conceptual design of software
sad stories & design puzzles
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.

________________________  February 11, 2013
Parents signature  Date
acrobat to the rescue

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
what we hate ... & love

from http://amplicate.com
just need some charm?
just need user anticipation?

It looks like you're writing a letter.

Would you like help?
- Get help with writing the letter
- Just type the letter without help
- Don't show me this tip again

Clippy
2003-2008
RIP
puzzles

about product
what makes a well-designed app?

about process
how does design impact project success?

about teaching
how can we teach students to design well?

about research
what would a theory of software design look like?
a theory of software design

explanatory
why is this app good or bad?
why is this feature unusable?
why is this hard to code?

constructive
how to fix this problem?
how to grow a good design?

objective & articulated
more than an ethos
substance, not apprenticeship
concepts & software
what characterizes an app?

Concepts!

Apple Mail
- Message
- Folder
- Conversation

Microsoft Word
- Paragraph
- Format
- Style

Twitter
- User
- Tweet
- Following

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

text editor
line, buffer, character set

word processor
paragraph, format, style

desktop publishing app
text flow, link, page template

waffling about concepts and fine points of design

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 is described here:
http://www.macobserver.com/tmo/article/pages-linking-text-boxes

Am I missing something, or is it really not possible anymore?
- Jamon
where are Word’s concepts from?

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

Ginn & Co, since 1868

Apple Pages, 2005

Microsoft Word, 1983

Bravo, 1974
where do concepts come from?

<table>
<thead>
<tr>
<th>domain concepts: exist in problem domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>photo, movie, song</td>
</tr>
<tr>
<td>account, balance</td>
</tr>
<tr>
<td>social security number</td>
</tr>
<tr>
<td>typeface, ligature</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>analogic concepts: based on known notions</th>
</tr>
</thead>
<tbody>
<tr>
<td>blog post, email, tweet</td>
</tr>
<tr>
<td>desktop, folder, file</td>
</tr>
<tr>
<td>layer, mask, stacking</td>
</tr>
<tr>
<td>cart, order, item</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>synthetic concepts: invented for software</th>
</tr>
</thead>
<tbody>
<tr>
<td>friend, follower</td>
</tr>
<tr>
<td>relative reference</td>
</tr>
<tr>
<td>selection, buffer</td>
</tr>
<tr>
<td>permission, capability</td>
</tr>
</tbody>
</table>
pervasiveness of concepts


code

interface

user’s model

Image  Ratio
Crop  Resolution

devices

concepts
Software design is primarily the design of concepts. Once concepts are chosen, game over (for the most part).

Good concepts are usable, robust, maintainable.

Bad concepts are frustrating, fragile, inflexible.
so what exactly is a concept?
a behavioral model
on: bool
time: Slot
schedule: set Slot

inv on = (time ∈ schedule)
tick ≜ time := next(time)
toggle (s: Slot) ≜
  if s ∉ schedule then schedule := schedule ∪ {s}
  else schedule := schedule \ {s}
concepts as explanatory state

a concept is part of the internal state modifiable by user actions indirectly affecting the external world

examples

style (Word): affects formatting
tag (Facebook): affects view permission
selection (Finder): affects result of delete, move, etc
if you modify the concept like this, the outcome will be...

“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 a file and it belongs to a folder with keyboard focus, then pressing delete will move the file to the trash”
concept sets and apps

for \( c(a) \), set of concepts used in application \( a \),
\[
\langle x, y \rangle \in \text{depends} \iff \forall a \cdot x \in c(A) \Rightarrow y \in c(A)
\]

- **StyleSheet**
  - **Style**
    - **Format**
    - **Paragraph**
  - **Selection**
  - **Layer**
  - **PixelMap**
- **Mask**
  - **Layer**
  - **Adjustment**

**note**: if depends is cyclic, then cycle suggests a grouping of concepts
what makes a good concept?
concept criteria

compelling
simple operational principle & motivated by one purpose

coherent
realization and interaction with other features is predictable

controllable
fulfills purpose without interference from other concepts

complete
general and uniform over all cases within concept’s scope

consistent
represented consistently in the user interface

conventional
reuses existing concepts when applicable
compelling

simple operational principle & motivated by one purpose

**trash (OS X)**

- **principle**: delete moves to special folder; emptying it removes contents for good
- **purpose**: allow undo of deletions

**layer (Photoshop)**

- **principle**: resulting pixel map is background map with composition of functions given by layers
- **purpose**: non-destructive edits
call forwarding

Pamela Zave, Secrets of Call Forwarding (1995)

how should call to p1 be routed?

depends on purpose
“follow-me”: to p2
“delegate”: to p3
1.8 My Refrigerator. Two compartments—fresh food and freezer—and two controls (in the fresh food unit). The illustration shows the controls and instructions. Your task: Suppose the freezer is too cold, the fresh food section just right. How would you adjust the controls so as to make the freezer warmer and keep the fresh food the same? (From Norman, 1986.)

<table>
<thead>
<tr>
<th>Normal Settings</th>
<th>C AND 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colder Fresh Food</td>
<td>C AND 6-7</td>
</tr>
<tr>
<td>Coldest Fresh Food</td>
<td>B AND 6-9</td>
</tr>
<tr>
<td>Colder Freezer</td>
<td>D AND 7-8</td>
</tr>
<tr>
<td>Warmer Fresh Food</td>
<td>C AND 4-1</td>
</tr>
<tr>
<td>Off (Fresh FD &amp; FR2)</td>
<td>0</td>
</tr>
</tbody>
</table>

- Set both controls
- Allow 24 hours to stabilize

**Explanation of controls**

**Actual implementation**

Diagram showing the flow of cold air from the thermostat to the control units, through the valve, and into the fresh food compartment.
refrigerator mapping

concepts

control a

control b

purposes

set freezer temp

set fridge temp
faucets

compelling

not compelling
rating stars
from Marc Hamburg, lead Lightroom engineer

purpose? not collection or even catalog specific
more uncompelling concepts

- no single clear purpose
- Git’s staging area
- JPEG quality and resolution
- Gmail’s categories (vs labels)

- no simple operational principle
- CSS’s dimensions (inches, pixels)
- Tumblr’s answers vs comments

- serves someone else’s purpose
- direct flight (legs share flight number)
coherent

realization and interaction with other features is predictable

relative reference

adding row: values unchanged
can apply sharpening on luminance channel
email conversations

Apple Mail: conversation consists of messages in multiple folders move, delete, etc apply only to the subset in this folder
deletion woes

if you move an old file to trash by mistake, how do you find it?

how do you make space on a USB key?
what’s a font?

so character style can only italicize some fonts
Apple Mail’s contact names appear in sent messages!

Facebook’s shared album can move photos in but not out

Google form column hide hides in sheet, but not in published summary
controllable
fulfills purpose without interference from other concepts

skip slide
make parent
make parent and skip

skipping and hierarchy do not interfere in Apple Keynote
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! Uggh!

(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
http get & post

POST: query params & form data

GET: query params but no form data

choice of http method interferes with data packaging
cropping in photoshop
cropping in photoshop (part 2)

bounding box ratio interferes with resolution & dimensions
aspect ratio fuji x100s
image quality setting

- FINE
- NORMAL
- FINE+RAW
- NORMAL+RAW
- RAW
aspect ratio
“image size” setting
non-standard ratio + RAW?

image quality interferes with image size
complete

general and uniform over all cases within concept’s scope

general

no special subsets for scope of action

uniform

same (sub)purpose fulfilled with same (sub)concept
This Keynote '09 presentation may look different.
Here's a list of what changed when you opened it in the new version of Keynote.

Builds were removed from master slide placeholders. They remain on slide placeholders.
Master Slides: centered, centered grey, left

Builds were removed from master slides.
Master Slide: quote

master slide placeholders can no longer include animation properties
keynote connection lines

connection lines are not groupable
filtering rules

cc field is a parameter for filtering but not searching

searching rules
2 Highlight a custom settings bank and press MENU/OK to select. Adjust the following as desired and press DISP/BACK when adjustments are complete: ISO ISO, D-Ring DYNAMIC RANGE, FILM Simulation, WB WHITE BALANCE, Color COLOR, Sharp SHARPNESS, Tone HIGHLIGHT TONE, Tone SHADOW TONE, NR NOISE REDUCTION, and reset.

Only some settings can be defined in a custom settings bank.
what a reviewer said

"The X100's Custom Settings memories are useless. Unlike Canon's brilliant C1, C2 and C3 Total Recall modes, the X100's EDIT/SAVE CUSTOM SETTINGS function only stores and recalls a few of the image parameters like sharpness and white balance, but not Auto ISO, image size, AF mode, flash or anything else. For these to be useful, they need to save everything, as Canon does. Even the LCD brightness needs to be saved and recalled, for instance, on my Canons, I use different presets for shooting outdoors or indoors."

from http://www.kenrockwell.com/fuji/x100.htm
consistent
represented consistently in the user interface

interface elements

concepts

consistent
deviation
deviation in OS X apps

OmniGraffle: control key

Apple apps: option key

copy style

⌥⌘C

^⌘C
conflation in unix
from the Unix Hater’s Handbook

[chim:~] dnj% mv readme -README
[chim:~] dnj% mv -README readme
mv: illegal option -- R
usage: mv [-f | -i | -n] [-v] source target
       mv [-f | -i | -n] [-v] source ... directory
Someone accidentally deleted thousands of files in my company Dropbox: how can I quickly undelete them?
Reader Paul Cramblett has a problem with others who just don’t know how to share. He writes:

I maintain a Dropbox folder that I use to share files with a select group of friends. I’ve tried to explain how Dropbox works to these people but someone invariably drags all the files out of the folder, which means they’re no longer available to the rest of us. Is there some way to prevent files from being removed by someone who doesn’t understand the difference between “copy” and “move”? 
alyssa & ben plan a party
alyssa spoils everything

Are you sure you want to delete party from your Dropbox?

Are you sure you want to delete invitations from your Dropbox?
How do I leave a shared folder?

“By changing the folder’s settings or by deleting it”

You can leave a shared folder at any time by changing the folder's settings on the Dropbox website or deleting it. If you change your mind or leave a folder accidentally, you can rejoin it later.
small survey of MIT Dropbox users

**Correctly predicting behavior**

- **Good knowledge**: 60.0%
- **Average knowledge**: 20.0%
- **Poor knowledge**: 40.0%

- **Delete shared folder results in leaving**: blue
- **Delete shared subfolder removes it**: green

Study by Kelly Zhang
conventional

reuses existing concepts when applicable

concept idioms: across apps
style: separate formatting from element
selection: select objects to apply action to set

subtle issues & their solution
reapply in different context
eg, partial styles

some apps are just cliches
collection of idiomatic concepts
social app = \{profile, post, friend, notify\}
example word styles
There is no problem in computer science that cannot be solved by introducing another level of indirection.  
*David Wheeler*
other instantiations of style idiom

Powerpoint schemes

Indesign swatches
non-instantiations of style idiom

Apple color picker

style concept:
value is mutable

Rule

property

Value

property

Color

value

RGB

value

Apple color picker

value is immutable
non-instantiations of style idiom

Write 2 text editor

style concept: paragraphs related to styles

Write 2 (and TextEdit) no relation: style just for formatting command
Purpose: make it easy to maintain consistent format across set of elements
# idiom 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>actions</td>
<td>update style from element, reapply style to element,...</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>
### Idiom 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></td>
<td>OOBA</td>
</tr>
<tr>
<td>style buffer</td>
<td>label</td>
<td>REST</td>
<td>sync</td>
<td></td>
<td></td>
<td>rating</td>
</tr>
<tr>
<td></td>
<td>layer</td>
<td>cart</td>
<td>export</td>
<td></td>
<td></td>
<td>status</td>
</tr>
<tr>
<td></td>
<td>stack</td>
<td>subscription</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>alias</td>
<td>purchase order</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>preset</td>
<td>RMA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cursor</td>
<td>coupon</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>filter</td>
<td>catalog</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>property</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>metadata</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
does this invariant hold?

all \( s: \text{Style}, p: \text{Property} \mid \text{some} \ r: s.\text{rules} \mid r.\text{prop} = p \)
creating a style microsoft word

A plain paragraph.

A paragraph in Futura.
does the style set to 12pt or not?
applying a style microsoft word

A plain paragraph.

A paragraph in Futura.

A paragraph in a larger size.

A plain paragraph.

A paragraph in Futura.

A paragraph in a larger size.
idiom misfit style

Word: property sometimes absent until entered; remove only in Visual Basic!

Indesign: property absent until entered; then remove only with “Reset to Base” (since 2007)

Pages: aaah! properties are optional
concept idiom 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
subtlety active element

Adobe Lightroom: brightest thumbnail is the “active photo”
Photoshop: outline shown with “marching ants”

Photoshop: selection shown in Quick Mask mode
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
missing concept
no concept fulfilling implied purpose

Apple Preview: assemble PDF from multiple files but can’t save
a happy end to a sad story?
hard to discern any compelling concepts
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Thank you!

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Parents signature       Date
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Thank you!

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

Count Olaf

Parents signature

August 15, 2014

Date

conceptual reworking: now just text
related work
other approaches

“design thinking”
   eg: David Kelley, Bill Moggridge
   empathy for user, incrementality, brainstorming

ethos of simplicity
   eg: Dijkstra, Hoare, Perlis
   good design comes from minimality & generality

user interface heuristics
   eg: Don Norman, Jakob Nielson, Bruce Tognazzini
   undoability, visibility of state, anticipation
influences

Nam Suh: axiomatic design

Aristotle: telos

Christopher Alexander: misfits

Michael Polanyi: the operational principle

David Parnas: dependencies as feature subsets

Martin Fowler: analysis patterns

Michael Jackson: preformal design
reflections
on software as math

The choice of functional specifications — and of notation to write them down in — may be far from obvious, but their rôle is clear: it is to act as a logical firewall between two different concerns. The one is the “pleasantness problem”, i.e., the question of whether an engine meeting the specification is the engine we would like to have; the other one is the “correctness problem”, i.e., the question of how to design an engine meeting the specification.

Dijkstra, EWD952

A very large program is, by necessity, composed of a large number, say N, individual components and the fact that N is large implies that the individual program components must be produced with a very high confidence level. If for each individual component the probability of being right equals p, for the whole program the probability P of being right will satisfy

\[ P \leq p^N \]

and if we want P to differ appreciably from zero, p must be very close to one, because N is so large.

Dijkstra, EWD303

Fortunately, the problem of program correctness has turned out to be far less serious than predicted.

Hoare, 1996
sources of reliability

- interfaces
- concepts
- localization

bad concepts confuse user and developer and lead to unreliable code
limits of formalism

engineering science
mathematical models of behavior
engineering as application of science

but
physics cannot understand a clock
purposes cannot be formalized
essence of design is intent, not behavior