what are the elements of software design?

Daniel Jackson · MIT

Northwestern University · Chicago · February 29, 2016
three software design problems
#1 email categories
gmail's categories

<table>
<thead>
<tr>
<th>Primary</th>
<th>Social</th>
<th>Promotions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keith Muhammad at DeMont.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AT&amp;T High Speed Internet.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keith Muhammad at DeMont.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>betterbatonrougejobs.com</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Email</th>
<th>Subject</th>
<th>Details</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google</td>
<td>New sign-in from Chrome on Mac</td>
<td>New sign-in from Chrome</td>
<td>12:30 pm</td>
</tr>
<tr>
<td>Keith Muhammad at DeMont.</td>
<td>DeMontrond Auto Group</td>
<td>14101 North Freeway Houston</td>
<td>12:19 pm</td>
</tr>
<tr>
<td>AT&amp;T High Speed Internet.</td>
<td>AT&amp;T High Speed Internet Service Activation</td>
<td>Your AT&amp;T High Speed Internet Service Activation</td>
<td>10:37 am</td>
</tr>
<tr>
<td>Keith Muhammad at DeMont.</td>
<td>DeMontrond Auto Group</td>
<td>14101 North Freeway Houston</td>
<td>Aug 26</td>
</tr>
<tr>
<td>betterbatonrougejobs.com</td>
<td>Job Update -- 2015-08-26</td>
<td>Looking For An Advantage</td>
<td>Aug 26</td>
</tr>
</tbody>
</table>
Choose which message categories to show as inbox tabs. Other messages will appear in the Primary tab.
some reactions
Everything You Need to Know About Gmail's New, Super-Confusing Layout

Melanie Pinola

Filed to: GMAIL  6/07/13 9:00am

301,482  12  ★

some reactions
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!
Like many Gmail users, I greeted the news of the introduction of tabs to the interface with a degree of anticipation -- now it was just a matter of waiting for the feature to roll out so I could try it for myself. Earlier today I was randomly signed out of my Gmail account, and after signing back in and checking the settings menus, I could see that tabs were now available to me. Excitement was short-lived, however; it quickly became apparent that this new feature is a disaster.
categories? labels?
Why the Tabs Are So Confusing

The tabs do give you a convenient way to automatically sort your inbox according to Gmail's preset categories and get notifications at a glance for when new emails come in.

However, the tabbed view introduces a new, not-so-clear element in Gmail called "categories."
Why the Tabs Are So Confusing

The tabs do give you a convenient way to automatically sort your inbox according to Gmail's preset categories and get notifications at a glance for when new emails come in. However, the tabbed view introduces a new, not-so-clear element in Gmail called "categories."

The problem is, you already have labels that *also* match these categories. Gmail, for example, adds Social Updates, Promotions, and Forums as SmartLabels in the left menu. The "Notifications" SmartLabel corresponds to the Updates tab (I wonder why they didn't just call the tab Notifications), but

**SmartLabels are not the same as Categories.** Gmail's pre-designed SmartLabel filters makes it seem like that, but they're really two different things.
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
what you can’t do

associate tabs with labels
feature available only for categories
what you can’t do

associate tabs with labels
feature available only for categories

use tabs outside inbox
tabs disappear when you filter on a label
#2 camera settings
my camera fuji x100s
image quality setting
image quality setting
image quality setting
aspect ratio
aspect ratio
image size setting
image size setting

<table>
<thead>
<tr>
<th>Format</th>
<th>Width</th>
<th>Height</th>
<th>Frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>L 3:2</td>
<td>664</td>
<td>681</td>
<td>681</td>
</tr>
<tr>
<td>L 16:9</td>
<td>702</td>
<td>719</td>
<td>719</td>
</tr>
<tr>
<td>L 1:1</td>
<td>707</td>
<td>734</td>
<td>734</td>
</tr>
<tr>
<td>M 3:2</td>
<td>746</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
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<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S 3:2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4896x3264 (16M) 664 FRAMES
<table>
<thead>
<tr>
<th>Image Size</th>
<th>Frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:2</td>
<td>664</td>
</tr>
<tr>
<td>16:9</td>
<td>681</td>
</tr>
<tr>
<td>1:1</td>
<td>702</td>
</tr>
<tr>
<td>3:2</td>
<td>707</td>
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<td>1:1</td>
<td>734</td>
</tr>
<tr>
<td>3:2</td>
<td>746</td>
</tr>
</tbody>
</table>

3264x3264 (11M) 702 FRAMES
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!
#3 fonts & styles
what’s a font?
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
what kind of problems are these?
what kind of problems are these?

minor nitpicks?
in all cases, can’t do useful things
what kind of problems are these?

**minor nitpicks?**
in all cases, can’t do useful things

**coding bugs?**
code seems to meet a coherent spec
what kind of problems are these?

minor nitpicks?
in all cases, can’t do useful things

coding bugs?
code seems to meet a coherent spec

user interface flaws?
interfaces are clear and faithful to function
research goals
elements of software design?
elements of software design?

designer

engineer
elements of software design?

<table>
<thead>
<tr>
<th>building</th>
<th>designer</th>
<th>engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>facade, entry flow, access, light</td>
<td>beam, wall structural integrity</td>
</tr>
</tbody>
</table>
### elements of software design?

<table>
<thead>
<tr>
<th></th>
<th>designer</th>
<th>engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>building</td>
<td>facade, entry flow, access, light</td>
<td>beam, wall structural integrity</td>
</tr>
<tr>
<td>software</td>
<td>function, datatype decoupling, localization</td>
<td></td>
</tr>
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### elements of software design?

<table>
<thead>
<tr>
<th></th>
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<td>software</td>
<td>?</td>
<td>function, datatype decoupling, localization</td>
</tr>
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</table>
what’s an app about?
what characterizes an app?

Apple Mail
Microsoft Word
Twitter
Photoshop
what characterizes an app?

concepts!

Apple Mail
Microsoft Word
Twitter
Photoshop
what characterizes an app?

concepts!

Apple Mail

Microsoft Word

Twitter

Photoshop

EmailAddress
Message
Folder or Label
what characterizes an app?

concepts!

Apple Mail
- Email Address
- Message
- Folder or Label

Microsoft Word
- Paragraph
- Format
- Style

Twitter

Photoshop
what characterizes an app?

concepts!

Apple Mail
- Email Address
- Message
- Folder or Label

Microsoft Word
- Paragraph
- Format
- Style

Twitter
- Tweet
- Hashtag
- Following

Photoshop
what characterizes an app?

concepts!

Apple Mail
- EmailAddress
- Message
- Folder or Label

Microsoft Word
- Paragraph Format Style

Twitter
- Tweet
- Hashtag
- Following

Photoshop
- PixelMap
- Layer/Mask
- Adjustment
concepts define classes
concepts define classes
concepts define classes

text editor

word processor
concepts define classes

text editor

word processor

desktop publishing app

waffling about concepts and fine points of design
concepts define classes

text editor
  line
  buffer

word processor

desktop publishing app

waffling about concepts and fine points of design
concepts define classes

text editor
  line
  buffer

word processor
  paragraph
  format
  style

desktop publishing app
  waffling about concepts
  and fine points of design
concepts define classes

text editor
  line
  buffer

word processor
  paragraph
  format
  style

desktop publishing app
  stylesheet
  text flow
  page template

waffling about concepts and fine points of design
concepts define classes

- 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?
where are Word’s concepts from?
where are Word’s concepts from?
where are Word’s concepts from?

Charles Simonyi: brought key concepts to Word from Xerox PARC
rich concepts have long journeys
rich concepts have long journeys

Ginn & Co, since 1868
rich concepts have long journeys

Ginn & Co, since 1868

Bravo, 1974
rich concepts have long journeys

Ginn & Co, since 1868

Bravo, 1974

Microsoft Word, 1983
rich concepts have long journeys
kinds of concept
kinds of concept

given concepts
  electoral vote
  reservation
  social security number
  calendar event
kinds of concept

given concepts
- electoral vote
- reservation
- social security number
- calendar event

instrumental concepts
- hashtag
- label
- friend
- follower
kinds of concept

<table>
<thead>
<tr>
<th>given concepts</th>
<th>instrumental concepts</th>
<th>enabling concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>electoral vote</td>
<td>hashtag</td>
<td>relative reference</td>
</tr>
<tr>
<td>reservation</td>
<td>label</td>
<td>public key</td>
</tr>
<tr>
<td>social security number</td>
<td>friend</td>
<td>layer mask</td>
</tr>
<tr>
<td>calendar event</td>
<td>follower</td>
<td>conference call</td>
</tr>
</tbody>
</table>
kinds of concept

even these were invented

given concepts
- electoral vote
- reservation
- social security number
- calendar event

instrumental concepts
- hashtag
- label
- friend
- follower

enabling concepts
- relative reference
- public key
- layer mask
- conference call
kinds of concept

**given concepts**
- electoral vote
- reservation
- social security number
- calendar event

**instrumental concepts**
- hashtag
- label
- friend
- follower

**enabling concepts**
- relative reference
- public key
- layer mask
- conference call

even these were invented
analogical, or new
even these were invented

- electoral vote
- reservation
- social security number
- calendar event

analogue, or new

- hashtag
- label
- friend
- follower

solve a hard design problem

- relative reference
- public key
- layer mask
- conference call
concepts are machines
example word styles
concept model word styles

Diagram:

- **Document** with a property `sheet` that refers to **Stylesheet**.
- **Stylesheet** has a property `styles`.
- **Style** has a property `name` and `rules` that refer to **StyleName**.
- **Style** also has a property `overrides` that refers to **Rule**.
- **Rule** has properties `property` and `value`.
- **Paragraph** has a property `paras` that refers to **Style**.
  - **Style** has a property `style` that refers to **Rule**.
  - **Rule** has a property `overrides` that refers to **Property**.
There is no problem in computer science that cannot be solved by introducing another level of indirection. *David Wheeler*
concept model word styles

- Document
  - sheet
  - paras
  - style
  - overrides

- Stylesheet
  - styles

- Style
  - name
  - rules
  - basedOn
  - overrides

- Paragraph
- Rule
  - property
  - value

- Property
- Value

operations
- add
- delete
- modify
- update
- apply
concept characteristics
concept characteristics

concepts are closed
state & all relevant operations
concept characteristics

concepts are closed
state & all relevant operations

concepts are situated
not awaiting composition
so a concept is not ...
so a concept is not ...
so a concept is not ...
so a concept is not ...
apps are concept families
concept dependences
concept dependences

\[ \langle c, c' \rangle \in \text{depends} \iff \forall a: \text{apps} \cdot c \in \text{concepts}(a) \Rightarrow c' \in \text{concepts}(a) \]
concept dependences

\[ \langle c, c' \rangle \in \text{depends} \iff \forall a : \text{apps} \cdot c \in \text{concepts}(a) \implies c' \in \text{concepts}(a) \]
concept dependences

\[ \langle c, c' \rangle \in \text{depends} \iff \forall a: \text{apps} \cdot c \in \text{concepts}(a) \Rightarrow c' \in \text{concepts}(a) \]
\[ \langle c, c' \rangle \in \text{depends} \iff \forall a: \text{apps} \cdot c \in \text{concepts}(a) \Rightarrow c' \in \text{concepts}(a) \]
concept dependences

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concept dependences

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concept dependences

\[ \langle c, c' \rangle \in \text{depends} \iff \forall a: \text{apps} \cdot c \in \text{concepts}(a) \Rightarrow c' \in \text{concepts}(a) \]
generic concepts
other instantiations style

Powerpoint schemes

Indesign swatches
style generic concept

Element → Style

Style → Rule

Rule → Value

Value → Property
style generic concept

Element \rightarrow_{\text{style}} \text{Style} \rightarrow \text{Rule} \rightarrow \text{Value} \rightarrow_{\text{property}} \text{Property}

base
Element \(\rightarrow\) Style

Style \(\rightarrow\) Rule

Rule \(\rightarrow\) Value

Property

Stylesheet \(\rightarrow\) Style

Style \(\rightarrow\) Stylesheet

Style \(\rightarrow\) Style

Style \(\rightarrow\) Name

Name

Add ons: basedOn, next, styles
style generic concept

Root concept diagram:
- **Element** styles **Style**
- **Style** has **rules**
- **Rule** has **property** and **value**
  - **Property** can have **property**
  - **Value** can have **value**

Add-ons:
- **Stylesheet** styles **Style**
  - **Style** has **basedOn** and **next**
  - **Name** has **name**

Variants:
- **Element** styles **Name**
# generic concept parts

<table>
<thead>
<tr>
<th>part</th>
<th>example</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td><strong>Style</strong></td>
</tr>
<tr>
<td>purpose</td>
<td>make it easy to maintain consistent format across set of elements</td>
</tr>
<tr>
<td>sample uses</td>
<td>Text formatting in word processors/layout apps (Word, Indesign, Pages, etc); rules in CSS; color themes in Powerpoint.</td>
</tr>
<tr>
<td>model</td>
<td><em>base, add-ons, variants</em></td>
</tr>
<tr>
<td>operations</td>
<td>add, delete, modify, apply, update</td>
</tr>
<tr>
<td>related to</td>
<td><strong>StyleBuffer, Stencil, Master</strong></td>
</tr>
<tr>
<td>issues</td>
<td>optional rules problem</td>
</tr>
</tbody>
</table>
concept selection
concept selection

slides in Keynote
concept selection

slides in Keynote

photos in Adobe Lightroom
concept selection

slides in Keynote

photos in Adobe Lightroom

messages in Apple Mail
concept selection

- slides in Keynote
- photos in Adobe Lightroom
- messages in Apple Mail
- notes in Evernote
concept selection

slides in Keynote

photos in Adobe Lightroom

messages in Apple Mail

thumbnails in Preview

notes in Evernote
concept selection

slides in Keynote
photos in Adobe Lightroom
messages in Apple Mail
objects in OS X Finder
thumbnails in Preview
notes in Evernote
subtlety selection scope

subset of selection in scope

subset of selection out of scope
Adobe Lightroom: brightest thumbnail is the “active photo”
subtlety continuous selection

Photoshop: outline shown with “marching ants”
Photoshop: outline shown with “marching ants”

Photoshop: selection shown in Quick Mask mode
Google Drive: selecting folder = selecting children
subtlety folder selection

Google Drive: selecting folder = selecting children

CrashPlan: selecting folder = selecting all future children
Purposes: apply action in aggregate to many items at once
## concept catalog (so far)

<table>
<thead>
<tr>
<th>instantiate</th>
<th>organize</th>
<th>relate</th>
<th>resource</th>
<th>save</th>
<th>communicate</th>
<th>personalize</th>
</tr>
</thead>
<tbody>
<tr>
<td>stylesheet</td>
<td>selection</td>
<td>friend</td>
<td>access token</td>
<td>history</td>
<td>message</td>
<td>account</td>
</tr>
<tr>
<td>master</td>
<td>folder</td>
<td>clique</td>
<td>notification</td>
<td>buffer</td>
<td>posting</td>
<td>karma</td>
</tr>
<tr>
<td>stencil</td>
<td>group</td>
<td>invitation</td>
<td>reservation</td>
<td>cursor</td>
<td>OOB A</td>
<td>rating</td>
</tr>
<tr>
<td>style buffer</td>
<td>label</td>
<td>REST</td>
<td>sync</td>
<td>export</td>
<td>status</td>
<td></td>
</tr>
<tr>
<td>style buffer</td>
<td>layer</td>
<td>cart</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>style buffer</td>
<td>stack</td>
<td>subscription</td>
<td></td>
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<tr>
<td></td>
<td>alias</td>
<td>purchase order</td>
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<td>preset</td>
<td>RMA</td>
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<td>coupon</td>
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<tr>
<td></td>
<td>metadata</td>
<td></td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>
designing
on purpose
design is driven by purpose
design is driven by purpose
design is driven by purpose

purpose

motivates
design is driven by purpose

- purpose
  - motivates
  - contrivance
design is driven by purpose

purpose

motivates

fulfills?

contrivance
design is driven by purpose

- purpose
- motivates
- fulfills?
- contrivance
- misfit
design is driven by purpose

purpose

motivates

fulfills?

contrivance

misfit

✘

not a counterexample
example: a photo wall
example: a photo wall

changeable wall
display of prints
example: a photo wall

changeable wall display of prints

motivates
example: a photo wall

changeable wall display of prints

motivates
corkboard tiles
example: a photo wall

changeable wall display of prints

motivates

adhesive corners
corkboard tiles
example: a photo wall

- changeable wall display of prints
  - motivates
  - adhesive corners
  - corkboard tiles
  - magnetic paint
example: a photo wall

changeable wall display of prints

motivates

fulfills?

adhesive corners
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example: a photo wall

changeable wall
display of prints

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fulfills?

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magnetic paint

not strong enough
example: a photo wall

changeable wall display of prints

motivates

fulfills?

adhesive corners
not strong enough

not strong enough

corkboard tiles

 damages prints

magnetic paint

not strong enough

not strong enough

not strong enough
example: a photo wall

changeable wall display of prints

motivates

fulfills?

adhesive corners

✔

corkboard tiles

✘

magnetic paint

✔

not strong enough

damages prints
as implemented
refining the purpose with misfits

changeable wall display of prints

motivates

adhesive corners
corkboard tiles

fulfills?
refining the purpose with misfits

changeable wall display of prints

strong enough

motivates

fulfills?

adhesive corners

corkboard tiles

✘

✘
refining the purpose with misfits

changeable wall display of prints

motivates

fulfills?

adhesive corners

corkboard tiles

strong enough

no damage

no damage

no damage

no damage
refining the purpose with misfits

changeable wall display of prints

motivates

fulfills?

anticipated misfits

strong enough

no damage

adhesive corners

corkboard tiles

✘

✘

no damage
refining the purpose with misfits

- adhesive corners
- corkboard tiles
- magnetic paint

changeable wall display of prints

motivates

fulfills?

strong enough

no damage

anticipated misfits
refining the purpose with misfits

changeable wall display of prints

strong enough
no damage

motivates

fulfills?

anticipated misfits

adhesive corners

✘

corkboard tiles

✘
magnetic paint

✘

blocks wifi
refining the purpose with misfits

changeable wall display of prints

motivates

fulfills?

strong enough
no damage

anticipated misfits

adhesive corners
corkboard tiles
magnetic paint

blocks wifi

unanticipated misfits
NOTES ON THE SYNTHESIS OF FORM

CHRISTOPHER ALEXANDER
Such a list of requirements is potentially endless... But if we think of the requirements from a negative point of view, as potential misfits, there is a simple way of picking a finite set.
concepts driven by purposes too

application purpose

application
concepts driven by purposes too

application purpose

concept

application
concepts driven by purposes too
concepts driven by purposes too

application purpose

concept

concept

concept
concepts driven by purposes too

application purpose

purpose

concept  concept  concept

application
concepts driven by purposes too
concepts driven by purposes too

application purpose

purpose purpose purpose

application

concept concept concept
concepts driven by purposes too
concepts driven by purposes too

application purpose

- purpose
- purpose
- purpose

motivates?
motivates?
motivates?

fulfills?
fulfills?
fulfills?

application

concept
concept
concept
concepts driven by purposes too

![Diagram showing concepts driven by purposes and motivating concepts](image-url)
example: microsoft word

create & format documents

microsoft word
example: microsoft word

create & format documents

paragraph

microsoft word
example: microsoft word

create & format documents

style  paragraph

microsoft word
example: microsoft word

create & format documents

style  paragraph  stylesheet

microsoft word
example: microsoft word

create & format documents

provide structure

motivates

microsoft word

style
paragraph
stylesheet
create & format documents

- consistency within docs
- provide structure

- style
- paragraph
- stylesheet

example: microsoft word
create & format documents

- consistency within docs
- provide structure
- consistency across docs

motivates

- style
- paragraph
- stylesheet

microsoft word
how to explain a concept
how would you explain this?
how would you explain this?
the operational principle

a way to explain a concept
the operational principle

a way to explain a concept

an archetypal scenario

separates essential from accidental aspects

shows how purpose is fulfilled

by combination of user & system actions
the operational principle
a way to explain a concept

an archetypal scenario
separates essential from accidental aspects
shows how purpose is fulfilled
by combination of user & system actions

“if you pull a tab out, then when that time slot comes around, the light will go on”
the operational principle
a way to explain a concept

an archetypal scenario
separates essential from accidental aspects
shows how purpose is fulfilled
by combination of user & system actions

“if you pull a tab out, then when that time slot comes around, the light will go on”

Michael Polanyi
“if you pull a tab out, then when that time slot comes around, the light will go on”
“if you change a style’s format, then all paragraphs of that style will change format accordingly.”

“if you pull a tab out, then when that time slot comes around, the light will go on.”
“if you change a style’s format, then all paragraphs of that style will change format accordingly”

“if you pull a tab out, then when that time slot comes around, the light will go on”

“if you tag a photo, then all friends of the person tagged will be able to see the photo”
“if you change a style’s format, then all paragraphs of that style will change format accordingly”

“if you tag a photo, then all friends of the person tagged will be able to see the photo”

“if you select some files and they belong to a folder with keyboard focus, then pressing delete will move the files to the trash”
purposes, principles & misfits
purposes, principles & misfits

concept: trash
purposes, principles & misfits

**purpose:** allow undo of deletions

**concept:** trash
purposes, principles & misfits

**Purpose**: allow undo of deletions

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

**Concept**: trash
purposes, principles & misfits

**concept:** trash

**purpose:** allow undo of deletions

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

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

**concept:** trash

**purpose:** allow undo of deletions

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

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

**misfit:** if you delete an old file and change your mind, you may not be able to find it again in the trash (if there are many deleted files and you forgot the file’s name)
characteristics of the OP
characteristics of the OP

connects to purpose
so OP for trash must include restore
characteristics of the OP

connects to purpose
so OP for trash must include restore

has sufficient span
so OP for secure trash must go up to data recovery
characteristics of the OP

connects to purpose
so OP for trash must include restore

has sufficient span
so OP for secure trash must go up to data recovery

separates essential from accidental
so OP for trash doesn’t say files disappear when eject disk
concept
design criteria
the fundamental principle
the fundamental principle in a well-designed system
the fundamental principle

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

purposes

P1 ─── C1

P2 ─── C2

concepts
4 bad smells

- Unfulfilled purpose
  - P1 - C1

- Unmotivated concept
  - P1 - C1 - C2

- Overloaded concept
  - P1 - C1

- Redundant concepts
  - P1 - C1 - C2
unfulfilled purposes
unfulfilled purposes
unfulfilled purposes

Adobe Indesign: an unfulfilled purpose
unfulfilled purposes

Adobe Indesign: an unfulfilled purpose

allow typeface independent styling
unfulfilled purposes

Adobe Indesign: an unfulfilled purpose

allow

C1

P1

P2

C2

typeface

independent

styling

subfamily
unfulfilled purposes (more)

user (Apple Mail, Gmail)  
‘identify parties to communication’  
weak search, no authentication

slide hierarchy (Powerpoint)  
‘structure slides in a tree’  
sections provide just one level

eject-after-import (Lightroom)  
‘prevent accidental writing’  
feature removed (and reinstated!)

binder (Preview, Acrobat)  
‘maintain composite PDF doc’  
can insert pages, but forgets source
unmotivated concepts
unmotivated concepts

You never poke me on Facebook anymore.
unmotivated concepts (more)
unmotivated concepts (more)

buffer (text editors)
Apple got rid of it

stash (Git)
addresses branching misfits

boxing (Java)
addresses primitives vs objects misfit

null (Javascript)
when undefined is too vague
redundant concepts
redundant concepts

category in Gmail

e a redundant concept
redundant concepts

classify messages

category

label

category in Gmail

a redundant concept
redundant concepts in acrobat
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 understand that my child may encounter the normal risks of childhood play, including grazed knees, hurt feelings and exposure to toxic waste.

Parents signature

Date
redundant concepts in acrobat

text object, text box, document text (Acrobat)
all subtly different (Acrobat 10)
merged into one (Acrobat 11)
redundant concepts in acrobat

text object, text box, document text (Acrobat)
all subtly different (Acrobat 10)
merged into one (Acrobat 11)
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]

3 forms of overloading:
- piggybacking: new purpose hacked onto old concept
- false convergence: two purposes looked the same
- emergent purpose: users found second purpose for concept
piggybacking fuji camera
new purpose hacked onto old concept
piggybacking fuji camera
new purpose hacked onto old concept

<table>
<thead>
<tr>
<th>Image Size</th>
<th>Width</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>664</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>707</td>
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</tr>
<tr>
<td>M</td>
<td>719</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>734</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>746</td>
<td></td>
</tr>
</tbody>
</table>
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
two purposes looked the same

evaluation & goal setting
incompatible purposes
false convergence

two purposes looked the same

filter incoming posts
control access to my posts
distinct purposes

2011: Facebook added subscribe/follow
emergent purpose

users found second purpose for concept
emergent purpose
users found second purpose for concept

To: Daniel Jackson <dnj@mit.edu>
Re: Catch me if you can in real life!

caption: email subject
initial purpose: summarize content
emergent purpose
users found second purpose for concept

To: Daniel Jackson <dnj@mit.edu>
Re: Catch me if you can in real life!

concept: email subject
initial purpose: summarize content

To: csail-related@lists.csail.mit.edu
Re: [csail-related] turn off the lights?

emergent purpose: show sender
nasty result (thanks to Shriram Krishnamurthi)
if you bcc a list, subject reveals to-address
emergent purpose
users found second purpose for concept

To: Daniel Jackson <dnj@mit.edu>
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concept: email subject
initial purpose: summarize content

To: csail-related@lists.csail.mit.edu
Re: [csail-related] turn off the lights?

emergent purpose: show sender
nasty result (thanks to Shriram Krishnamurthi)
if you bcc a list, subject reveals to-address

To: Daniel Jackson <dnj@mit.edu>
your trip reservation

emergent purpose: group by conversation
nasty result (thanks to Eunsuk Kang)
can’t label reservations from Expedia by trip
efficiency in design
sharing: the essence of good design?

thanks to Yishai Feldman
when overloading is acceptable

concrete purposes  abstract purpose  concept

P1  P  C

P2
<table>
<thead>
<tr>
<th>Wish List (15)</th>
<th>Private</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shopping List (2)</td>
<td>Private</td>
</tr>
</tbody>
</table>

**Wish List**

![Image of book cover](https://via.placeholder.com/150)

**Before They Pass Away**
by Jimmy Nelson (Hardcover)

![Star Rating](https://via.placeholder.com/150) (149)

$99.37  
Price dropped 13% (was $115.20 when added to List)
In Stock. Offered by Amazon.com.
53 Used & New from $95.32

Add comments, quantity & priority

**What Can We Believe Where?: Photographs of the American West (Yale University Art Gallery)**
by Robert Adams, Joshua Chuang, Jock Reynolds (Paperback)

![Star Rating](https://via.placeholder.com/150) (5)

$23.11  
Only 7 left in stock--order soon. Offered by Amazon.com.
50 Used & New from $13.64

Add comments, quantity & priority
abstract purpose amazon lists

concrete purposes

- get friends to buy you items
- remember to buy items later

abstract purpose

- record items you want

concept

list
shared concept doodle poll

concrete purpose: schedule a meeting

concrete purpose: vote on a choice
shared concept grayscale image in Ps

greyscale image

brushing pixels

brushing pixels in layer mask

Layers Channels Paths

Brightness

Background
Keynote: no shared concept for title & body

Keynote: shared concept of placeholder

shared concept placeholder
risks of shared concepts
risks of shared concepts

limited functionality for concrete purpose

Doodle doesn’t offer some scheduling specific functionality that when2meet offers
risks of shared concepts

limited functionality for concrete purpose

Doodle doesn’t offer some scheduling specific functionality that when2meet offers

security & safety oversights

Amazon wishlists privacy risk

http://www.dailymail.co.uk/news/article-2984542
risks of shared concepts

limited functionality for concrete purpose

Doodle doesn’t offer some scheduling specific functionality that when2meet offers

security & safety oversights

Amazon wishlists privacy risk
http://www.dailymail.co.uk/news/article-2984542

unexpected couplings

Google forms: spreadsheet not synced with responses
conclusions
thoughts on agile development
thoughts on agile development

the achille’s heel of agile
hacking scenario by scenario
risk is you end up with CSS
thoughts on agile development

the achille’s heel of agile
hacking scenario by scenario
risk is you end up with CSS

questions
what is the right granularity?
how do scope an MVP?
how do you justify an increment?
thoughts on agile development

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hacking scenario by scenario
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what is the right granularity?
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how do you justify an increment?

concepts?
dependences?
purposes?
elements of software design?
elements of software design?

designer

engineer
elements of software design?

<table>
<thead>
<tr>
<th>Building</th>
<th>Designer</th>
<th>Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>facade, entry flow, access, light</td>
<td>beam, wall structural integrity</td>
<td></td>
</tr>
</tbody>
</table>
## Elements of Software Design?

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<tr>
<td>Software</td>
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<td>function, datatype decoupling, localization</td>
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elements of software design?

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<td>software</td>
<td>purpose, concept fitness for purpose</td>
<td>function, datatype decoupling, localization</td>
</tr>
</tbody>
</table>
a common view of software design

UI design
soft & human
about presentation

programming
hard & technical
about content
a better view of software design

- **conceptual design:** essential concepts & behavior
- **representation design:** organization & performance
backup
material
case studies
Gitless: a version control system

About Gitless

Gitless is an experimental version control system built on top of Git. Many people complain that Git is hard to use. We think the problem lies deeper than the user interface, in the concepts underlying Git. Gitless is an experiment to see what happens if you put a simple veneer on an app that changes the underlying concepts. Because Gitless is implemented on top of Git (could be considered what Git pros call a "porcelain" of Git), you can always fall back on Git. And of course your coworkers you share a repo with need never know that you’re not a Git aficionado.

Check out the documentation to get started. If you are a novice user that never used any version control system the documentation should be enough to get you started. If you are a Git pro looking to see what’s different from your beloved Git you’ll be able to spot the differences by glancing through the Gitless vs. Git section.

Download

- Mac OS X Binary (.tar.gz)
- Linux Binary (.tar.gz)
- Source Code (.tar.gz)

For installation instructions see the readme file. After installation, you should be able to execute the gl command. The current Gitless version is 0.7 which was released on 4/2015 (release notes).

Santiago Perez De Rosso
I enjoyed using Gitless
I found Gitless to be easier to use than Git
I found Gitless to be easier to learn than Git
I would continue using Gitless if I could

<table>
<thead>
<tr>
<th>Task completion time (minutes)</th>
<th>Git</th>
<th>Gitless</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
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<td></td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

results of a user study

- Task completion time (minutes)
- Git
- Gitless

- I enjoyed using Gitless
- I found Gitless to be easier to use than Git
- I found Gitless to be easier to learn than Git
- I would continue using Gitless if I could
small survey of MIT Dropbox users

correctly predicting behavior

- good knowledge
- average knowledge
- poor knowledge

Kelly Zhang
the root of the problem
The rôle of a formal functional specification is simply to act as a logical firewall between two completely different concerns... The **pleasantness problem** concerns the question whether a system... would satisfy our needs... The correctness problem concerns the question whether a given design meets such-and-such a formal functional specification. The logical firewall ... isolates computing science’s well-carved niche from the pleasantness problem to which science has little to contribute. Please note that I did not say that the one problem is more important than the other; after all, no chain is stronger than its weakest link.
user interface levels

- physical level
- linguistic level
- navigation level
- conceptual level

shallower → deeper
concept

distinctions
given vs instrumental concepts
given vs instrumental concepts

- banking app
- overdraft protection loan
- automatic bill payment
- available funds balance
- account balance
given vs instrumental concepts

instrumental:
invented for app

<table>
<thead>
<tr>
<th>banking app</th>
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</tr>
</thead>
<tbody>
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<td></td>
</tr>
<tr>
<td>account balance</td>
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</table>
### given vs instrumental concepts

**instrumental:** invented for app
- banking app
- overdraft protection loan
- automatic bill payment
- available funds balance

**given:** preexisted in domain
- account balance
given vs instrumental concepts

**instrumental:** invented for app
- banking app
  - overdraft protection loan
  - automatic bill payment
  - available funds balance
  - account balance

**given:** preexisted in domain
- travel app
  - itinerary
  - agony factor
  - passenger profile
  - flight number
  - reservation
given vs instrumental concepts

**Instrumental**: invented for app
- banking app
  - available funds balance
  - overdraft protection loan
  - automatic bill payment
- social networking app
  - tag
  - post
  - friendship
- travel app
  - itinerary
  - flight number
  - reservation

**Given**: preexisted in domain
- account balance
- URL
- passenger profile
given vs instrumental concepts

instrumental: invented for app
- banking app
  - overdraft protection loan
  - automatic bill payment
  - available funds balance
  - account balance

given: preexisted in domain
- social networking app
  - friendship
  - tag
  - post
  - photo
  - URL

- travel app
  - itinerary
  - agony factor
  - passenger profile
  - flight number
  - reservation

note that all concepts, even given concepts are a means to an end
these are not concepts...
these are not concepts...

search authentication
these are not concepts...

search  authentication

purposes
these are not concepts...

search authentication

purposes

concepts

search string certificate
these are not concepts...

<table>
<thead>
<tr>
<th>search</th>
<th>authentication</th>
</tr>
</thead>
<tbody>
<tr>
<td>purposes</td>
<td>concepts</td>
</tr>
<tr>
<td>search string</td>
<td>certificate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DOM element</th>
<th>HTTP request</th>
</tr>
</thead>
<tbody>
<tr>
<td>implementation details</td>
<td></td>
</tr>
</tbody>
</table>
these are not concepts...

search  authentication

<table>
<thead>
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<th>concepts</th>
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<tbody>
<tr>
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<td>certificate</td>
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DOM element  HTTP request

<table>
<thead>
<tr>
<th>implementation details</th>
<th>concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>web page</td>
<td>link</td>
</tr>
</tbody>
</table>
these are not concepts...

but this is a concept for a user of the jQuery API (vs. a user of Chrome)
orthogonality & uniformity
orthogonality is violated when one concept’s fitness for purpose is undermined by another concept.
non-orthogonal concepts
non-orthogonal concepts

origin, space, exclusion (CSS)
4 position values for $2 \times 3 \times 2$ options
non-orthogonal concepts

origin, space, exclusion (CSS)
4 position values for $2 \times 3 \times 2$ options

conversation & label (Gmail)
same subject, get same label
non-orthogonal concepts

- origin, space, exclusion (CSS)
  - 4 position values for $2 \times 3 \times 2$ options

- conversation & label (Gmail)
  - same subject, get same label

- listserv & bcc (SMTP)
  - modified subject reveals target
non-orthogonal concepts

P1 → C1

P2 → C2

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- title & reply (Tumblr)
  - adding ? to title enables replies (!)
non-orthogonal concepts

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  - adding ? to title enables replies (!)

- **group & selection** (many old apps)
  - can’t select object in a group
non-orthogonal concepts

**origin, space, exclusion** (CSS)
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can’t select object in a group

**group & connector** (Keynote 5.3)
can’t select box if connected
non-orthogonal concepts

P1 C1

P2 C2

origin, space, exclusion (CSS)
4 position values for $2 \times 3 \times 2$ options

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same subject, get same label

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group & selection (many old apps)
can’t select object in a group

group & connector (Keynote 5.3)
can’t select box if connected

Shriram Krishnamurthi
BCC example
Hi Daniel, Santiago,

I am not sure whether this falls into one of the conceptual design issues that you have been analyzing, but here's a little annoyance that I just ran into using labels in Gmail.

This evening, I made two separate reservations with Enterprise (one in Phoenix and another one in Vegas), and the company sent me a confirmation e-mail for each one of them. Usually, I tag travel-related e-mails using a label (e.g. "Vegas Trip 2014") so that I can easily find all the relevant e-mails for a particular trip. Now, the problem is that Gmail automatically grouped the two Enterprise emails into a single conversation. It turns out that in Gmail, a label applied to an e-mail in a conversation is applied to every other e-mail in the same conversation. This means I can't assign separate labels to the two car rentals! Ughh!

(By the way, is it possible to take an e-mail out of a conversation? Either this is impossible or the Gmail UI does not make this easy).

Eunsuk
an orthogonality violation
an orthogonality violation

overloaded concept too
uniformity is violated when instantiations differ with respect to fulfillment of purpose
uniformity is violated when instantiations differ with respect to fulfillment of purpose

... directly or indirectly
uniformity is violated when a concept has different versions or instantiations that behave differently for no good reason
non-uniform concepts

P → C

C → Ca
C → Cb
non-uniform concepts

deposits by check (banking)
funds arrive before clearing
non-uniform concepts

deposits by check (banking)
funds arrive before clearing

primitive type (Java)
not like a class type
non-uniform concepts

- deposits by check (banking)
  funds arrive before clearing

- primitive type (Java)
  not like a class type

- direct flight (Official Airline Guides)
  1 flight number, but >1 stop
non-uniform concepts

deposits by check (banking)
  funds arrive before clearing

primitive type (Java)
  not like a class type

direct flight (Official Airline Guides)
  1 flight number, but >1 stop

alerts (Apple iCal)
  can't select email alerts for default
non-uniform concepts

- **deposits by check** *(banking)*
  - funds arrive before clearing

- **primitive type** *(Java)*
  - not like a class type

- **direct flight** *(Official Airline Guides)*
  - 1 flight number, but >1 stop

- **alerts** *(Apple iCal)*
  - can’t select email alerts for default

- **custom settings** *(Fuji x100s)*
  - only some settings selectable
conceptual acrobatics
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.

________________________________________________________________________

Parents signature Date
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[Signature]

_________________________  _________________________
Parents signature          Date
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_____________________________  _________________________
Parents signature                Date

February 11, 2013
acrobat to the rescue
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Parents signature  Date
how to add a signature in acrobat
-- open document in acrobat
-- Tools—>Advanced Editing—>Touchup Object Tool
-- right click at desired point | Place Image...
then select jpg

how to add date
-- Tools—>Typewriter
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Parents signature       Date
acrobat to the rescue
what we hate ... & love

from http://amplicate.com
what we hate ... & love

from http://amplicate.com
what we hate ... & love

from http://amplicate.com
what we hate ... & love

from http://amplicate.com
cropping in adobe lightroom
cropping in adobe lightroom
cropping photoshop
cropping photoshop
cropping photoshop

Width: 6 in
Height: 4 in
Resolution: 300 pixels/inch
cropping the whole image
cropping the whole image
cropping the whole image
cropping the whole image
it’s all about the concepts

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

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

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

53% Hate Acrobat

30% Hate Photoshop

11% Hate Lightroom

237 Negative Opinions out of 444

12,978 Negative Opinions out of 43,283

297 Negative Opinions out of 2,632

Acrobat
- text box
- object
- document text

Photoshop
- channel
- layer
- mask

Lightroom
- action
- treatment
- effect
it’s all about the concepts

Acrobat
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incoherent concepts, no clear purpose
it’s all about the concepts

Acrobat
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incoherent concepts, no clear purpose

powerful concepts with low level purposes
it’s all about the concepts

Acrobat
- text box
- object
- document text

Photoshop
- channel
- layer
- mask

Lightroom
- action
- treatment
- effect

- incoherent concepts, no clear purpose
- powerful concepts with low level purposes
- simple concepts with purposes aligned to common tasks
all’s well that ends well
all’s well that ends well

acrobat 9
deployed troubled
all’s well that ends well

acrobat 9
deeply troubled

acrobat 10
user interface tweaks
all's well that ends well

**acrobat 9**
deeply troubled

**acrobat 10**
user interface tweaks

**acrobat 11**
conceptual reworking
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Parents    Date

Select All  Place Image...  Find...  Edit Page...  TouchUp Object Tool
hard to discern any compelling concepts
acrobat (version 10)
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Parents signature       Date

user interface has been reworked but still text, text box, object
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Parents signature

Date

August 15, 2014

conceptual reworking: now just text
designing
the user
designing the user too

purpose

fulfills?

contrivance

assuming a user behavior
example: magnetic paint

- changeable wall display of prints
- fulfills?
- magnetic paint
example: magnetic paint

changeable wall display of prints

fulfills?

magnetic paint

six coats
example: magnetic paint

changeable wall display of prints

fulfills?

magnetic paint

six coats

neodymium magnets
example: aligning elements

purpose: help align objects
example: aligning elements

purpose: help align objects

a contrivance: autoalign
example: aligning elements

purpose: help align objects

a contrivance: autoalign

a better contrivance: snap align
example: auto align

align diagram elements

motivates

fulfills

auto align
example: auto align

align diagram

elements

fulfills

motivates

auto align

user applies

operations
example: snap align

align diagram
elements

motivates

fulfills

snap align
example: snap align

align diagram
elements

motivates

fulfills

snap align

user moves until guideline flashes
in conventional software terms

purpose

fulfills?

contrivance

assuming a user behavior

anticipated misfits
in conventional software terms

requirements

purpose

fulfills?

contrivance

assuming a user behavior

anticipated misfits
in conventional software terms

requirements

specification

contrivance

assuming a user behavior

purpose

fulfills?

anticipated misfits
abstract
affordances
The early bird (A) arrives and catches worm (B), pulling string (C) and shooting off pistol (D). Bullet (E) busts balloon (F), dropping brick (G) on bulb (H) of atomizer (I) and shooting perfume (J) on sponge (K)—As sponge gains in weight, it lowers itself and pulls string (L), raising end of board (M)—Cannon ball (N) drops on nose of sleeping gentleman—String tied to cannon ball releases cork (O) of vacuum bottle (P) and ice water falls on sleeper’s face to assist the cannon ball in its good work.
Alarm Time: 6:00 AM

Alarm Date:
- One time alarm: 4/16/2013
- Repeating alarm

Enable Alarm: ✔️
Delete
Cancel
OK
Invalid alarm time
Please select a date and time in the future.

Alarm Date:

- One time alarm
  4/16/2013
- Repeating alarm

Enable Alarm
Delete
Cancel
OK
New Alarm

Alarm Time: 6:00 AM

Alarm Date:
- One time alarm: 4/17/2013
- Repeating alarm

Enable Alarm
OK
The Design of Everyday Things

Previously published as The Psychology of Everyday Things

Donald A. Norman

Donald Norman
James Gibson (1977): “action possibilities” latent in environment
James Gibson (1977): “action possibilities” latent in environment

Donald Norman (1988): action possibilities that are perceivable
a door with good affordances
a door with good affordances

“affords pushing”
a door with good affordances

“affords pushing”

“affords pulling”
“norman doors”
“norman doors”

push or pull?
“norman doors”

push or pull?

doors with user manual
“norman doors”

push or pull?

conflicting instructions

door with user manual
Who Is in These Photos?

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

Who is this?  Who is this?

Skip Tagging Friends  Save Tags
who can see the image?

Bob

Carol

dave

Alice

posts

Image

tags
who can see the image?

Bob
Carol
Alice
Dave

Image

posts

tags

sees
friends

posts

sees

who can see the image?

tags

posts

sees
what facebook says

When someone adds a tag to a photo or other post I shared, who can see it?

When someone adds a tag to something you shared, it's visible to:
- The audience you chose for the post or photo
- The person tagged in the post and their friends
When someone adds a tag to a photo or other post I shared, who can see it?

When someone adds a tag to something you shared, it's visible to:
- The audience you chose for the post or photo
- The person tagged in the post and their friends

as a textual constraint in Alloy:
all i: Image | sees.i = (posts.i).friends + (i.tags).friends
what facebook should say

When a psychopathic stranger takes a photo of me at a party and tags me, who can see it?

When someone adds a tag to something you didn’t share, it's visible to:

- All of their friends and fellow psychopaths
- All of your future employers, boyfriends, girlfriends and in-laws
lesson
For physical designs, effects are clear, if hard to predict. Affordances connect actions to effects.
lesson

for physical designs
effects are clear, if hard to predict
affordances connect actions to effects

for software designs
effects are often not clear
affordances become ‘abstract’
for physical designs
effects are clear, if hard to predict
affordances connect actions to effects

for software designs
effects are often not clear
affordances become ‘abstract’

so we need to
convey to users effects of actions
challenge: effects are indirect
design
thinking
process
process

optimize organization & task structure
Taylor (1880s), Toyota JIT (1980s), CMM (1990s), agile (2000s)
“new” activities
"new" activities

brainstorming
“new” activities

brainstorming

user studies
“new” activities

brainstorming

user studies

prototypes
style
Dieter Rams, 1958
pocket transistor radio T3
style

Dieter Rams, 1958
pocket transistor radio T3

Henry Hobson Richardson, 1877
Trinity Church, Boston
Dieter Rams, 1958
pocket transistor radio T3

Henry Hobson Richardson, 1877
Trinity Church, Boston

Leica, 1953
M3 rangefinder camera
Dieter Rams, 1958
pocket transistor radio T3

Henry Hobson Richardson, 1877
Trinity Church, Boston

Alfonso Bialetti, 1933
La Moka coffee maker

Leica, 1953
M3 rangefinder camera
broadening
broadening psychology
broadening

anthropology

psychology
broadening

anthropology

psychology

economics
broadening

anthropology

psychology

art

economics
nature of software design
fred brooks: essence and accident
(T)o see what rate of progress one can expect in software technology, let us examine the difficulties of that technology. Following Aristotle, I divide them into **essence**, the difficulties inherent in the nature of software, and **accidents**, those difficulties that today attend its production but are not inherent.
To see what rate of progress one can expect in software technology, let us examine the difficulties of that technology. Following Aristotle, I divide them into \textit{essence}, the difficulties inherent in the nature of software, and \textit{accidents}, those difficulties that today attend its production but are not inherent.

The \textbf{essence of a software entity is a construct of interlocking concepts}: data sets, relationships among data items, algorithms, and invocations of functions. This essence is abstract in that such a conceptual construct is the same under many different representations. It is nonetheless highly precise and richly detailed.
[T]o see what rate of progress one can expect in software technology, let us examine the difficulties of that technology. Following Aristotle, I divide them into essence, the difficulties inherent in the nature of software, and accidents, those difficulties that today attend its production but are not inherent.

The essence of a software entity is a construct of interlocking concepts: data sets, relationships among data items, algorithms, and invocations of functions. This essence is abstract in that such a conceptual construct is the same under many different representations. It is nonetheless highly precise and richly detailed.

I believe the hard part of building software to be the specification, design, and testing of this conceptual construct, not the labor of representing it and testing the fidelity of the representation. We still make syntax errors, to be sure; but they are fuzz compared with the conceptual errors in most systems.
mental models