how to become a great software designer
how to build software?

two problems to solve
functional structures

implementation structures

is it usable? effective? fit for purpose?

software design

is it robust? performant? maintainable?

software engineering
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 meeting such-and-such a formal functional specification would satisfy our needs, meet our expectations and fulfill our hopes. The **correctness problem** concerns the question whether a given design meets such-and-such a formal functional specification.

Dijkstra, EWD952 (1986)
Conceptual integrity is the most important consideration in system design.
Fred Brooks, Mythical Man Month (1975)

I am more convinced than ever. Conceptual integrity is central to product quality.

The essence of a software entity is a construct of interlocking concepts... 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...
No Silver Bullet (1986)
When you go to design a house, you talk to an architect first, not an engineer. Why is this?

Because the criteria for what makes a good building fall outside the domain of engineering.

Similarly, in computer programs, the selection of the various components and elements of the application must be driven by the conditions of use. How is this to be done? By software designers.

A Software Design Manifesto
Mitchell Kapor, 1996
paraphrasing slightly
what makes great designers?
inspiration = talent + process

the design thinking process

empathize → define → ideate → prototype → test

problem at hand defines context

is there any great design that is the result of a great design process?
expertise = patterns + design moves

familiar structures  familiar steps

The well-kept secret behind the most successful designs is that they are less new than they appear. Invariably, it turns out that, in some form or other, the designer has done the same thing before. — AFD
what are the elements of software design?
Jackson structured programming (wikipedia.org)

106 points by hakonhr 63 days ago | hide | past | favorite | 69 comments

Jackson structured programming (wikipedia.org)

user: danielnicholas
created: 63 days ago
karma: 11

You might find helpful an annotated version [0] of Hoare's explanation of JSP that I edited for a Michael Jackson festschrift.

; I’d point to these ideas as worth knowing:
- The archetypal problems that, however you code, can’t be pushed under the rug—most notably structure clashes—and just recognizing them helps.
- Coroutines (or code transformation) let you structure code more cleanly when you need to read or write more than one structure. It’s why real iterators (with yield), which offer a limited form of this, are (in my view) better than Java-style iterators with a next method.
- The idea of viewing a system as a collection of asynchronous processes (Ch. 11 in the JSP book, which later became JSD) with a long-running process for each real-world entity. This was a notable contrast to OOP, and led to a strategy (seeing a resurgence with event storming for DDD) that began with events rather than objects.

[0] https://groups.csail.mit.edu/sdg/pubs/2009/hoare-jsp-3-29-09...

ob-nix 63 days ago

... this brings back memories! In the late eighties I, as a teenager, found a Jackson Struct. Pr. book at the town library. I remember I was amazed at the text and wondered why I hadn’t heard about the method before.

If I remember correctly did the book clearly point out backtrack as the standard method, while mentioning that most languages lacked that, so it had to be implemented manually.

CraigJPerry 63 days ago

This is referenced(1) as a core inspiration in the preface to “How to Design Programs” but i never researched it further because i’ve found the “design recipes” approach in htdp to be pretty solid in real life problems.
A concept has a name.

Same concept in HackerNews, NYTimes comment section, StackOverflow, etc.
a concept has a purpose

**concept** Upvote
**purpose** rank items by popularity

**concept** Reaction
**purpose** send reactions to author

**concept** Recommendation
**purpose** use prior likes to recommend

---

This is homework and I'm having a hard time understanding the definitions of the objects:

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

---

Daniel I think we should organize a software concepts forum.

👍 1 😊
A concept has a state like bounded context in DDD, but even more localized. Include in state only what's needed for the concept's own computations.

**Concept**: Upvote

**Purpose**: Rank items by popularity

**State**
- Votes: User → set Vote
- For: Vote → one Item
- Upvote, Downvote: set Vote
- Rank: Item → one Int

Include in state only what's needed for the concept's own computations.

Track users to prevent duplicate voting.
a concept has actions

concept Upvote

purpose rank items by popularity

state
votes: User -> set Vote
for: Vote -> one Item
Upvote, Downvote: set Vote
rank: Item -> one Int

actions
upvote (u: User, i: Item)
downvote (u: User, i: Item)
unvote (u: User, i: Item)

actions capture the concept behavior in full

downvote (i: Item, u: User)
// no existing Downvote for i in u.votes
// remove any Upvote for i from u.votes
// add a Downvote for i in u.votes
// update i.rank ...
concept Upvote

related concepts
Recommendation, Reaction, ...

design variants
downvote as unvote
use age in ranking
weigh downvotes more

typical uses
social media posts
comments on articles
Q&A responses

known issues
preventing double votes
(require login, use IP address, save cookie)
saving storage space
(freeze old posts and from user info)

often used with
Karma, Session, ...
composing concepts by synchronization
how to extend behavior?

**concept** Upvote

**actions**
- upvote (u: User, i: Item)
- downvote (u: User, i: Item)
- unvote (u: User, i: Item)

**suppose I want this behavior:**
you can’t downvote an item until you’ve received N upvotes on your own items

**define a new concept!**
a hint: not just used by Upvote

**concept** Karma

**purpose** privilege good users

**state**
- karma: User -> one Int
- contribs: User -> set Item

**actions**
- contribute (u: User, i: Item)
- reward (u: User, r: Int)
- permit (u: User, r: Int)
**concept** Upvote

**actions**
- upvote (u: User, i: Item)
- downvote (u: User, i: Item)
- unvote (u: User, i: Item)

**when** upvote (u, i)
and i in u'.contribs
**also** reward (u', 10)

**concept** Karma

**actions**
- contribute (u: User, i: Item)
- reward (i: Item, r: Int)
- permit (u: User, r: Int)

**when** downvote (u, i)
**also** permit (u, 20)
**concept Upvote**

- upvote (Bob, post1)
- upvote (Carol, post1)
- downvote (Alice, post2)

**when upvote (u, i) also reward (u, 10)**

**concept Karma**

- contrib (Alice, post1)
- contrib (Bob, post2)
- reward (Alice, 10)
- reward (Alice, 10)
- permit (Alice, 20)

**composition uses event sync from Hoare’s CSP**

**no concept coupling concepts preserve properties**
design moves
mechanical analogs
three pairs of design moves
**split-merge**: tradeoff simplicity/flexibility

- **split**
  - photocopier
  - printer + scanner

- **merge**
  - emergency flashlight
  - flashlight + battery + charger
unify-specialize: tradeoff simplicity/specificity

set of wrenches -> unify -> adjustable wrench

macro lens -> specialize -> general-purpose lens
tighten-loosen: tradeoff automation/flexibility

light pull / door lock

tighten

dimmers with separate controls

loosen

airplane toilet lock

rotary dimmer switch
successful design moves in software
split: emergence of a concept in Keynote

- **Full screen toggle** emerges as a partial concept (c. 2010?)
- **Play-in-window option** now an independent concept (2021)
merge: a simple & clever new shortening concept

yellkey

enter url and length of time for key to exist.

https://dnj.photo

5 minutes

generate yellkey

your key is: move.
go to www.yellkey.com/move to use.

one concept, allows familiar words as short URLs
unify: subsuming access control in MIT’s Moira

List

Mailing List

Access List

can toggle mailing list attribute

can create admin list with no login users!
Squarespace: can schedule blog posts but not other pages, and can change pub date independently (only affects order)

Hugo: any page can have date field to schedule, just set date in future

---

author: "Daniel Jackson"
title: "The Class Number Dilemma"
date: "2022-02-24"
description: "A Concept Example in Everyday Life"
summary: "Who knew such a simple thing could be so challenging?"
---

The Class Number Dilemma

Who knew such a simple thing could be so challenging?

February 24, 2022 · 3 min · Daniel Jackson
tighten: label and trash concepts in Gmail

Label

Trash

tighten

a label

also implemented as a label

show messages with label hacking
<table>
<thead>
<tr>
<th>Concept</th>
<th>Trash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Undo deletion</td>
</tr>
<tr>
<td>Structure</td>
<td>Trash: set Item</td>
</tr>
<tr>
<td>Actions</td>
<td>delete (i: Item)</td>
</tr>
<tr>
<td></td>
<td>restore (i: Item)</td>
</tr>
<tr>
<td></td>
<td>empty ()</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concept</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Organize with overlapping</td>
</tr>
<tr>
<td>Structure</td>
<td>Labels: Item -&gt; set Label</td>
</tr>
<tr>
<td>Actions</td>
<td>add (i: Item, l: Label)</td>
</tr>
<tr>
<td></td>
<td>remove (i: Item, l: Label)</td>
</tr>
<tr>
<td></td>
<td>find (ls: set Label, out is: set Item)</td>
</tr>
</tbody>
</table>
integrating these concepts is tricky

- click on trash
- filter on todo label
- filter on todo and trash
- filter on something else
a beautiful (but tricky) synergy

Folder sortable by volume!

new in Lion (2011)

Folder
Trash

Folder
Trash

tighten
loosen: expert control in ProCamera

focus and exposure points aligned

focus and exposure points separated

Focus

Exposure

loosen

Focus

Exposure
design moves in response to problems
aspect ratio

in Fujifilm cameras
a lovely camera fuji x100
complex menu system: image quality setting
aspect ratio
image size setting
non-standard ratio + raw?
problem #1: no non-standard ratio unless also save JPG!

raw image showing non-destructive aspect ratio crop
problem #2: very few ratio options

Fuji, give us 4:3, 5:4, and 6:7 aspect ratios on X-series cameras

636 have signed. Let's get to 1,000!

At 1,000 signatures, this petition is more likely to be featured in recommendations!
aspect ratio is not a concept
merged into JPEG image size concept
so cannot be controlled independently
I call this “overloading by piggybacking”

solution: split concepts
would allow ratio change to raws without JPEGs
would avoid combinatoric explosion of options
message filters

in apple mail
how many ways to filter messages?

- search for a message
- create a rule
- define a smart folder

search options

- From
- To
- Cc
- Subject
- Any recipient
- Message is addressed to my full name
- Message is not addressed to my full name
- Date sent
- Date received
- Account
- Sender is in my contacts
- Sender is not in my contacts
- Sender is in my previous recipients
- Sender is not in my previous recipients
- Sender is VIP
- Sender is member of group
- Sender is not a member of group
- Message content
- Message is junk mail
- Message is signed
- Message is encrypted
- Priority is high
- Priority is normal
- Priority is low
- Any attachment name
- Attachment type
- Edit header list...

rule options

- Entire message
  - From
  - Any recipient
  - Subject
  - Date received
  - Date last viewed
  - Account
  - Sender is member of group
  - Sender is VIP
  - Message is flagged
  - Message is unread
  - Priority is high
  - Priority is normal
  - Priority is low
  - Message has flag
  - Message was replied to
  - Message was not replied to
  - Message is in mailbox
  - Message is not in mailbox
  - Contains attachments
  - Any attachment name
  - Attachment type
search, rule and smart folder
all include their own specialized concepts
incomparable features, different UIs
unify in a single message filter concept
include “create folder from search”, eg
sticky hands
in zoom
likes in facebook
are angry reactions upvotes?

**concept** Upvote
**purpose** rank items by popularity
**actions**
  - upvote (u: User, i: Item)
  ...

**concept** Reaction
**purpose** convey emotion to author
**actions**
  - reactAngry (u: User, i: Item)
  ...

unwanted sync?
a facebook split
event deletion in google calendar
Despite some erroneous messages sent to this list accidentally, Kanit's talk is happening! Please join us on Monday.
Canceling and deleting events in the Google Calendar mobile app is similar to on a desktop.

1. First, open Google Calendar.
2. Tap on the event you wish to cancel.
3. Press on the three dots in the top right corner of the event window.
4. Select Delete.
5. Tap Delete event. Google Calendar will send a cancellation email to the guests.

Mar 22, 2021

https://wpamelia.com Blog

How to Cancel an Event in Google Calendar - Amelia booking ...
a long time problem in iCal too
how to delete spam calendar events?
concept calendar
purpose record engagements
actions
  createEvent (...): Event
  deleteEvent (e: Event)
  ...

concept invitation
purpose coordinate events
actions
  accept (e: Event)
  decline (e: Event)
  ...

unwanted sync!
apple's solution

resolution to design problem
make sync optional

Are you sure you want to delete this event?
Deleting this event will notify the organizer that you’re declining the event and deleting it from your calendar. You can’t undo this action.

Cancel  Delete and Don't Notify  Delete and Notify

loosen

Event → Invite

Invite → Event

Event → Invite

Event → Invite
structure your software design with concepts
inventory the concepts, identify the critical ones
see if you can describe them fully independently
then formulate interactions as synchronizations

apply design moves to explore new options
never a panacea, always a tradeoff

software concepts as patterns
only hinted at this, but equally important
don’t reinvent the wheel!
express your design as sync of familiar concepts?
unused slides
Dropbox & the case of the disappearing files
making space: list big files and delete the ones you don’t recognize

very unhappy colleagues
Someone accidentally deleted thousands of files in my company Dropbox: how can I quickly undelete them?
Ava is a party planner
Bella is having a party

Does the name change for Ava too?

Answer: It depends

If Ava just shares Bella Plan with Bella and Bella renamed the folder, Ava sees no change

If Ava shared a folder containing Bella Plan, then Ava does see the change
Bella deletes Bella Plan from shared folder Bella Party

Delete folder?

Are you sure you want to delete Bella Plan from the shared folder ‘Bella Party’?

Cancel  Delete

Bella deletes shared folder Bella Party

Remove shared folder?

Are you sure you want to remove the shared folder Bella Party from your Dropbox? This folder will stay shared with any existing members. You can re-add it later.

Cancel  Remove
survey of dropbox users (MIT CS undergrads)

Correctly predicting behavior

- Good knowledge
  - Delete shared folder results in leaving
  - Delete shared subfolder removes it

- Average knowledge

- Poor knowledge
how many users believe Dropbox is structured

how Dropbox is actually structured

confusing concept
concept metadata
purpose tag items with properties for lookup

state
properties: Item → set Property
key: Property → one Key
val: Property → one Val

concept folder
purpose organize items into disjoint categories

state
contents: Folder → set (Folder + Item)
root: one Folder

concept unix directory
purpose organize items into overlapping categories

state
entries: Dir → set Entry
name: Entry → one Name
item: Entry → one (File + Dir)
Twitter & the case of the surprised first lady
Seems the only #Wall @realDonaldTrump's built is the one between him and @FLOTUS #Melania #trump
We are changing our star icon for favorites to a heart and we’ll be calling them likes... **We know that at times the star could be confusing, especially to newcomers.** You might like a lot of things, but not everything can be your favorite. *Twitter press release*
what concept is this?

concept Upvote

purpose rank items by popularity

? concept Bookmark

purpose save items to revisit

missing concept!
Twitter adds a new concept (2018)

**Upvote**
- **Purpose**: Rank items by popularity

**Bookmark**
- **Purpose**: Save items to revisit
a new path
inspired by old ideas
A diagram illustrating the process of design implementation and user interpretation:

1. **User's Model**: The user interprets the interface.
2. **Designer's Model**: The interface designer conveys the design.
3. **Programmer**: The programmer implements the design.

This flowchart shows the interaction between user, designer, and programmer in the context of software or interface design.
designer’s model

user’s model

classic usability research
but what if the system just does the wrong thing?

go this way instead?
focus on faithful projection of design model mapping, affordance/signifiers, gulfs

theory turned into practice through heuristics
8 Golden Rules (Shneiderman)
First Principles of Interaction Design (Tognazzini)
10 Usability Heuristics (Nielsen)

result: huge improvements in usability
anyone can design a great UI
If a simple model is not explicitly or implicitly provided, users formulate their own myths about how the system works... The system has to be designed with an explicit conceptual model that is easy enough for the user to learn.

Stuart Card & Thomas Moran (1986)
should Facebook concepts be desynchronized too?

Concept: Upvote
Purpose: Rank items by popularity
Actions: Upvote (u: User, i: Item)

Concept: Reaction
Purpose: Convey emotion to author
Actions: ReactAngry (u: User, i: Item)

Unwanted sync?