Building Systems with Ideas
Daniel Jackson, MIT
sneak preview
sneak preview

what does a software designer do?
build idea structures
sneak preview

what does a software designer do?
build idea structures

who designs software?
software designers
analysts and consultants
business process engineers
what does a software designer do? build idea structures

who designs software? software designers analysts and consultants business process engineers

so what? to get better software, focus more on these idea structures
sneak preview

what does a software designer do? build idea structures

who designs software? software designers analysts and consultants business process engineers

so what? to get better software, focus more on these idea structures

and it’s not just software policy, organizational systems
a story of apps, good and bad
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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Count Olaf

February 11, 2013

Parents signature

Date
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__________________________
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Parents signature

Date
Parents:

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

Thank you!

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

Parents signature

Date
Parents:

Frizzle will again be taking her second grade class on a "Look and Feel" field trip. Please sign and return the permission form below.

Thank you!

I give permission for my child to go on the "Look and Feel" trip on Friday February 13th to the Bear Dump. I understand that my child may encounter the normal risks of childhood play, including grazed knees and exposure to toxic waste.

Parents signature

Date
Parents:

Frizzle will again be taking her second grade class on a field trip. Please sign and return the permission form below.

---

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
need a friendlier interface?
need a friendlier interface?
or a helping hand?
or a helping hand?

Clippy
2003-2008
RIP
no: can be complicated & usable
no: can be complicated & usable
i’m not alone

from http://amplicate.com
i’m not alone

from http://amplicate.com
i’m not alone

from http://amplicate.com
I'm not alone

from http://amplicate.com
i’m not alone

from http://amplicate.com
i’m not alone

from http://amplicate.com
i’m not alone

from http://amplicate.com
so what makes things easy to use?
James Gibson (1977): “action possibilities” latent in environment
James Gibson (1977): “action possibilities” latent in environment
Donald Norman (1988): action possibilities that are perceivable
Donald Norman
a door with good affordances
a door with good affordances

“affords pushing”
a door with good affordances

“affords pushing”

“affords pulling”
unhappy doors
unhappy doors

push or pull?
unhappy doors

push or pull?

door with user manual
unhappy doors

push or pull?

door with user manual
unhappy doors

push or pull?
door with user manual
using more complex things
The early bird (A) arrives and catches worm (B), pulling string (C) and shooting off pistol (D). Bullet (E) bursts 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.
how to use this?
how to use this?
it’s getting harder...

Braun Clock Radio (1978)

Dieter Rams

photo by Koichi Okuwaki
Android phone app
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: Yes
Delete
Cancel
OK
Alarm Time: 6:00 AM

Alarm Date: 4/17/2013

- One time alarm
- Repeating alarm

Enable Alarm
Delete
Cancel
OK

- New Alarm...
- New Timer...
- New Stopwatch...
- About Alarm Clock 2
- Check for updates...
- Preferences...
- Quit
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.
so how do we use these things?
conceptual models
conceptual models

to use a complex application
we imagine what’s inside
we form structures in our mind
we connect actions to structural changes
conceptual models

to use a complex application
we imagine what’s inside
we form structures in our mind
we connect actions to structural changes

“abstract affordances”
opening the box
opening the box
opening the box

Clock

Alarm

CST
4/19/13
11:30am
4/20/13
8:00am
opening the box

- CST
- 4/19/13
- 11:30am
- Clock
- Alarm
- 4/20/13
- 8:00am
- Alarm
- 4/21/13
- 9:00am
an infinity of abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states

Clock

Alarms:
- 4/20/13 8:00am
- 4/21/13 9:00am
summarizing abstract states
summarizing abstract states
summarizing abstract states

Clock
Zone
zone
Clock

4/20/13 CST
8:00am
11:30am

4/19/13
CST
4/19/13
8:00am
11:30am

4/20/13
8:00am
4/21/13
9:00am

Alarm

CST
4/19/13
11:30am

CST
4/19/13
11:30am

Alarm

4/20/13
8:00am
4/21/13
9:00am
summarizing abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states
summarizing abstract states

- **Zone**: current zone
- **Clock**: current date, time, and alarms
- **Date**: for date
- **Time**: current time
- **Alarm**: for date

Examples:

- **Clock**: 4/20/13 CST, 8:00am
- **Clock**: 4/21/13 9:00am
summarizing abstract states
who can see the image?
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:

1. The audience you chose for the post or photo
2. The person tagged in the post and their friends
who can see the image?

posts

Image

tags

Bob —— Alice —— Image —— Dave

Bob —— Carol —— Dave

Bob ——Image —— Dave

Alice —— Image —— Dave
who can see the image?

User

friends

sees

posts

Image

Bob

Carol

Dave

Alice

Image

Bob

Carol

Dave

Alice

Image

sees
how do we learn so many conceptual models?
Why, a four-year-old child could understand this!
Why, a four-year-old child could understand this!

Run out and get me a four-year-old child! I can’t make head or tail out of it.
conceptual idioms
conceptual idioms

applications

Lightroom
Powerpoint
Word
Gmail
Amazon
conceptual idioms

applications
- Lightroom
- Powerpoint
- Word
- Gmail
- Amazon

idioms
- tagging
- style
- selection
- presets
conceptual idioms

applications:
- Lightroom
- Powerpoint
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idioms

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- presets
conceptual idioms

applications

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- Word
- Gmail
- Amazon

idioms

- tagging
- style
- selection
- presets
an idiom: selection

slides in Keynote

photos in Adobe Lightroom

messages in Apple Mail
an idiom: directory

mailboxes in Apple Mail

files and folder in Unix/OS X

domain names in DNS
an idiom: tagging

twitter hashtags

photo keywords

Gmail labels
Search finds Object contains Smart Collection

Object has tags defined by Tag for tags

Tag has tags

Keyword Tags: Enter Keywords

Adam, Claudia, Judy

Keyword Suggestions:

<table>
<thead>
<tr>
<th>Melissa</th>
<th>Akiva</th>
<th>Rebecca</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lakeville</td>
<td>Rachel</td>
<td>New York</td>
</tr>
<tr>
<td>Michael</td>
<td>Emily</td>
<td>London</td>
</tr>
</tbody>
</table>
an idiom: upvoting

recommending comments on NY Times

questions on Stack Overflow

posts on reddit
Carolyn Egeli  ·  Valley Lee, Md.

As always, the battle is set between the haves, and the rest. The haves have just lost out, and the movement back towards the greater good has begun. Let's hope the American public sees the sense in what the French and Greeks have done yesterday, by reclaiming their governments to represent the people for a change. The stock markets will likely be unhappy.

May 7, 2012 at 3:23 p.m. · RECOMMEND 8

This is homework and I'm having a lot of trouble with it. I am using Alloy to model a library. Here are the definitions of the objects:

```alloy
sig Library {
  patrons : set Person,
  on_shelves : set Book,
}

sig Book {
  authors : set Person,
  loaned_to : set Person,
}

sig Person{}
```

Then we need to have a fact that states, every book is either on the shelf, or taken out by a patron. However, they cannot be in both places.

My cat was sick and got meds. Now my cat is high as a kite.

submitted 3 hours ago by ogden24  to funny

146 comments  share
an idiom: presets

printer settings

exporting PDF

Amazon’s one-click settings
an idiom: styles

color schemes in Powerpoint

swatches in Indesign

paragraph styles in Word
There is no problem in computer science that cannot be solved by introducing another level of indirection.

--David Wheeler
so is it a good conceptual model?
<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>are the concepts rich enough?</td>
</tr>
<tr>
<td>are the concepts simple enough?</td>
</tr>
<tr>
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</tr>
<tr>
<td>are idioms &amp; conventions leveraged?</td>
</tr>
<tr>
<td>are suitable generalizations introduced?</td>
</tr>
<tr>
<td>are concepts decoupled?</td>
</tr>
</tbody>
</table>
## Conceptual Criteria

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are the concepts rich enough?</td>
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<td>Conceptual Criteria</td>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>Criteria</td>
<td>Status</td>
</tr>
<tr>
<td>------------------------------------------------------------</td>
<td>--------</td>
</tr>
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## conceptual criteria

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| ✔   | are the concepts rich enough? |
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</tr>
</tbody>
</table>
example: macintosh trash
example: macintosh trash

deleting from external drive (eg USB)
  › can’t reuse space until trash emptied
example: macintosh trash

deleting from external drive (eg USB)
  › can’t reuse space until trash emptied

retrieving accidentally deleted files
  › no date of deletion
example: macintosh trash

deleting from external drive (eg USB)
› can’t reuse space until trash emptied

retrieving accidentally deleted files
› no date of deletion

partial emptying
› not possible
what exists

Machine
  - drives
  - one trash

Trash
  - files
  - deleted files

Drive
  - files

File
  - mod date
  - File
what exists

Machine
  drives

Trash
  one trash

Drive
  files
    deleted files
    files
      File
        mod date
          File
            del date
              mod date

what we need

Drive
  files
    del date
      mod date

Trash
  trash
    deleted files
      File
        del date
          mod date

File
example: photoshop cropping
example: photoshop cropping
example: photoshop cropping
Photoshop 5 and before
Photoshop 5 and before

Resolution

Resolution

new resolution

Photo

crops

Crop

optional dimension

Dimensions

Pixel

selected pixels

Aspect Ratio

Physical Dimensions
Photoshop 6 and Lightroom
example: Apple Mail conversations

Disable conversation view in Mail.app 5.0 for OS X Lion

I abhor “conversation view” in my email client. To me, it just isn’t intuitive and makes for more work. I might want to delete or file away a previous message, but keep a current message thread in my inbox as actionable. The conversation view for me just makes for more clutter. And it reminds me of Microsoft Outlook. Blech.

Reverting to the “classic” inbox style of Mail.app in OS X Lion is simple.

View > Organize by Conversation

By default, Mail.app should have this checked. When you click on ‘Organize by Conversation’, it will then become unchecked, and will bring your Mail.app inbox back to the way that you know and love.
example: Apple Mail conversations
example: Apple Mail conversations

number of messages in conversation
example: Apple Mail conversations

number of messages in conversation
example: Apple Mail conversations

- Number of messages in conversation
- Sent message not included in message count
example: Apple Mail conversations

- Number of messages in conversation
- Blue border means message is selected
- Sent message not included in message count
example: Apple Mail conversations

number of messages in conversation

blue border means message is selected

grey background means conversation is not selected

sent message not included in message count
some questions
› does a mailbox contain all the messages its conversations involve? *no.*
› do move, delete, etc apply to conversations? *yes.*
› when you move a conversation to another mailbox, do all messages move with it? *no.*
closing thoughts
it's not just about usability

<table>
<thead>
<tr>
<th>weak concepts</th>
<th>strong concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>hard to use</td>
<td>intuitive, predictable</td>
</tr>
<tr>
<td>a mess to maintain</td>
<td>decoupling &amp; localization</td>
</tr>
<tr>
<td>unreliable &amp; buggy</td>
<td>more dependable</td>
</tr>
</tbody>
</table>
Conceptual integrity is the most important consideration in system design.

—Fred Brooks, 1975
Conceptual integrity is the most important consideration in system design.
—Fred Brooks, 1975

I am more convinced than ever. Conceptual integrity is central to product quality.
—Fred Brooks, 1995
Conceptual integrity is the most important consideration in system design.
—Fred Brooks, 1975

I am more convinced than ever. Conceptual integrity is central to product quality.
—Fred Brooks, 1995

Because ease of use is the purpose, this ratio of function to conceptual complexity is the ultimate test of system design. Neither function alone nor simplicity alone defines a good design.
building a method of conceptual design
building a method of conceptual design

underlying theory
building a method of conceptual design

underlying theory  case studies
building a method of conceptual design

- modeling notations
- underlying theory
- case studies
building a method of conceptual design

- modeling notations
- idioms & patterns
- underlying theory
- case studies
building a method of conceptual design

- design criteria
- idioms & patterns
- modeling notations
- underlying theory
- case studies
building a method of conceptual design

- analysis tools
- design criteria
- modeling notations
- idioms & patterns
- underlying theory
- case studies
alloy: a language & tool for relational models

about alloy

Alloy is a language for describing structures and a tool for exploring them. It has been used in a wide range of applications from finding holes in security mechanisms to designing telephone switching networks.

An Alloy model is a collection of constraints that describes (implicitly) a set of structures, for example: all the possible security configurations of a web application, or all the possible topologies of a switching network. Alloy’s tool, the Alloy Analyzer, is a solver that takes the constraints of a model and finds structures that satisfy them. It can be used both to explore the model by generating sample structures, and to check properties of the model by generating counterexamples. Structures are displayed graphically, and their appearance can be customized for the domain at hand.

At its core, the Alloy language is a simple but expressive logic based on the notion of relations, and was inspired by the Z specification language and Tarski’s relational calculus. Alloy’s syntax is designed to make it easy to build models incrementally, and was influenced by modeling languages (such as the object models of OMT and UML). Novel features of Alloy include a rich subtype facility for factoring out common features and a uniform and powerful syntax for navigation expressions.

The Alloy Analyzer works by reduction to SAT. Version 4 was a complete rewrite that included Kodkod, a new model finding engine that optimizes the reduction, and a new front end.
the heart of software
the heart of software

interface
the heart of software

interface

user’s model
the heart of software

code

interface

user's model

the heart of software

takeaway
takeaway

conceptual design is at the heart of the design of software and many other complex systems
takeaway

conceptual design is at the heart of the design of software and many other complex systems

it’s what you do if you’re an analysis, consultant, programmer...
takeaway

conceptual design is at the heart of the design of software and many other complex systems. It’s what you do if you’re an analysis, consultant, programmer...

focusing on concept structure
low cost, potentially high gain
To design something really well, you have to get it. You have to really grok what it’s all about. It takes a passionate commitment to really thoroughly understand something, chew it up, not just quickly swallow it. Most people don’t take the time to do that.