Trash
- Categories
  - Social
  - Promotions
  - Updates
  - Forums
- hacking
- meetups
- todo
- More

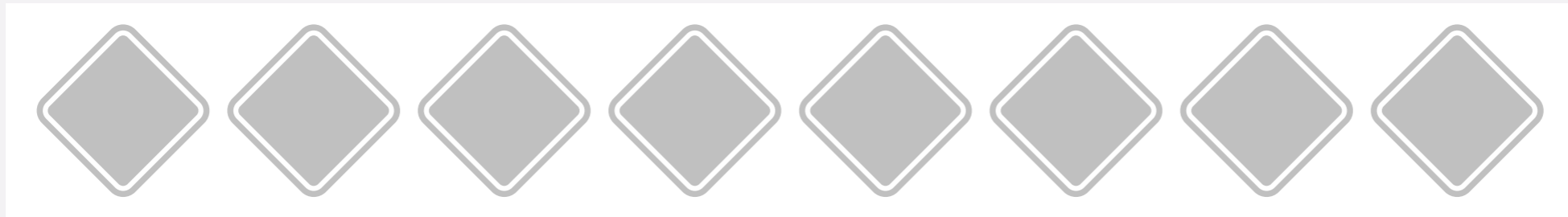


# judging composite behavior

a simple criterion

projected behavior must satisfy concept spec:

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



system

concept **A**

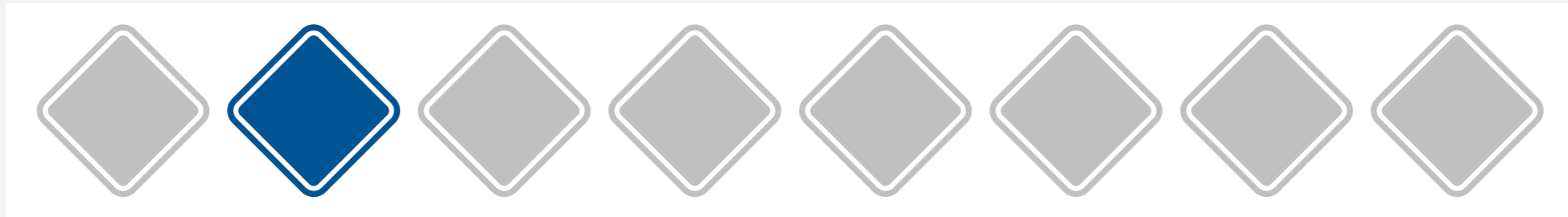
concept **B**

# judging composite behavior

a simple criterion

projected behavior must satisfy concept spec:

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



system

concept **A**

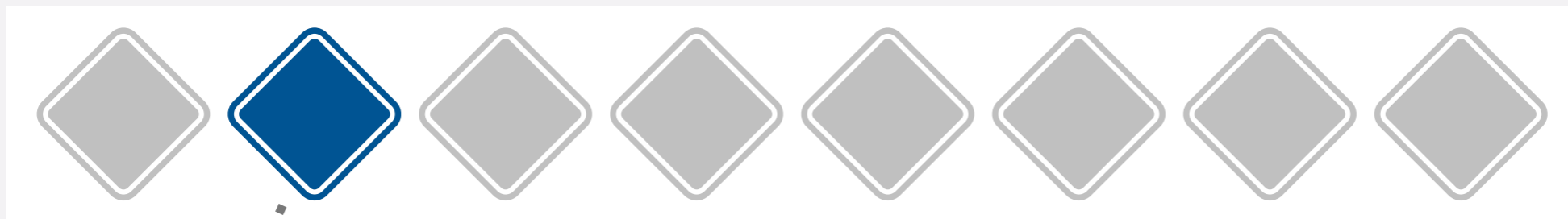
concept **B**

# judging composite behavior

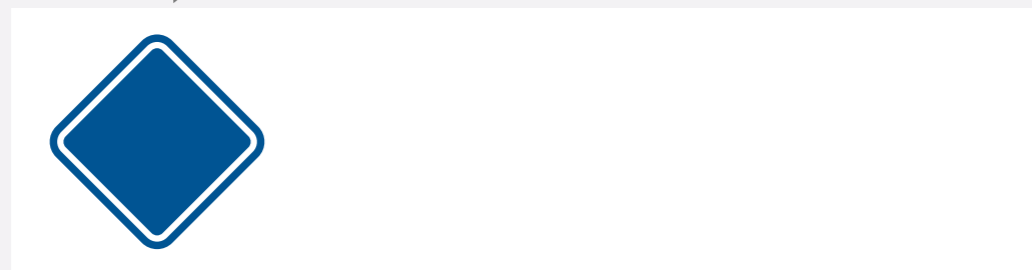
a simple criterion

projected behavior must satisfy concept spec:

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system



concept **A**

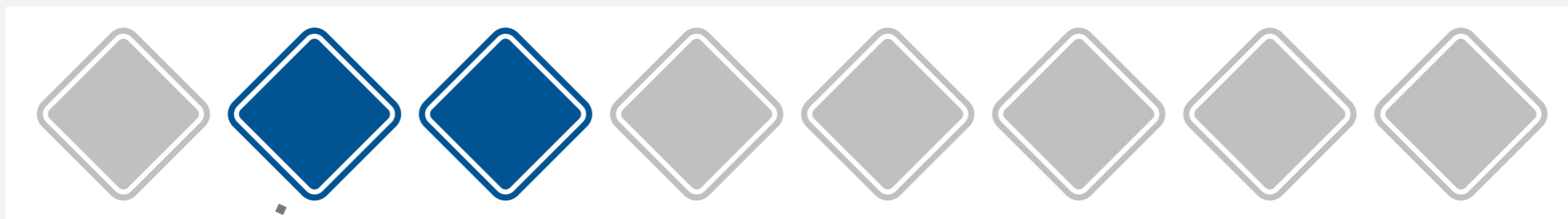
concept **B**

# judging composite behavior

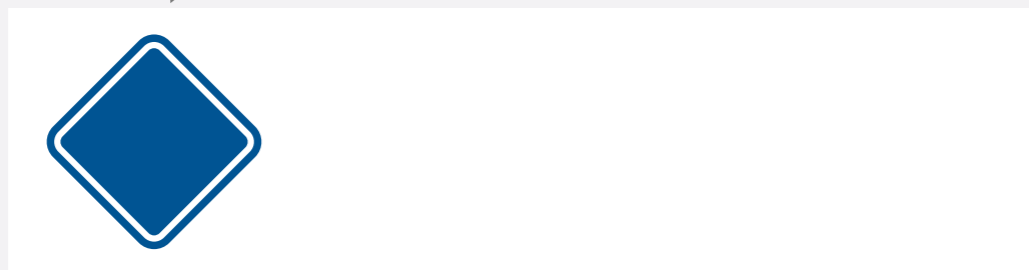
a simple criterion

projected behavior must satisfy concept spec:

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



system



concept **A**

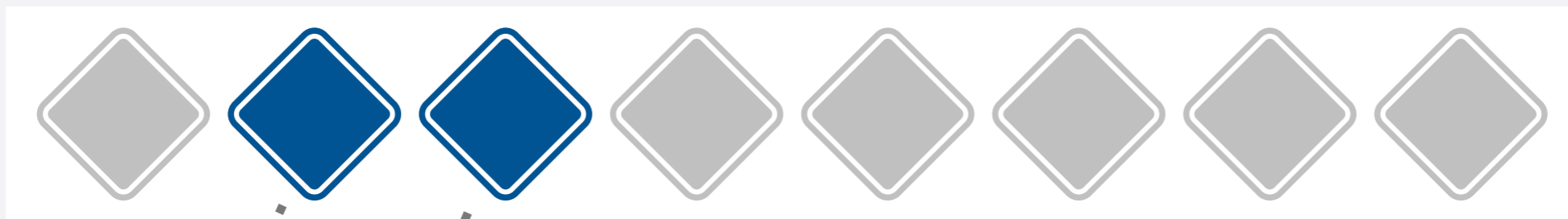
concept **B**

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a simple criterion

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



system



concept **A**

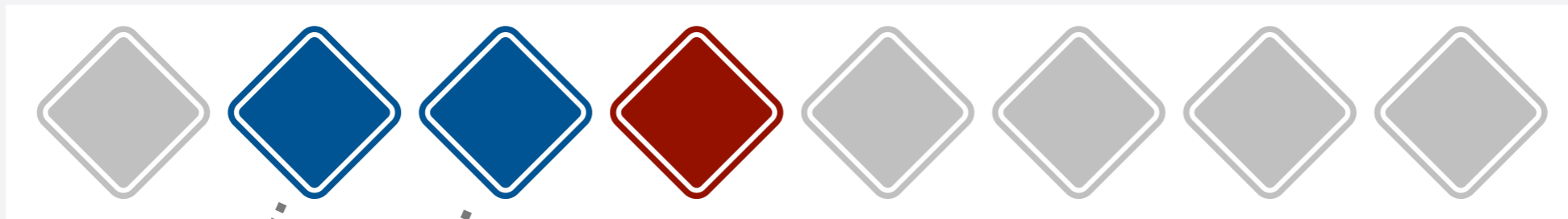
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system



concept **A**

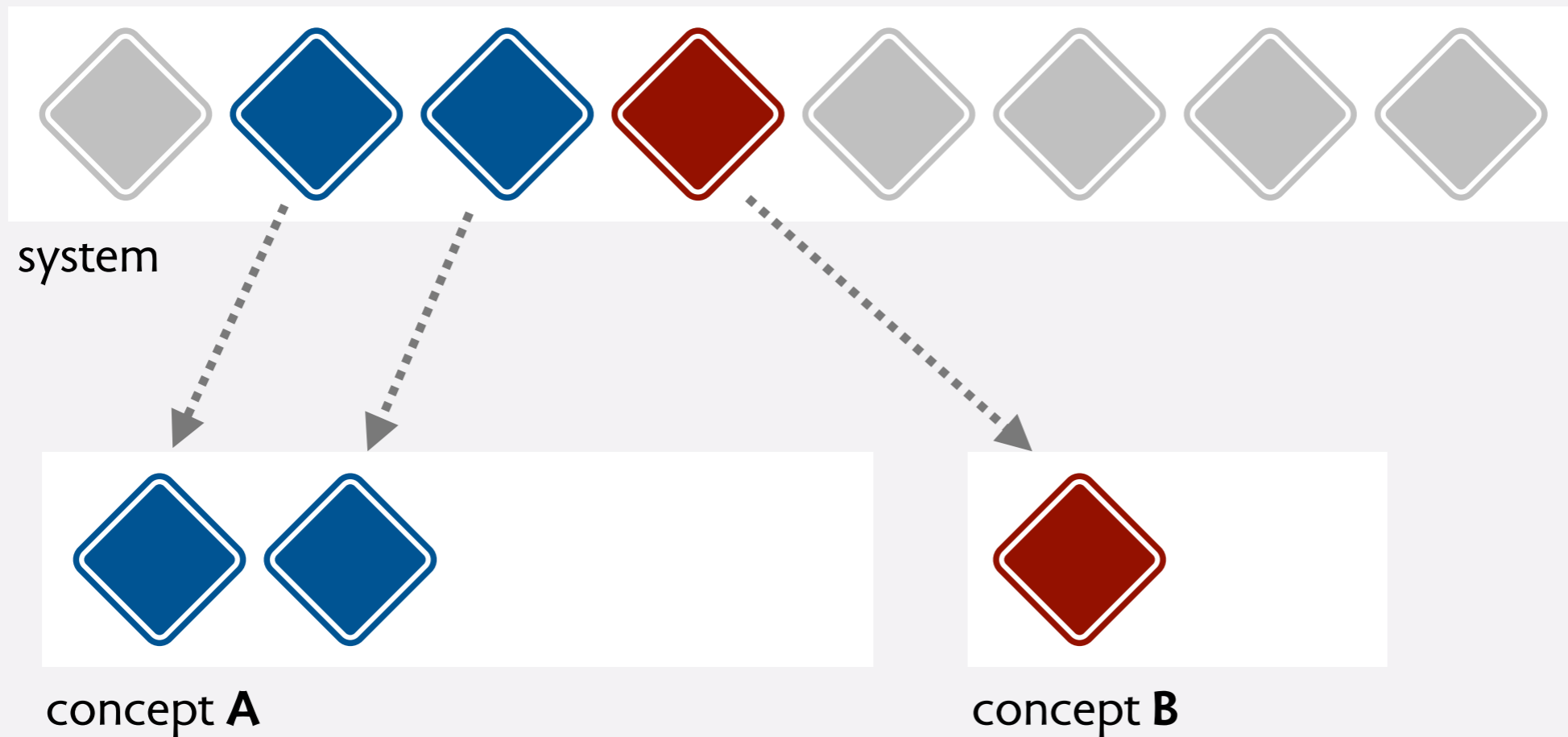
concept **B**

# judging composite behavior

a simple criterion

projected behavior must satisfy concept spec:

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



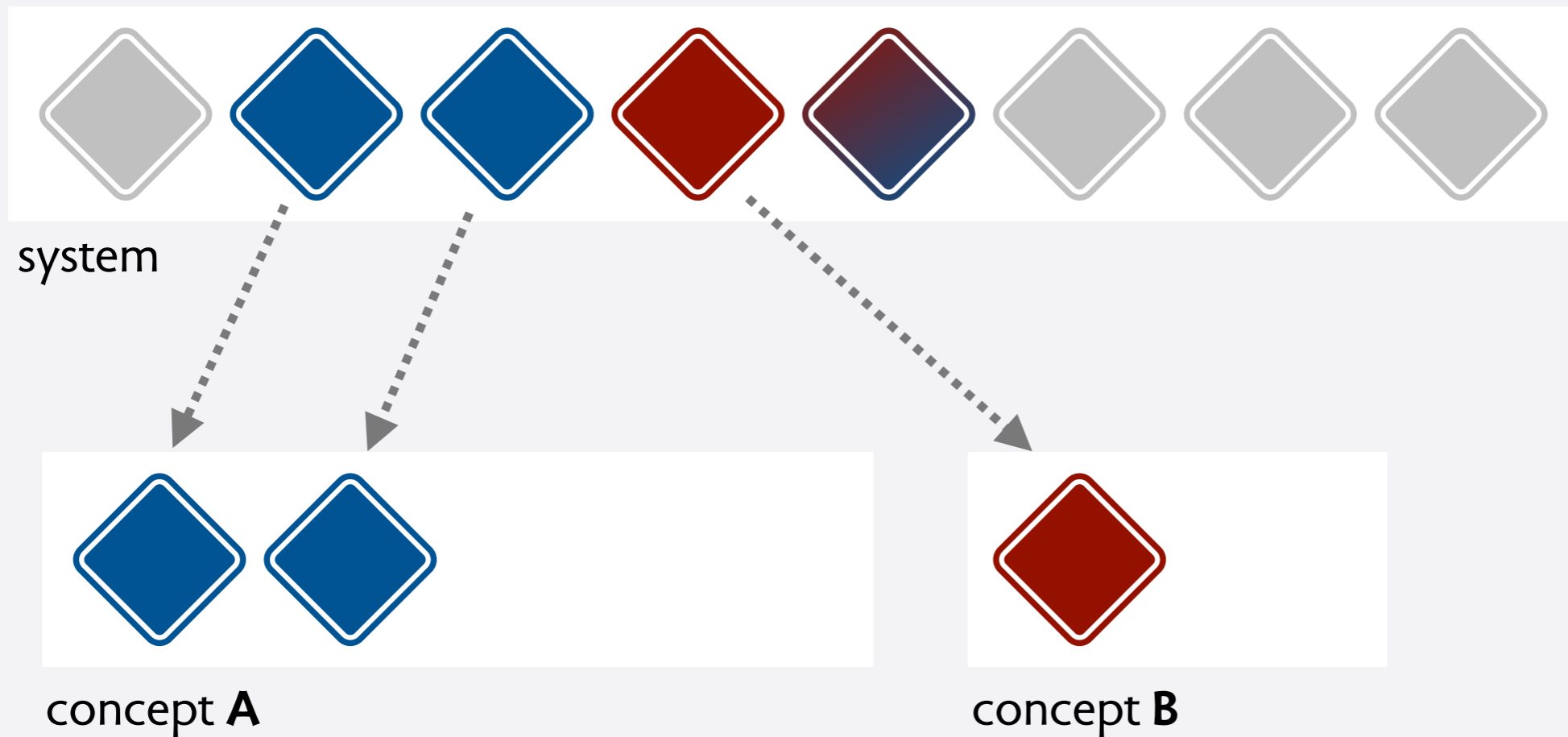


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projected behavior must satisfy concept spec:

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

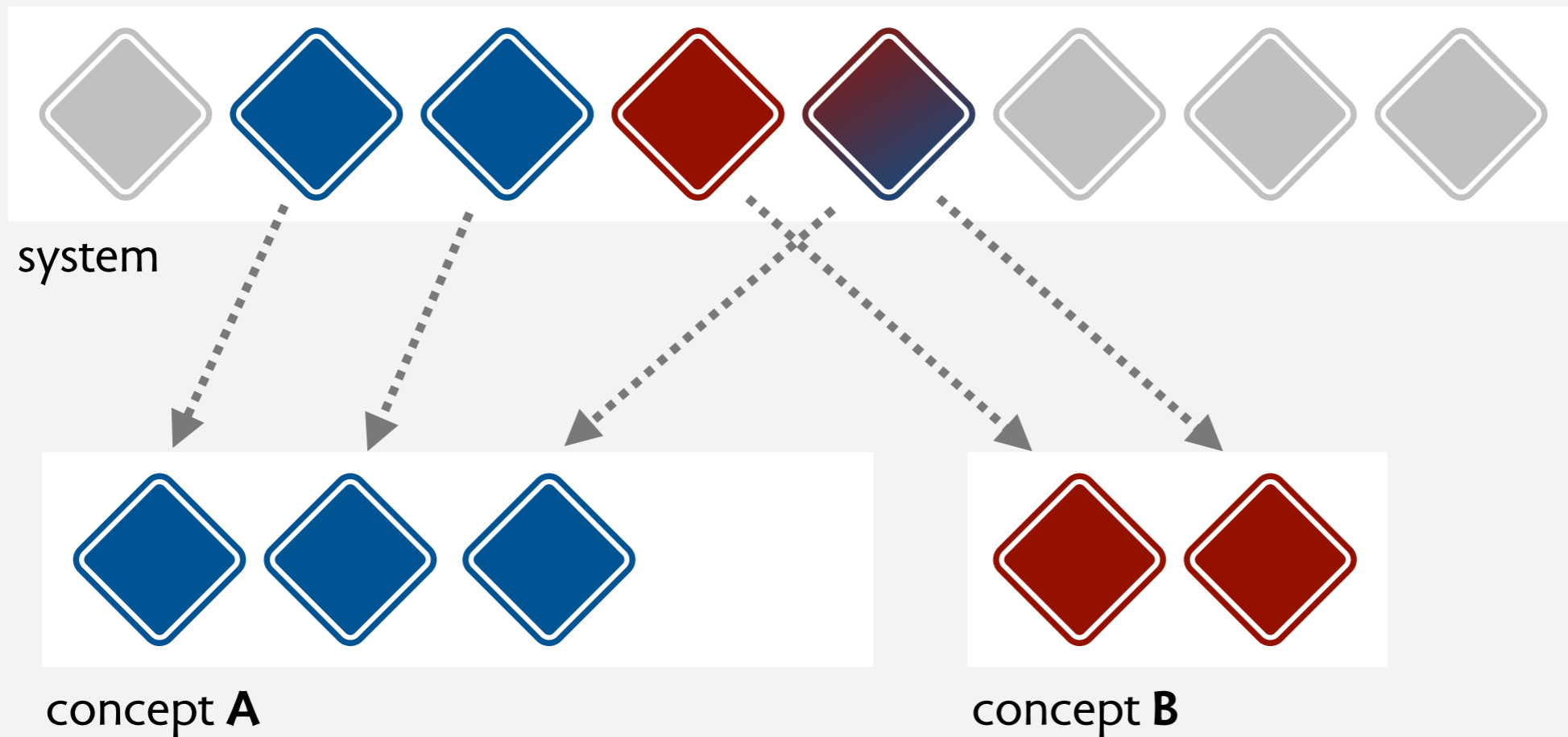


# judging composite behavior

a simple criterion

projected behavior must satisfy concept spec:

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



# example gmail

This screenshot shows the Gmail search interface. The search bar contains the query 'in:sent'. The search results show one email from Alyssa P. Hacker with the subject 'javascript - Yes, it does. On'. The interface includes a 'COMPOSE' button, a sidebar with 'Inbox', 'Starred', and 'Sent Mail', and a top navigation bar with the Gmail logo and search bar.

*violates spec of Label.search*

This screenshot shows the details of the email found in the search results. The email is titled 'javascript' and is from Alyssa P. Hacker. The subject line is 'Reminds you of the old days, eh?'. The email was received at 9:14 PM (33 minutes ago). The interface includes a 'COMPOSE' button, a sidebar with 'Inbox', 'Starred', 'Sent Mail', 'Drafts', 'Trash', and 'Categories', and a top navigation bar with the Gmail logo and search bar.

# example gmail

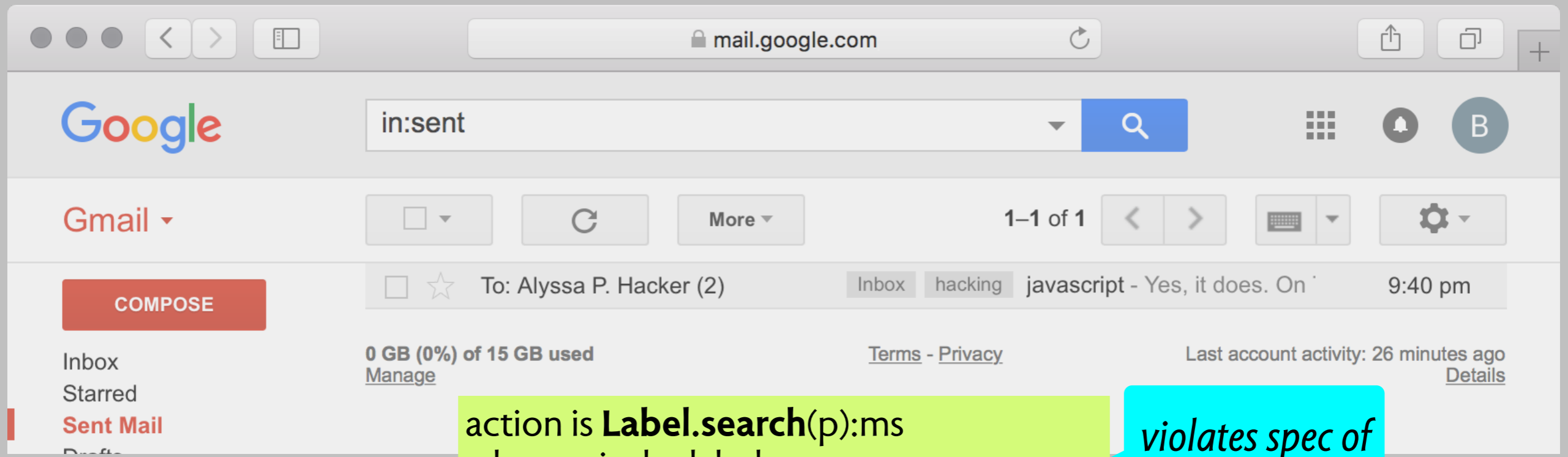
A screenshot of the Gmail web interface. The browser address bar shows 'mail.google.com'. The search bar contains 'in:sent'. Below the search bar, there are navigation buttons: a square icon, a refresh icon, and a 'More' dropdown. To the right, it says '1-1 of 1' with left and right arrow buttons, a keyboard icon, and a settings gear icon. The main content area shows a search result for 'To: Alyssa P. Hacker (2)' with labels 'Inbox', 'hacking', and 'javascript - Yes, it does. On'. The time is '9:40 pm'. On the left sidebar, there is a 'COMPOSE' button and a list of folders: 'Inbox', 'Starred', 'Sent Mail', and 'Drafts'. At the top right, there is a '0 GB (0%) of 15 GB used' status, 'Terms - Privacy' links, and 'Last account activity: 26 minutes ago' with a 'Details' link.

action is **Label.search(p):ms**  
where p is the label sent  
and ms is the set of two messages listed

*violates spec of  
Label.search*

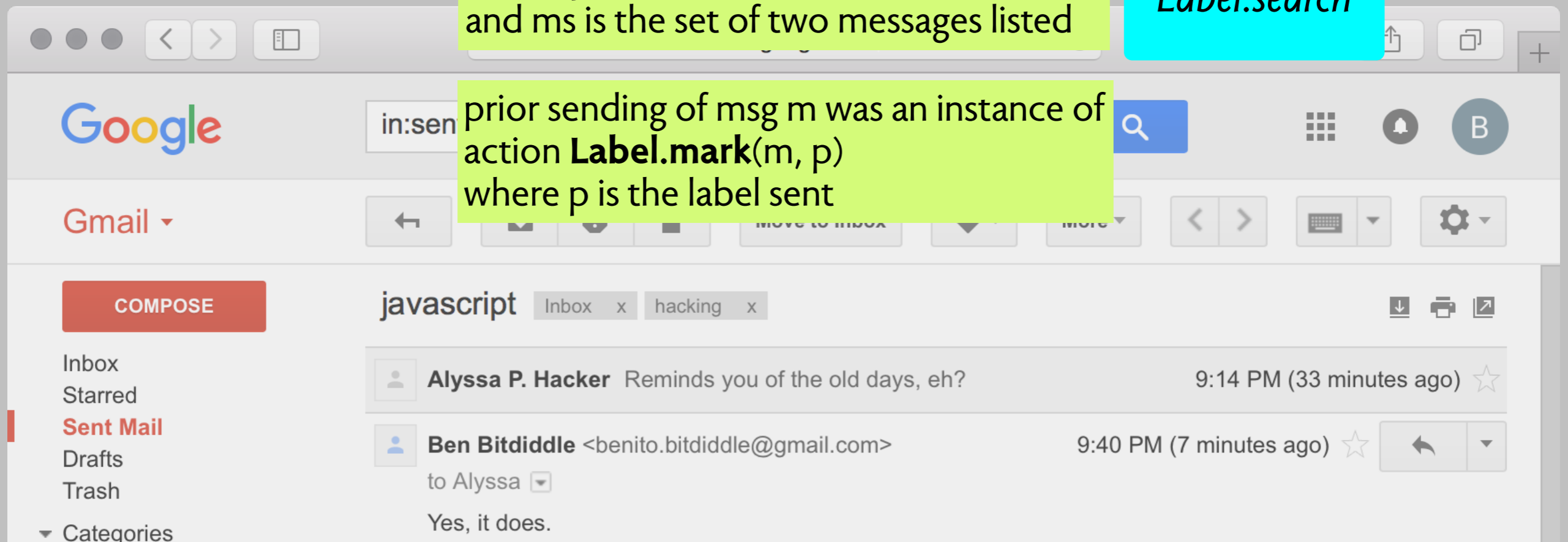
A screenshot of the Gmail web interface showing the details of a message. The browser address bar shows 'mail.google.com'. The search bar contains 'in:sent'. Below the search bar, there are navigation buttons: a back arrow, a download icon, a warning icon, a trash icon, a 'Move to Inbox' button, a tag icon, a 'More' dropdown, left and right arrow buttons, a keyboard icon, and a settings gear icon. The main content area shows the message title 'javascript' with labels 'Inbox x' and 'hacking x'. There are download, print, and share icons. The message is from 'Alyssa P. Hacker' with the subject 'Reminds you of the old days, eh?' and time '9:14 PM (33 minutes ago)'. Below it is a reply from 'Ben Bitdiddle <benito.bitdiddle@gmail.com>' with the subject 'to Alyssa' and time '9:40 PM (7 minutes ago)'. The body of the message says 'Yes, it does.' On the left sidebar, there is a 'COMPOSE' button and a list of folders: 'Inbox', 'Starred', 'Sent Mail', 'Drafts', 'Trash', and 'Categories'.

# example gmail



action is **Label.search**(p):ms  
where p is the label sent  
and ms is the set of two messages listed

*violates spec of  
Label.search*



prior sending of msg m was an instance of  
action **Label.mark**(m, p)  
where p is the label sent

# integrity violations trash



interaction of Trash and Volume (Apple Finder)  
unmount of Volume removes files from Trash  
not expressible in terms of Trash actions  
a solution: one trash/volume

# integrating concepts to make apps

Deja Vu (Santiago Perez De Rosso)

library of polymorphic concepts, each implementing full stack  
composed in HTML by linking actions


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

cliché

closing  
thoughts

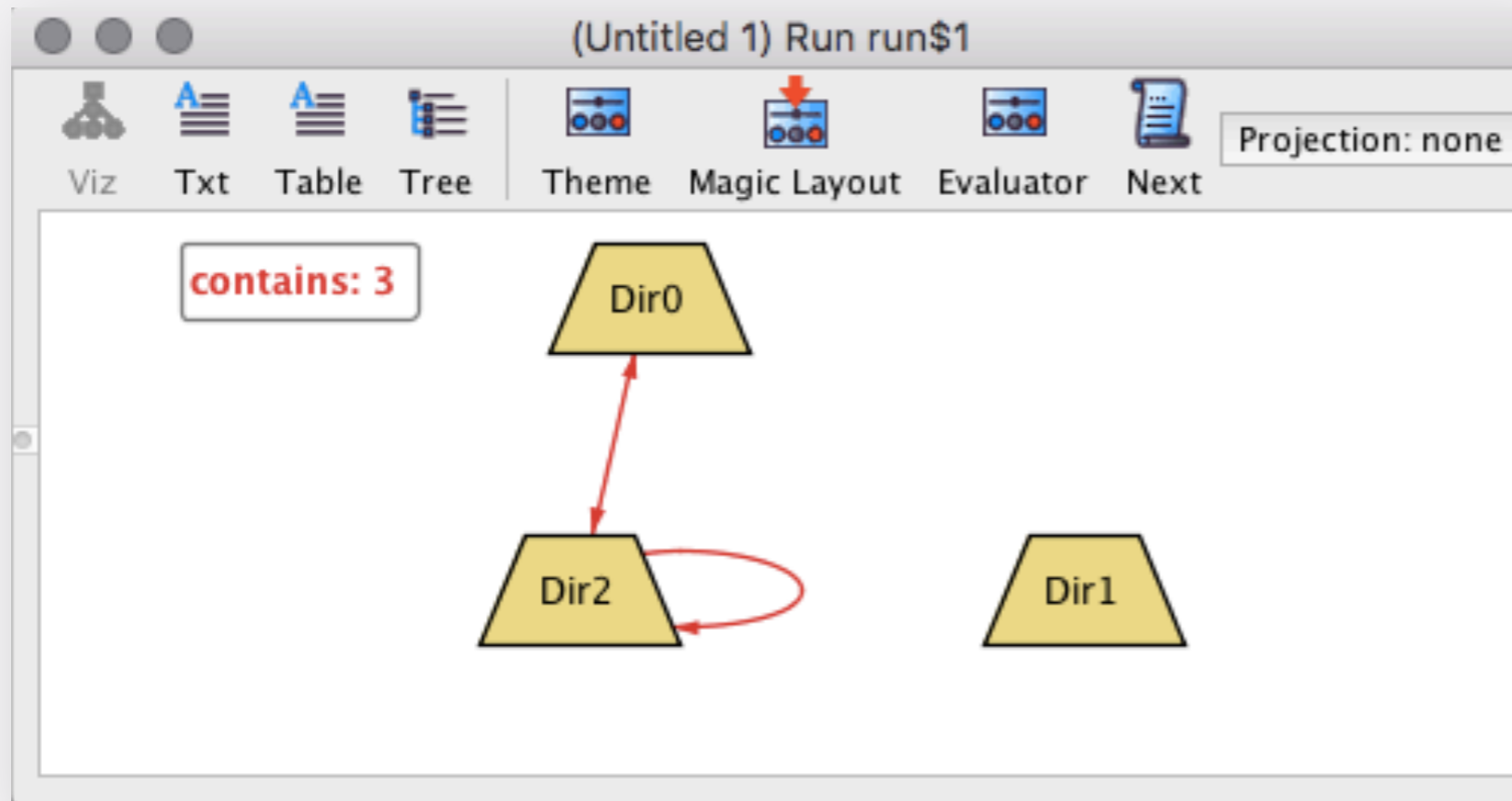


# finding bugs in design: what kind?




```
sig Object {}  
sig File extends Object {}  
sig Dir extends Object {contains: set Object}  
run {}
```

mantras: to reduce costs, find bugs early  
**but what kinds of bugs?**  
corner cases easily found & fixed later  
snags vs snafus

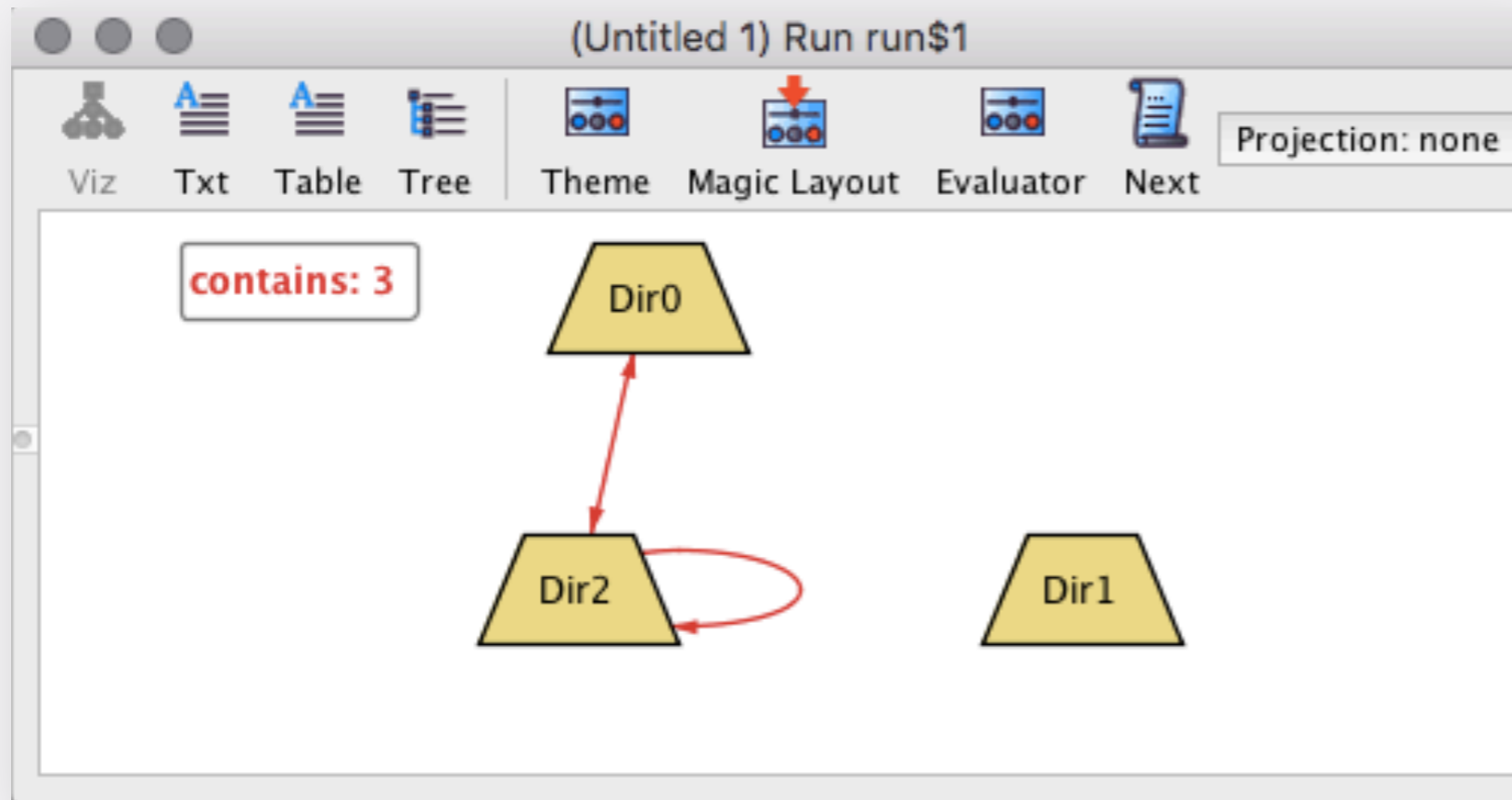


# finding bugs in design: what kind?



```
sig Object {}  
sig File extends Object {}  
sig Dir extends Object {contains: set Object}  
run {}
```

mantras: to reduce costs, find bugs early  
**but what kinds of bugs?**  
corner cases easily found & fixed later  
snags vs snafus



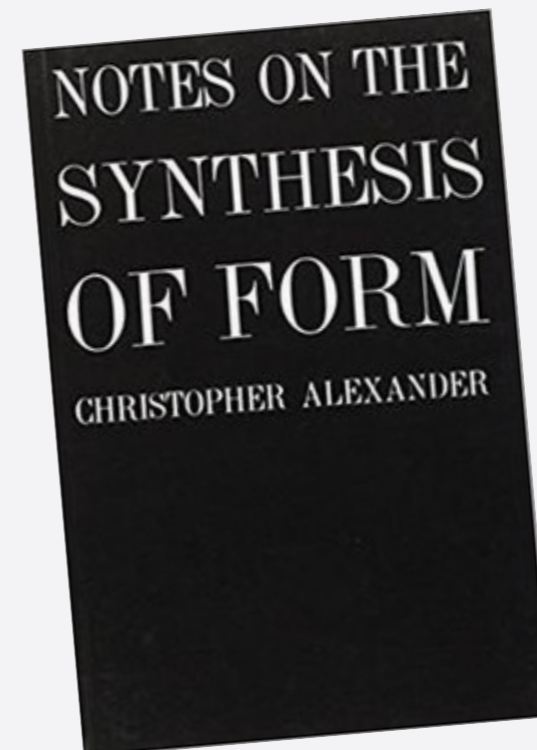
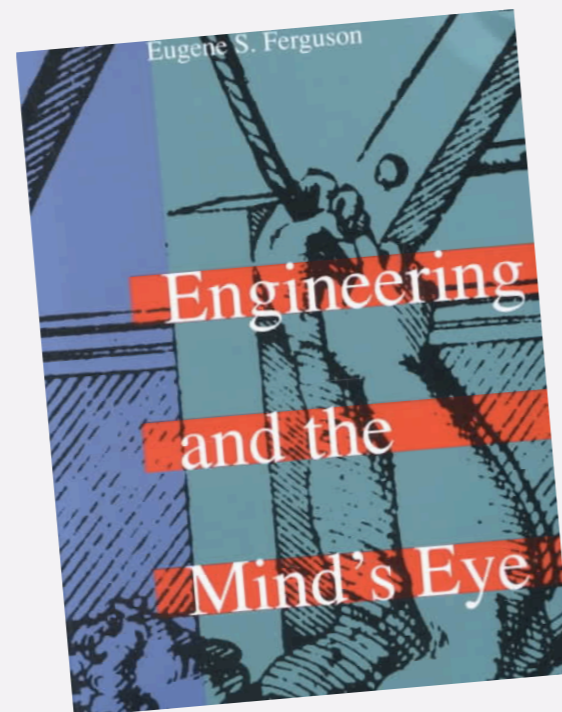
*simulation > proof*

# models in design vs engineering

what engineers use models for?

calculating properties, checking against higher level specs  
to find bugs

what designers actually use models for  
simulating experience of finished product  
to find unanticipatable misfits



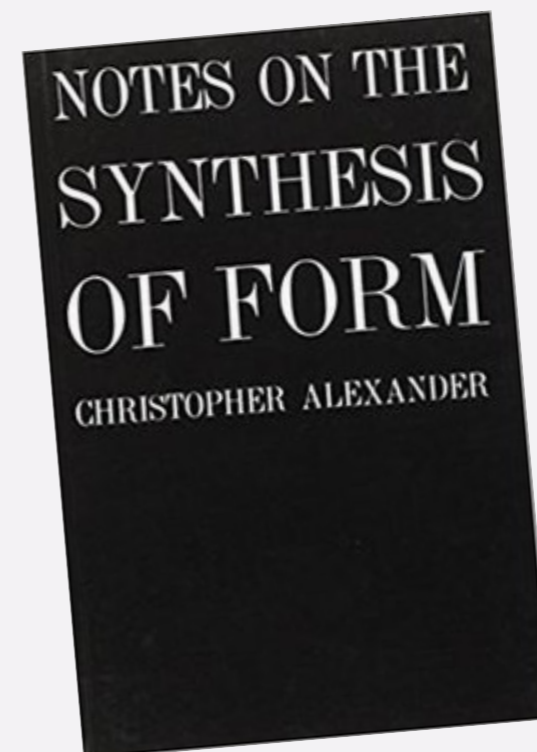
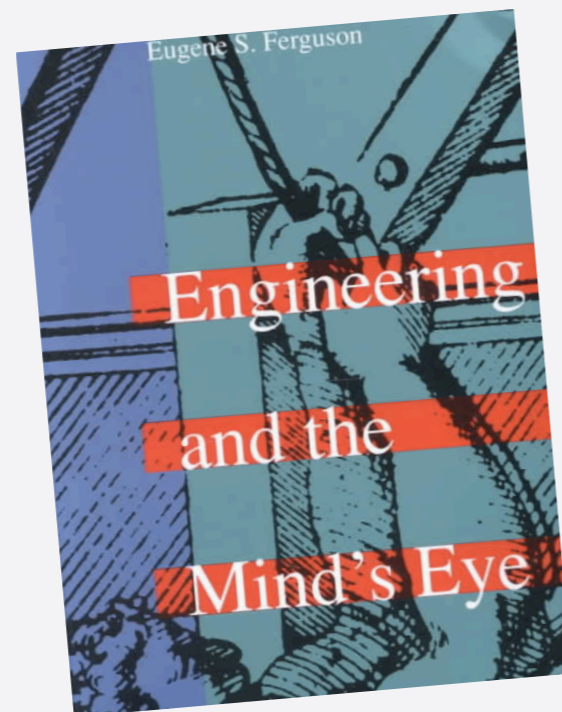
# models in design vs engineering

what engineers use models for?

calculating properties, checking against higher level specs  
to find bugs

*shallow flaws*

what designers actually use models for  
simulating experience of finished product  
to find unanticipatable misfits



# models in design vs engineering

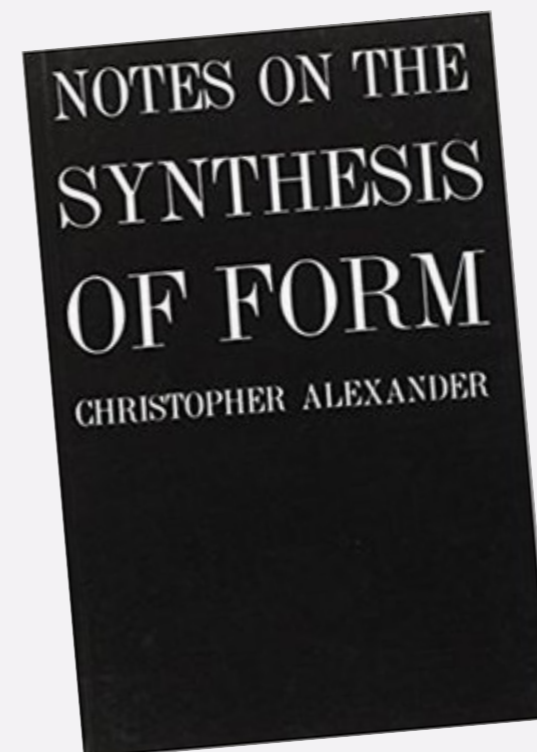
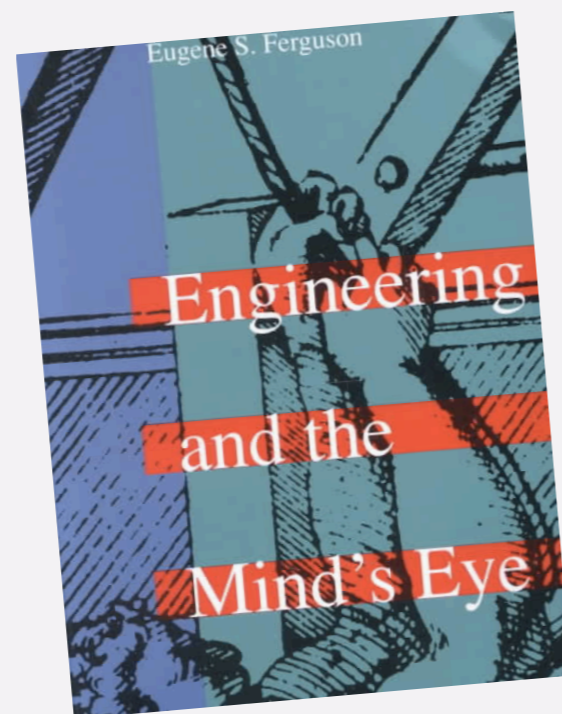
what engineers use models for?

calculating properties, checking against higher level specs  
to find bugs

*shallow flaws*

what designers actually use models for  
simulating experience of finished product  
to find unanticipatable misfits

*deep flaws*



## **the essence of UX design**

below surface of the UI, in the semantics

### **concepts: a structure for functionality**

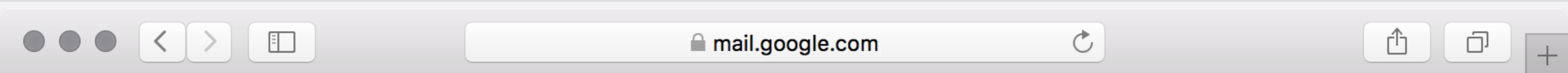
purpose-driven & free standing

### **(de)constructing apps**

non-conflicting concepts are “conjunctive”

# organizing messages

# organizing messages

A search input field with a magnifying glass icon on the right side, used for searching through emails.

Gmail ▾

Navigation controls including a refresh button (highlighted with a blue border), a "More" dropdown menu, "1-1 of 1" status, and navigation arrows.

COMPOSE

Category tabs for "Primary" (selected), "Social", and "Promotions", along with a "+" icon for more categories.

Inbox

☆ Alyssa P. Hacker javascript - Reminds you of the old days, eh? 9:14 pm

- Starred
- Sent Mail
- Drafts
- Trash

0 GB (0%) of 15 GB used  
[Manage](#)

[Terms](#) - [Privacy](#)

Last account activity: 14 hours ago  
[Details](#)

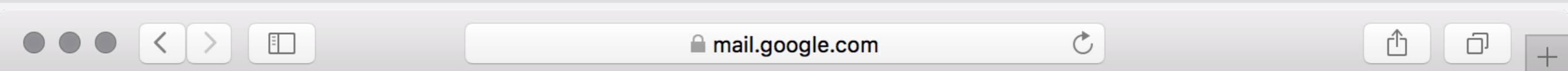
- Categories
- Social
- Promotions
- Updates
- Forums

- hacking
- meetups
- todo
- More ▾





# organizing messages

A search bar with a magnifying glass icon on the right side.

Gmail ▾



COMPOSE

- Inbox
- Starred
- Sent Mail
- Drafts
- Trash
- Categories
  - Social
  - Promotions
  - Updates
  - Forums

Primary

Alyssa P. Hacker

0 GB (0%) of 15 GB used  
[Manage](#)

Label as:

- hacking
- meetups
- todo
- Social
- Promotions
- Updates
- Forums

Apply

Promotions

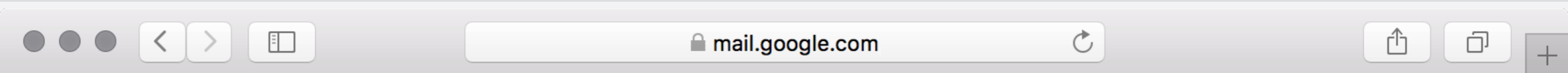
s you of the old days, eh? 9:14 pm

Last account activity: 14 hours ago  
[Details](#)

- hacking
- meetups
- todo
- More ▾



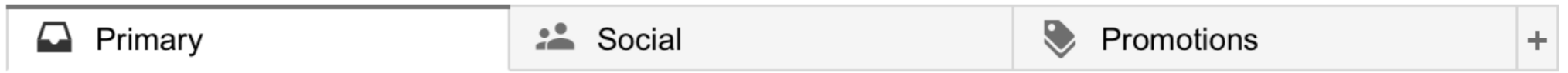
# organizing messages

A search input field with a magnifying glass icon on the right side.

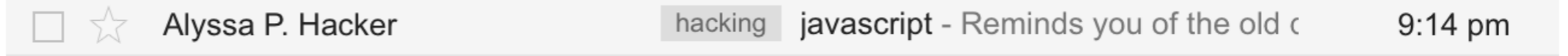
Gmail ▾



COMPOSE



Inbox



- Starred
- Sent Mail
- Drafts
- Trash

0 GB (0%) of 15 GB used  
[Manage](#)

[Terms](#) - [Privacy](#)

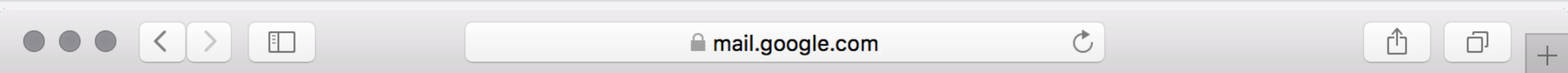
Last account activity: 14 hours ago  
[Details](#)

- Categories
- Social
- Promotions
- Updates
- Forums

- hacking
- meetups
- todo
- More ▾



# organizing messages



label:hacking



Gmail ▾



More ▾

1-1 of 1



COMPOSE

- Inbox
- Starred
- Sent Mail
- Drafts
- Trash

▾ Categories

- Social
- Promotions
- Updates
- Forums

**hacking**

- meetups
- todo
- More ▾

Alyssa P. Hacker

Inbox

javascript - Reminds you of the old da

9:14 pm

0 GB (0%) of 15 GB used  
[Manage](#)

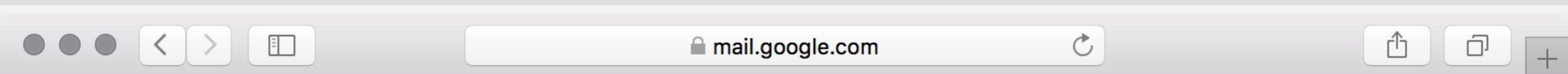
[Terms](#) - [Privacy](#)

Last account activity: 14 hours ago  
[Details](#)

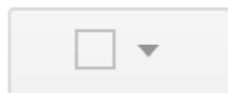


# automating filtering

# automating filtering

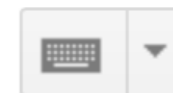


Gmail ▾



More ▾

1-2 of 2



COMPOSE

- Primary
- Social
- Promotions
- +

Inbox (2)

- Starred
- Sent Mail
- Drafts
- Trash

<input type="checkbox"/>		<b>Alyssa P. Hacker</b>	<b>hacking</b>	<b>javascript</b> - Reminds you of the old	<b>9:14 pm</b>
<input type="checkbox"/>		<b>Andy from Google</b>	<b>Updates</b>	<b>Ben, welcome to your new Googl</b>	<b>May 6</b>

0 GB (0%) of 15 GB used  
[Manage](#)

[Terms](#) - [Privacy](#)

Last account activity: 14 hours ago  
[Details](#)

Categories

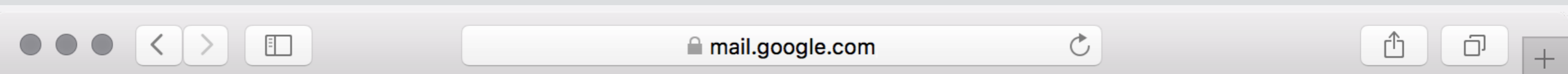
- Social
- Promotions
- Updates (1)**
- Forums

**hacking (1)**

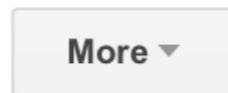
- meetups
- todo
- More ▾



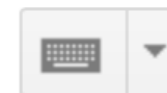
# automating filtering



Gmail ▾



1-1 of 1



COMPOSE

Primary

Social

Promotions +

**Inbox (2)**

Starred

Sent Mail

Drafts

Trash

Categories

Social

Promotions

**Updates (1)**

Forums

**hacking (1)**

meetups

todo

More ▾

Alyssa P. Hacker buy this! - My new JS book is out! May 6

**0 GB (0%) of 15 GB used**  
[Manage](#)

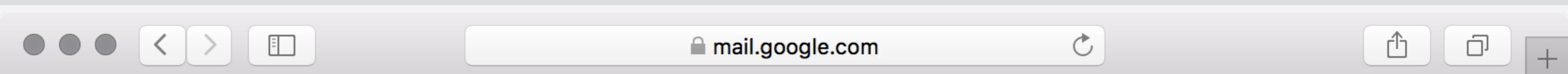
[Terms](#) - [Privacy](#)

Last account activity: 14 hours ago  
[Details](#)



# slightly surprising behavior #1

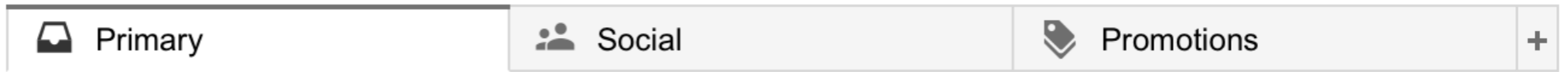
# slightly surprising behavior #1

A search input field with a blue search button on the right.

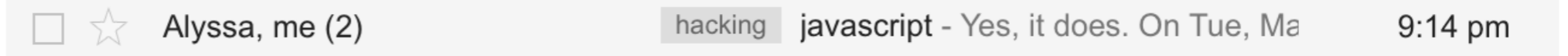
Gmail ▾



COMPOSE



Inbox



Starred  
Sent Mail  
Drafts  
Trash

0 GB (0%) of 15 GB used  
[Manage](#)

[Terms](#) - [Privacy](#)

Last account activity: 26 minutes ago  
[Details](#)

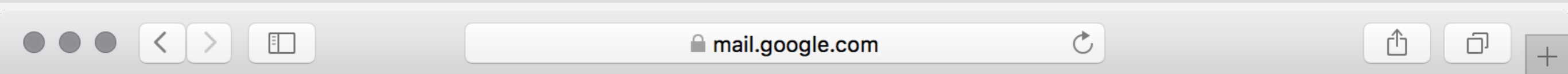
- Categories
- Social
- Promotions
- Updates
- Forums

hacking  
meetups  
todo  
More ▾





# slightly surprising behavior #1



in:sent



Gmail



More

1-1 of 1



COMPOSE



To: Alyssa P. Hacker (2)

Inbox

hacking

javascript - Yes, it does. On

9:40 pm

0 GB (0%) of 15 GB used  
[Manage](#)

[Terms](#) - [Privacy](#)

Last account activity: 26 minutes ago  
[Details](#)

Inbox

Starred

**Sent Mail**

Drafts

Trash

Categories

Social

Promotions

Updates

Forums

hacking

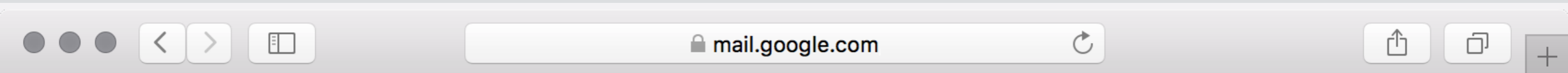
meetups

todo

More



# slightly surprising behavior #1



in:sent



Gmail



Move to Inbox



More





COMPOSE


javascript

Inbox x hacking x



 **Alyssa P. Hacker** Reminds you of the old days, eh?

9:14 PM (33 minutes ago) 

 **Ben Bitdiddle** <benito.bitdiddle@gmail.com>  
to Alyssa

9:40 PM (7 minutes ago) 



Yes, it does.



 Click here to [Reply](#) or [Forward](#)





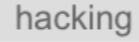
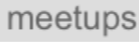
0 GB (0%) of 15 GB used  
[Manage](#)

[Terms](#) - [Privacy](#)

Last account activity: 26 minutes ago  
[Details](#)



# slightly surprising behavior #2

 Primary	 Social	 Promotions	+
<input type="checkbox"/>  me, Alyssa (12)	 	javascript - Hello again Be	11:48 am

# slightly surprising behavior #2

The screenshot shows the Gmail interface with the following elements:

- Navigation tabs:** Primary (selected), Social, Promotions, and a plus sign for more.
- Search bar:** Contains the text "label:hacking" and a search icon.
- Search results:** A single email is displayed with the following details:
  - From: me, Alyssa (12)
  - Labels: hacking, meetups
  - Subject: javascript - Hello again Be
  - Time: 11:48 am
- Toolbar:** Includes a checkbox, a refresh button, a "More" dropdown, "1-1 of 1" pagination, left and right navigation arrows, a keyboard icon, and a settings gear.
- Bottom email preview:** Shows a second email with the following details:
  - From: me, Alyssa (12)
  - Labels: Inbox, meetups
  - Subject: javascript - Hello again Ben
  - Time: 9:43 am

# slightly surprising behavior #2

Primary Social Promotions +

☆ me, Alyssa (12) hacking meetups javascript - Hello again Ben 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

# slightly surprising behavior #2

Primary Social Promotions +

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

label:hacking

▾   1-1 of 1

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

label:meetups

▾   1-1 of 1

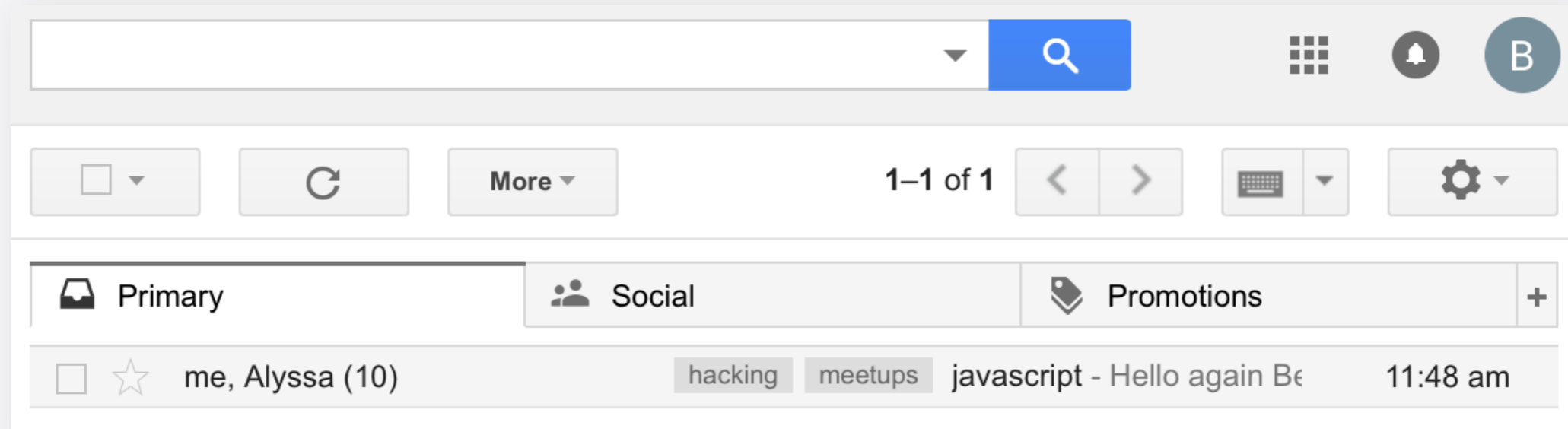
☆ me, Alyssa (12) Inbox hacking javascript - Hello again Ben. 9:58 am

label:hacking label:meetups

▾

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

# slightly surprising behavior #3



# slightly surprising behavior #3

Search bar: [ ] [Q] [Grid] [Bell] [B]

Actions: [ ] [Refresh] [More] 1-1 of 1 [Left] [Right] [Keyboard] [Settings]

Folder tabs: Primary | Social | Promotions | +

Message 1:  ☆ me, Alyssa (10) [hacking] [meetups] javascript - Hello again Be 11:48 am

Search bar: has:nouserlabels [Q] [Grid] [Bell] [B]

Actions: [List] [Download] [Warning] [Trash] [Move to Inbox] [Tag] [Refresh] [More] [Left] [Right] [Keyboard]

Message 2:  ☆ Alyssa P. Hacker [Inbox] [Promotions] buy this! - My new JS box 10:33 am

Message 3:  ☆ me, Alyssa (10) [Inbox] [hacking] [meetups] javascript - Oh, Al! 9:24 am



# slightly surprising behavior #4





# slightly surprising behavior #4

The image shows three screenshots of the Gmail interface, illustrating a search behavior. The top screenshot shows search results for 'label:todo', displaying two messages. The middle screenshot shows the search results for 'label:todo' are empty, with the message 'There are no conversations with this label.' The bottom screenshot shows search results for 'label:todo label:trash', displaying one message.

**Top Screenshot: Search results for 'label:todo'**

1-2 of 2

Empty Trash now (messages that have been in Trash more than 30 days will be automatically deleted)

<input type="checkbox"/>		me, Alyssa (13)	hacking	meetups	todo	javascript - Hello a	11:48 am
<input type="checkbox"/>		Andy from Google	Updates	Ben, welcome to your new Googl			9:01 am

label:todo

**Middle Screenshot: Search results for 'label:todo' are empty**

There are no conversations with this label.

**Bottom Screenshot: Search results for 'label:todo label:trash'**

1-1 of 1

<input type="checkbox"/>		me, Alyssa	Trash	hacking	meetups	todo	javascript -	10:11 am
--------------------------	--	------------	-------	---------	---------	------	--------------	----------

# slightly surprising behavior #4

☐ ↕ ↻ More ▾ 1-2 of 2 < > 🗂️ ▾ ⚙️ ▾

[Empty Trash now](#) (messages that have been in Trash more than 30 days will be automatically deleted)

☐ 🗑️	me, Alyssa (13)	hacking meetups todo javascript - Hello a	11:48 am
☐ 🗑️	Andy from Google	Updates Ben, welcome to your new Googl	9:01 am

label:todo 🔍 🗂️ 🔔 B

☐ ↕ ↻ More ▾ 🗂️ ▾ ⚙️ ▾

There are no conversations with this label.

label:todo label:trash 🔍 🗂️ 🔔 B

☐ ↕ ↻ More ▾ 1-1 of 1 < > 🗂️ ▾ ⚙️ ▾





☐ 🗑️	me, Alyssa	Trash hacking meetups todo javascript -	10:11 am
------	------------	---	----------

label:todo OR label:meetup 🔍 🗂️ 🔔 B

☐ ↕ ↻ More ▾ 🗂️ ▾ ⚙️ ▾

🔍 Some messages in Trash or Spam match your search. [View messages.](#)

# slightly surprising behavior #5

 Primary	 Social	 Promotions	+
<input checked="" type="checkbox"/>  Alyssa P. Hacker	<b>Promotions</b>	buy this! - My new JS book is out	10:33 am

# slightly surprising behavior #5

Primary	Social	Promotions	+
<input checked="" type="checkbox"/> ☆ Alyssa P. Hacker		<b>Promotions</b> buy this! - My new JS book is out	10:33 am

Primary	Social	Promotions	+
<input checked="" type="checkbox"/> ☆ Alyssa P. Hacker	<b>Social</b>	buy this! - My new JS book is out!	10:33 am

# slightly surprising behavior #5

The image displays three sequential screenshots of an email client interface, illustrating a specific behavior. Each screenshot shows a message from Alyssa P. Hacker with the subject "buy this! - My new JS book is out" and a timestamp of "10:33 am".

- Top Screenshot:** The message is in the "Promotions" label. The navigation tabs at the top are "Primary", "Social", and "Promotions".
- Middle Screenshot:** The message is in the "Social" label. The navigation tabs are "Primary", "Social", and "Promotions".
- Bottom Screenshot:** The message is in the "Social" label. The search bar contains "label:social". The navigation tabs are "Inbox", "Promotions", and "Social".

The bottom screenshot also shows a toolbar with various actions: a checkmark, "Remove label", a warning icon, a trash icon, a folder icon, a tag icon, "More", navigation arrows, a keyboard icon, and a settings icon.



# slightly surprising behavior #5

The image shows a sequence of four screenshots from a Gmail inbox, illustrating a specific behavior with email labels. The email in question is from Alyssa P. Hacker, titled "buy this! - My new JS book is out", and is highlighted in yellow.

- Top Screenshot:** The email is in the "Social" tab. The "Promotions" label is visible in the header, but it is not yet assigned to the email.
- Second Screenshot:** The "Promotions" label is now assigned to the email, indicated by a green highlight on the label.
- Third Screenshot:** The search filter is set to "label:social". The "Social" label is assigned to the email, indicated by a blue highlight.
- Bottom Screenshot:** The search filter is set to "label:promotions". The "Promotions" label is assigned to the email, indicated by a green highlight.

Between the third and fourth screenshots, a toolbar is visible with the following elements from left to right: a checkmark icon, a "Remove label" button, a warning icon, a trash icon, a folder icon, a tag icon, a "More" dropdown menu, left and right navigation arrows, a keyboard icon, and a settings gear icon.

# slightly surprising behavior #5

The image shows a sequence of four Gmail interface states. Each state displays a message from Alyssa P. Hacker with the subject "buy this! - My new JS book is out" and the time "10:33 am".

- State 1:** The message is in the "Promotions" tab. The "Social" tab is selected in the top navigation bar.
- State 2:** The message is in the "Social" tab. The "Promotions" tab is selected in the top navigation bar.
- State 3:** The message is in the "Social" tab. The "Promotions" tab is selected in the top navigation bar. The search bar contains "label:social".
- State 4:** The message is in the "Social" tab. The "Promotions" tab is selected in the top navigation bar. The search bar contains "label:social label:promotions".

At the bottom of the interface, a search result message states: "No messages matched your search. Try using [search options](#) such as sender, date, size and more."

## question

when you grow a design by adding a concept,  
how can you ensure its integrity is preserved?

## related question

given a design comprising some concepts,  
how can you tell if the concepts are mutually consistent?

## a really simple answer

1. interpret composite behavior in terms of concept actions
2. check that each behavior satisfies each concept's OP and spec

## notes

really saying: consistent if you can find an interpretation s.t. ...  
can attribute blame when one concept breaks another

# slightly surprising behavior #1

The screenshot shows a Gmail interface in a browser window. The address bar displays 'mail.google.com'. The search bar contains 'in:sent'. Below the search bar, there are several action buttons: 'Move to Inbox', 'More', and navigation arrows. On the left, a sidebar shows 'COMPOSE' and a list of folders: 'Inbox', 'Starred', 'Sent Mail', 'Drafts', 'Trash', and 'Categories'. The main content area shows search results for 'javascript' with two tabs: 'Inbox' and 'hacking'. The first result is from 'Alyssa P. Hacker' with the subject 'Reminds you of the old days, eh?' and a timestamp of '9:14 PM (33 minutes ago)'. The second result is from 'Ben Bitdiddle' with the subject 'Yes, it does.' and a timestamp of '9:40 PM (7 minutes ago)'. The email body for the second result is visible, showing 'to Alyssa' and 'Yes, it does.'

mail.google.com

Google

in:sent

Gmail

COMPOSE

Inbox

Starred

Sent Mail

Drafts

Trash

Categories

javascript

Inbox x hacking x

Alyssa P. Hacker Reminds you of the old days, eh? 9:14 PM (33 minutes ago)

Ben Bitdiddle <benito.bitdiddle@gmail.com> 9:40 PM (7 minutes ago)

to Alyssa

Yes, it does.

# slightly surprising behavior #1

The screenshot shows a Gmail interface with a search bar containing 'in:sent'. Below the search bar, there are several action buttons: 'Move to Inbox', 'More', and navigation arrows. The email list shows two entries:

- Alyssa P. Hacker** Reminds you of the old days, eh? 9:14 PM (33 minutes ago)
- Ben Bitdiddle** <benito.bitdiddle@gmail.com> 9:40 PM (7 minutes ago)  
to Alyssa  
Yes, it does.

The left sidebar shows navigation options: 'COMPOSE', 'Inbox', 'Starred', 'Sent Mail', 'Drafts', 'Trash', and 'Categories'.

violates Label's operational principle:  
**not** mark(m,p) ... search(p):ms  $\Rightarrow$  m **not in** ms

# slightly surprising behavior #1

The screenshot shows a Gmail interface with the search bar containing 'in:sent'. The left sidebar lists 'COMPOSE', 'Inbox', 'Starred', 'Sent Mail', 'Drafts', 'Trash', and 'Categories'. The main content area shows a conversation titled 'javascript' with two tabs: 'Inbox' and 'hacking'. The first email is from 'Alyssa P. Hacker' with the subject 'Reminds you of the old days, eh?' and a timestamp of '9:14 PM (33 minutes ago)'. The second email is a reply from 'Ben Bitdiddle' to Alyssa, with the subject 'Yes, it does.' and a timestamp of '9:40 PM (7 minutes ago)'. The reply button is visible next to the second email.

violates Label's operational principle:  
**not** mark(m,p) ... search(p):ms  $\Rightarrow$  m **not in** ms

attribute blame to Conversation

# slightly surprising behavior #2

The screenshot shows an email client interface. At the top, there are three tabs: 'Primary' (selected), 'Social', and 'Promotions'. Below the tabs, a search bar contains the text 'label:hacking label:meetups'. To the right of the search bar are icons for a grid, a notification bell, and a profile circle with the letter 'B'. Below the search bar, there are several action buttons: a square icon with a dropdown arrow, a refresh icon, a 'More' button with a dropdown arrow, a keyboard icon with a dropdown arrow, and a settings gear icon with a dropdown arrow. At the bottom of the interface, a message reads: 'No messages matched your search. Try using [search options](#) such as sender, date, size and more.'

# slightly surprising behavior #2

The screenshot shows an email client interface. At the top, there are tabs for 'Primary', 'Social', and 'Promotions'. Below the tabs, a search bar contains the query 'label:hacking label:meetups'. To the right of the search bar are icons for a grid, a notification bell, and a profile icon 'B'. Below the search bar, there are buttons for 'More', a refresh icon, and a keyboard icon. At the bottom, a message states: 'No messages matched your search. Try using [search options](#) such as sender, date, size and more.'

violates nothing: expected behavior of Label and Conversation



# slightly surprising behavior #4

The image shows a Gmail interface with a search filter 'label:todo' applied. The top navigation bar includes a checkbox, a refresh button, a 'More' dropdown, '1-2 of 2' items, navigation arrows, a keyboard icon, and a settings gear. Below this, a message list is visible with two entries: 'me, Alyssa (13)' with labels 'hacking', 'meetups', 'todo', and 'javascript - Hello a'; and 'Andy from Google' with a yellow 'Updates' label and the subject 'Ben, welcome to your new Googl'. The bottom navigation bar is identical to the top one. A search bar at the top of the message list contains 'label:todo' and a search button. To the right of the search bar are icons for a grid, a notification bell, and a profile picture with the letter 'B'. Below the message list, a message states: 'There are no conversations with this label.'

1-2 of 2

Empty Trash now (messages that have been in Trash more than 30 days will be automatically deleted)

<input type="checkbox"/>		me, Alyssa (13)	hacking	meetups	todo	javascript - Hello a	11:48 am
<input type="checkbox"/>		<b>Andy from Google</b>	Updates	<b>Ben, welcome to your new Googl</b>			9:01 am

label:todo

There are no conversations with this label.

# slightly surprising behavior #4

The screenshot shows the Gmail interface. At the top, there are navigation buttons: a checkbox with a dropdown, a refresh button, and a 'More' button. To the right, it says '1-2 of 2' with left and right arrow buttons, a keyboard icon, and a settings gear icon. Below this is a message in blue text: 'Empty Trash now (messages that have been in Trash more than 30 days will be automatically deleted)'. The main area shows two email snippets. The first is from 'me, Alyssa (13)' with labels 'hacking', 'meetups', and 'todo', and a subject 'javascript - Hello a'. The second is from 'Andy from Google' with a label 'Updates' and a subject 'Ben, welcome to your new Googl'. Below the snippets is a search bar containing 'label:todo' and a search button. To the right of the search bar are icons for a grid, a notification bell, and a profile picture 'B'. At the bottom, there are more navigation buttons: a checkbox with a dropdown, a refresh button, and a 'More' button. To the right, there is a keyboard icon and a settings gear icon. Below these buttons, a message states: 'There are no conversations with this label.'

violates Label's operational principle:  
 $\text{mark}(m,p) \dots \text{search}(p):ms \Rightarrow m \text{ in } ms$

# slightly surprising behavior #4

The screenshot shows the Gmail interface. At the top, there are navigation buttons: a checkbox with a dropdown, a refresh button, and a 'More' button. To the right, it says '1-2 of 2' with left and right arrow buttons, a keyboard icon, and a settings gear icon. Below this is a message list with two entries:

- Message 1: Sender 'me, Alyssa (13)', subject 'hacking meetups todo javascript - Hello a', time '11:48 am'. It has a trash icon and a checkbox.
- Message 2: Sender 'Andy from Google', subject 'Updates Ben, welcome to your new Googl', time '9:01 am'. It has a trash icon and a checkbox.

Below the message list is a search bar containing 'label:todo' and a search button. To the right of the search bar are icons for a grid, a notification bell, and a profile picture 'B'. Below the search bar is another set of navigation buttons: a checkbox with a dropdown, a refresh button, and a 'More' button. To the right, there is a keyboard icon and a settings gear icon. At the bottom of the search results area, it says 'There are no conversations with this label.'

violates Label's operational principle:  
 $\text{mark}(m,p) \dots \text{search}(p):ms \Rightarrow m \text{ in } ms$

attribute blame to Trash

# slightly surprising behavior #5

label:social

Remove label

Inbox Promotions Social buy this! - My ne 10:33 am

label:promotions

Remove label

Inbox Promotions Social buy this! - My ne 10:33 am

label:social label:promotions

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

Detailed description: The image shows three sequential screenshots of a Gmail search interface. The first screenshot shows a search for 'label:social' with a single message from Alyssa P. Hacker. The message has three labels: 'Inbox' (grey), 'Promotions' (green), and 'Social' (blue). The second screenshot shows a search for 'label:promotions' with the same message. The third screenshot shows a search for 'label:social label:promotions' with no results. The interface includes a search bar, navigation buttons (checkbox, Remove label, folder, tag, More, arrows, keyboard, settings), and a message list with sender, subject, and time information.

# slightly surprising behavior #5

The image displays three sequential screenshots of an email client's search interface. Each screenshot shows a search bar at the top with a search filter, a search button, and navigation icons. Below the search bar is a toolbar with various actions like 'Remove label', 'Inbox', 'Promotions', and 'Social'. The search results are shown in a list format with a yellow highlight.

**Screenshot 1:** Search filter: `label:social`. Search results: Alyssa P. Hacker, buy this! - My nev, 10:33 am. Labels: `Inbox`, `Promotions`, `Social`.

**Screenshot 2:** Search filter: `label:promotions`. Search results: Alyssa P. Hacker, buy this! - My nev, 10:33 am. Labels: `Inbox`, `Promotions`, `Social`.

**Screenshot 3:** Search filter: `label:social label:promotions`. Search results: No messages matched your search. Try using [search options](#) such as sender, date, size and more.

violates Label's spec

# slightly surprising behavior #5

The image displays three screenshots of an email client's search interface, illustrating a specific behavior. Each screenshot shows a search bar with a query, a search button, and a list of messages.

- Top Screenshot:** Search query is `label:social`. The message list shows a message from Alyssa P. Hacker with labels `Inbox`, `Promotions`, and `Social`. The subject is "buy this! - My ne" and the time is "10:33 am".
- Middle Screenshot:** Search query is `label:promotions`. The message list shows the same message from Alyssa P. Hacker with labels `Inbox`, `Promotions`, and `Social`.
- Bottom Screenshot:** Search query is `label:social label:promotions`. The message list is empty, with a message: "No messages matched your search. Try using [search options](#) such as sender, date, size and more."

violates Label's spec

attribute blame to Category

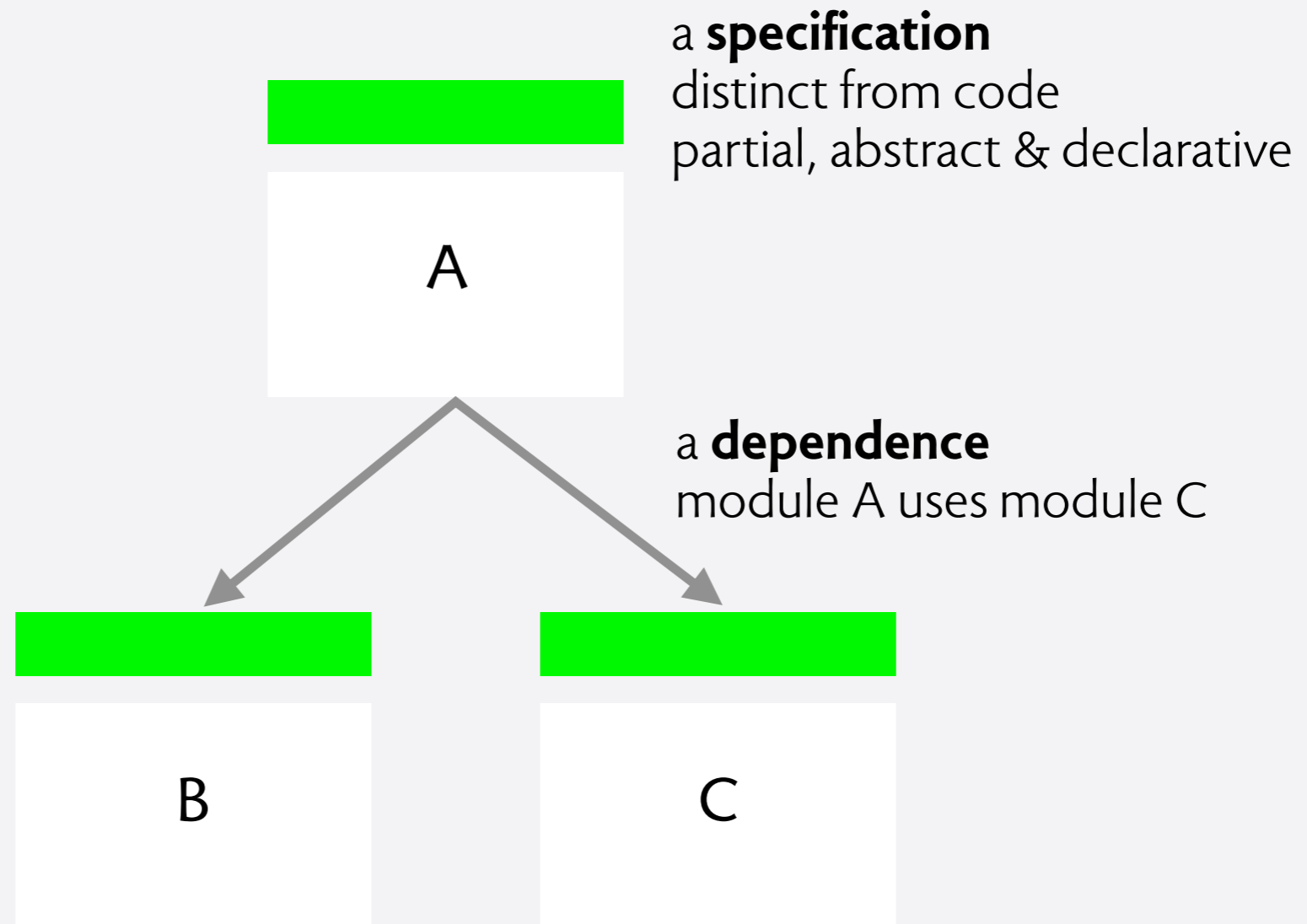
# table of interactions

	Label	Category	Conversation	Trash
Label	-	breaks spec	breaks OP	breaks OP
Category	breaks spec	-	breaks spec	
Conversation			-	breaks OP
Trash				-

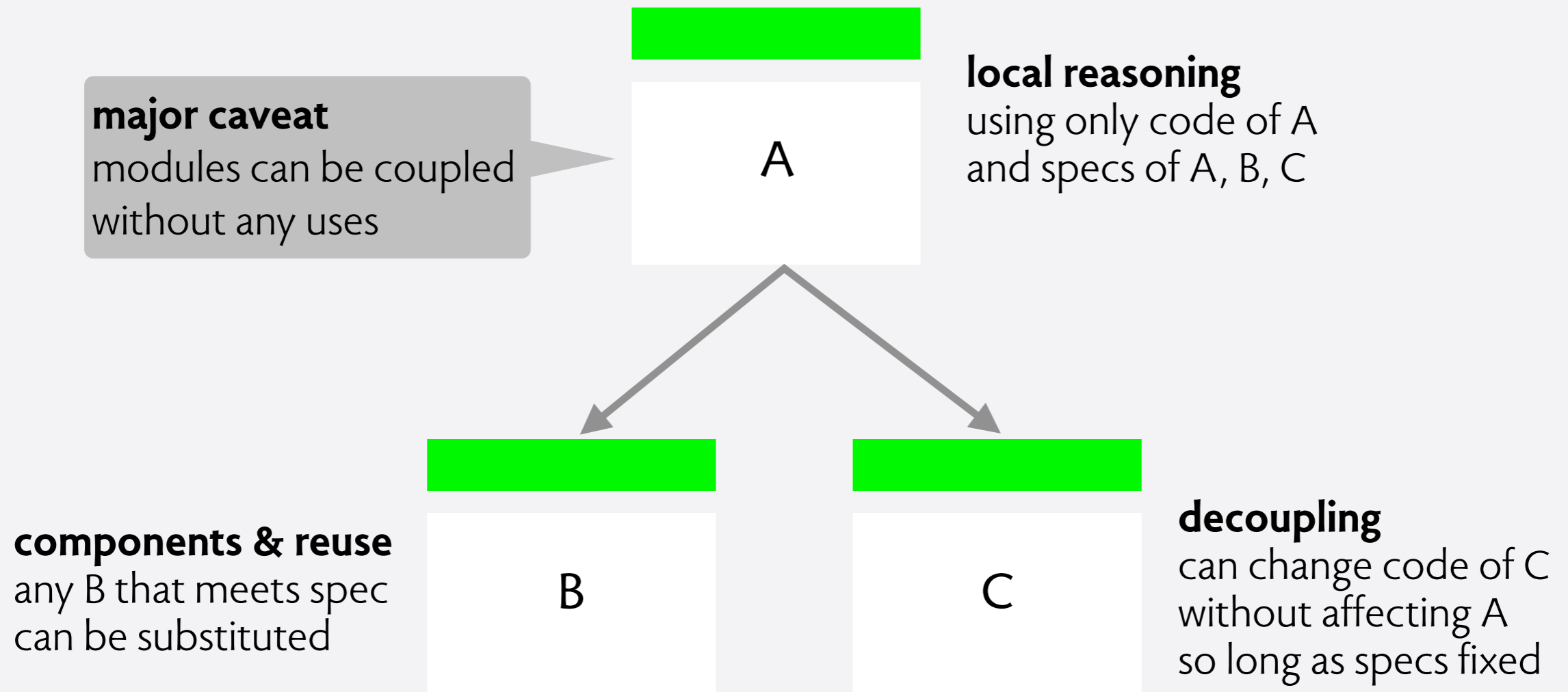
addendum:  
on specs



# what is a specification?



# what specifications gave us



# some specs matter more



## **top level specification**

determines the impact  
of the software in the world

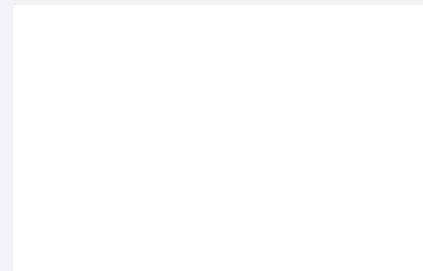
# separating concerns



**need**  
the motivation for  
building the system

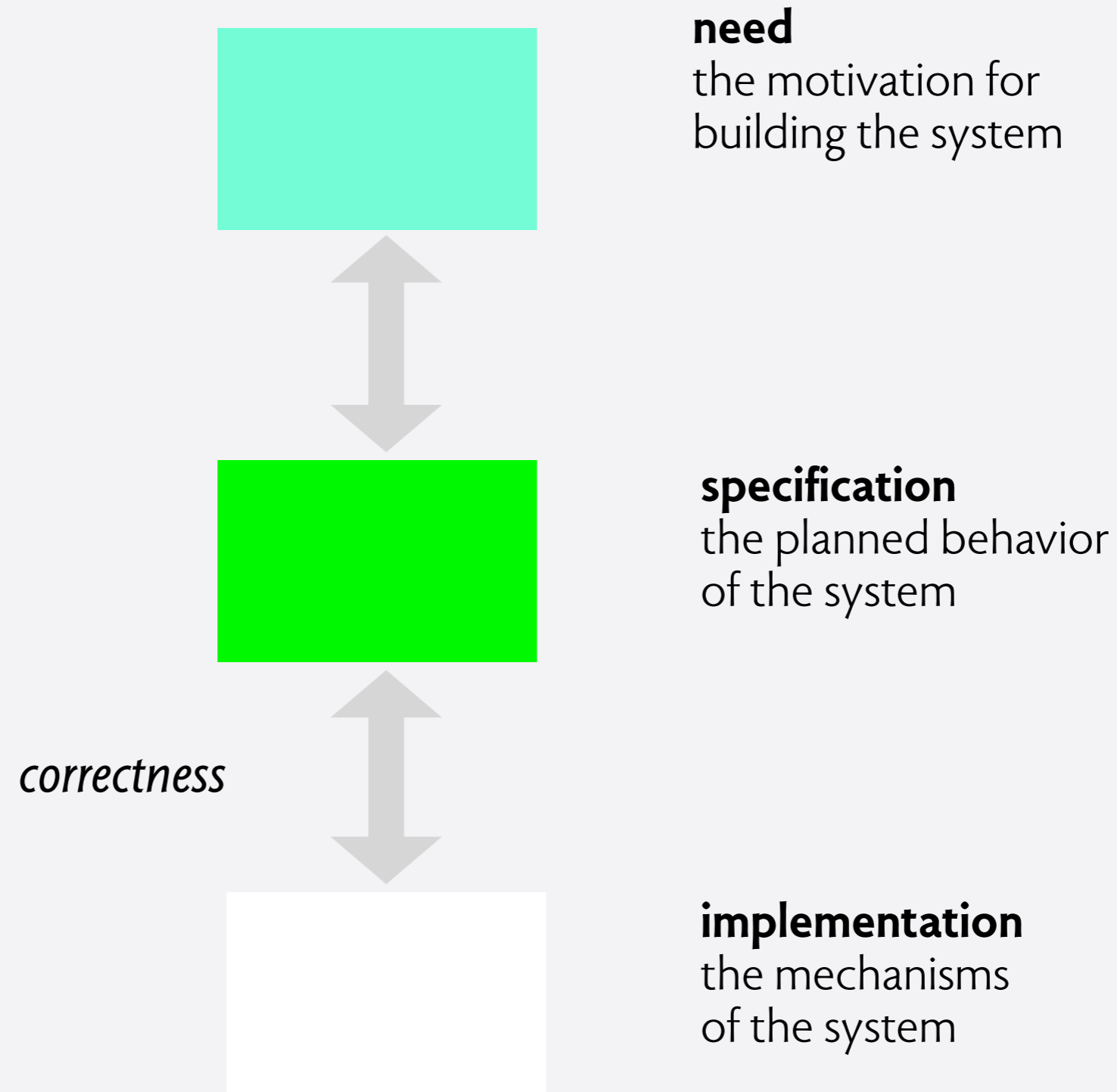


**specification**  
the planned behavior  
of the system

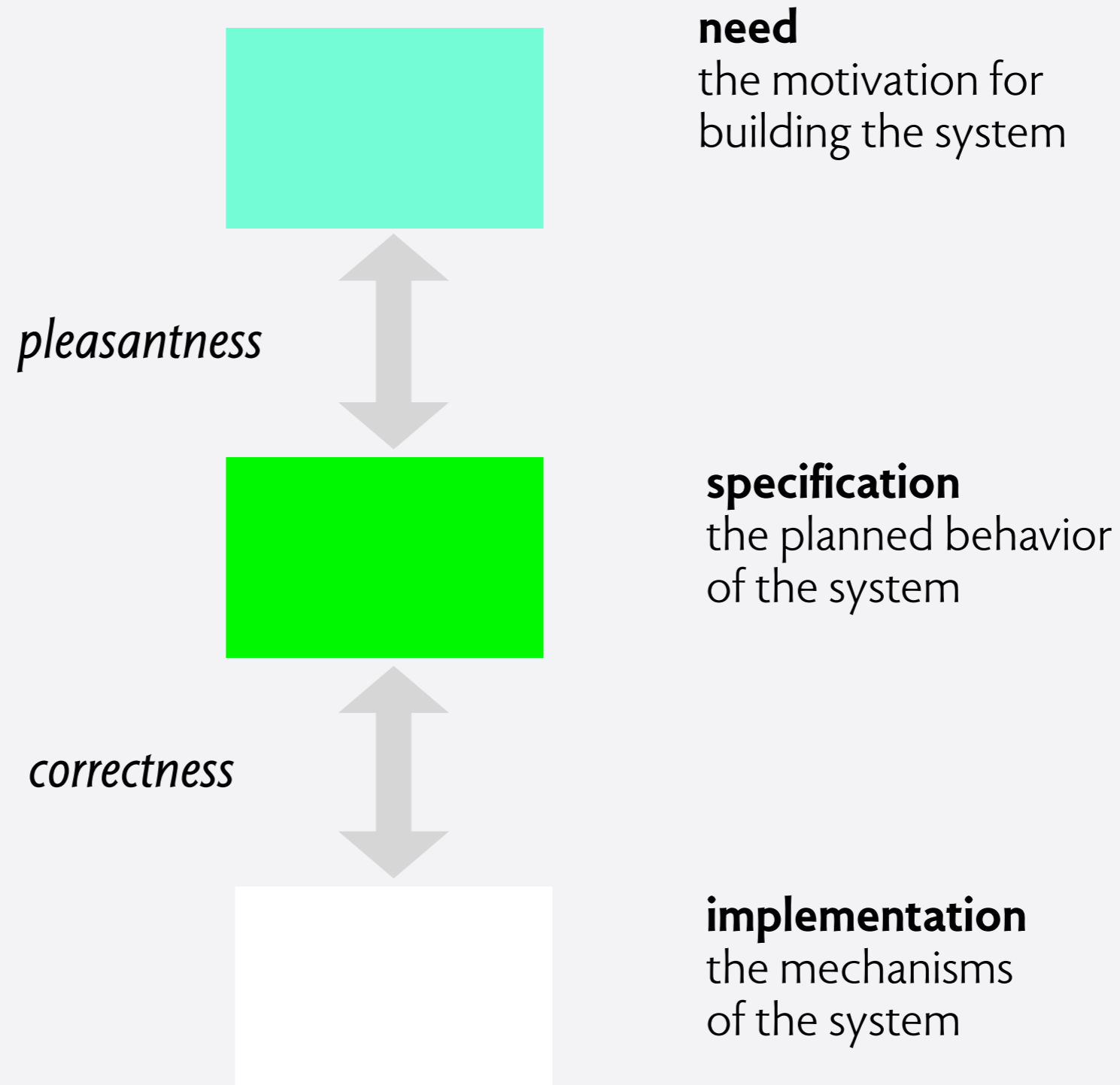


**implementation**  
the mechanisms  
of the system

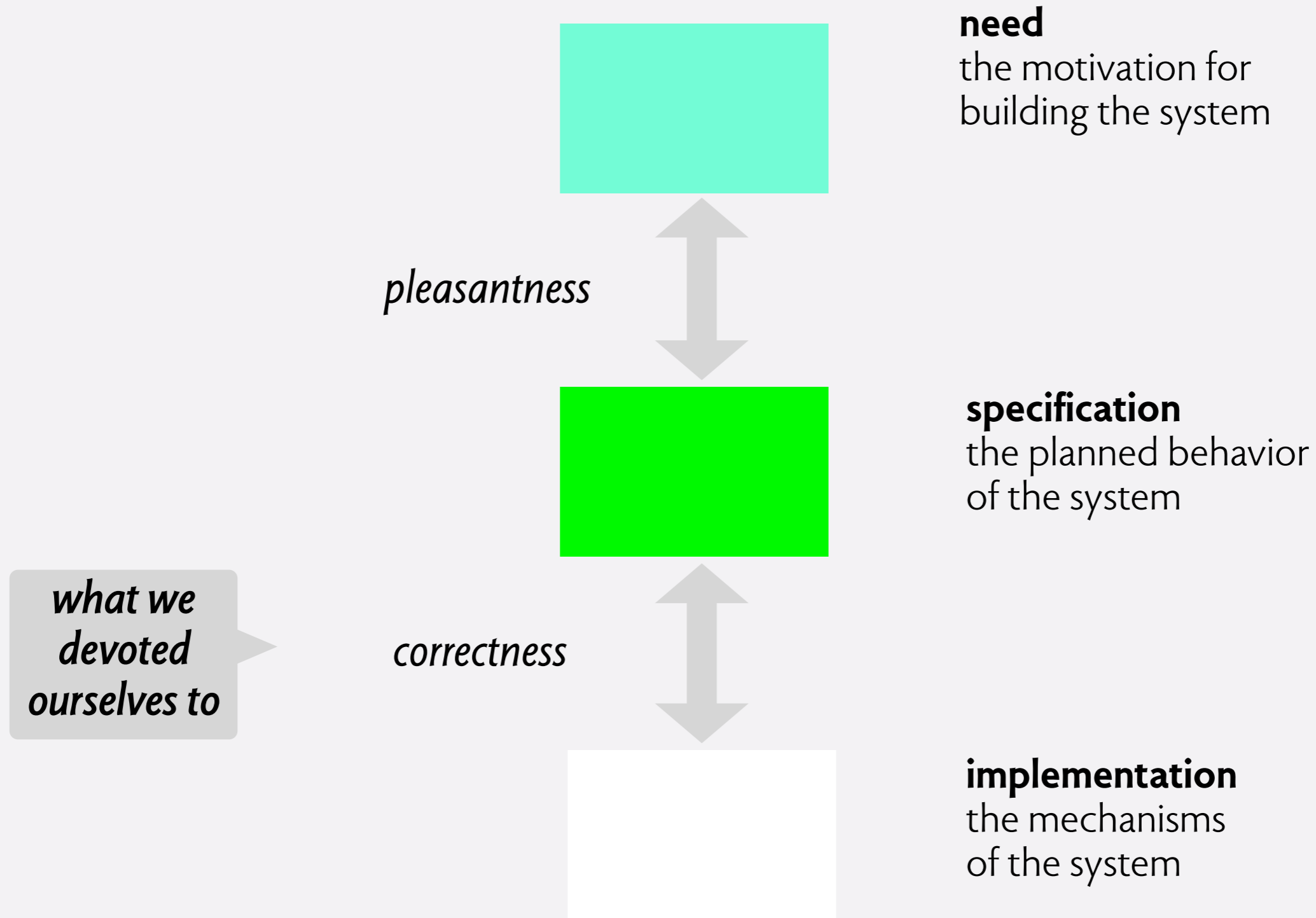
# separating concerns



# separating concerns



# separating concerns



# separating concerns

