introduction
my background

MA in Physics, Oxford University

PhD in Computer Science, MIT

Prof, MIT

Assistant Prof, CMU
other projects

cyberphysical security

new programming paradigms
changes in how we live & work
growth of online activity

72% of millennials research & shop online before going to a store

27 metro areas in US
connectivity
** Sabre reservation system **

<table>
<thead>
<tr>
<th>MARRIOTT SENIOR DISC.</th>
<th>305.00 USD GUAR /C-6P</th>
</tr>
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<tbody>
<tr>
<td>TTL TAX</td>
<td>132.67</td>
</tr>
<tr>
<td>APPROX. TOTAL PRICE</td>
<td>1047.67 USD</td>
</tr>
<tr>
<td>INCLUDES TAXES AND SURCHARGES</td>
<td></td>
</tr>
<tr>
<td>MARRIOTT SENIOR DISCOUNT RATE, 62 YEARS AND OLDER VALID ID REQUIRED GUEST ROOM, 1 KING OR 2 DOUBLE, CENTER OR PARK, POOL PLACE BED TYPE AND NS FEES IN /ST US GOVERNMENT SAFETY/FITN MD</td>
<td></td>
</tr>
<tr>
<td>** SABRE **</td>
<td></td>
</tr>
<tr>
<td>ADDITIONAL FEES - MB FOR</td>
<td></td>
</tr>
<tr>
<td>AIRPORT SHUTTLE - N-</td>
<td></td>
</tr>
<tr>
<td>CAR RENTAL COUNTER - N-</td>
<td></td>
</tr>
<tr>
<td>PARKING</td>
<td>-Y-</td>
</tr>
<tr>
<td>CHECK IN</td>
<td>-1600</td>
</tr>
<tr>
<td>CHECK OUT</td>
<td>-1200</td>
</tr>
</tbody>
</table>

** Property Information **

| FITN -Y- | CSNO -N- |
| TENS -N- | BCTR -Y- |
| CONV -Y- | PETS -Y- |
| JACZ -N- | BKST -N- |
| INTR -Y- | RMSV -Y- |
| EXEC -Y- | BECH -N- |

<hipmunk.com>
example: book publishing

**design layout**
Adobe InDesign

**printing**
Blurb

**marketing**
Facebook, Twitter, etc

**distribution**
Amazon
complexity

Braun SK4 by Dieter Rams (1957)

Apple iTunes (2016)
changes in how things are made
expectations of usability
an exciting launch

“Avon wanted to have the Avon lady enabled on the iPad so she could digitize the experience with the consumer... This was innovating a 100-year-old company and making it brand new again.”

AVON plans to use mobile technology to connect better with customers

SAP Sapphire Event (2011)
“While the new system based on software supplied by SAP AG worked as planned, it was so burdensome and disruptive to the representatives’ daily routine that they left in meaningful numbers.”

Avon spokesperson

Avon is pulling the plug on a $125 million software system...

The failure is the latest – and perhaps most dramatic – example of how usability has become a critical issue in the workplace. People who are accustomed to using simple, well-designed applications in their personal lives have no patience for disappointing technology at work...

Wall Street Journal (2013)
Apple vs Foxconn profit margins
iPhone 5: where the money goes

- Foxconn: $8
the emergence of design
progression from craft

The first scheme represents the unselfconscious situation described in Chapter 4. Here the process which shapes the form is a complex two-directional interaction between the context C1 and the form F1, in the world itself. The human being is only present as an agent in this process. He reacts to misfits by changing them; but is unlikely to impose any "designed" conception on the form.

The second scheme represents the selfconscious situation described in Chapter 5. Here the design process is remote from the ensemble itself; form is shaped not by interaction between the actual context’s demands and the actual inadequacies of the form, but by a conceptual interaction between the conceptual picture of the context which the designer has learned and invented, on the one hand, and ideas and diagrams and drawings which stand for forms, on the other. This interaction contains both the probing in which the designer searches the problem for its major "issues," and the development of forms which satisfy them; but its exact nature is unclear. In present design practice, this critical step, during which the problem is prepared and translated into design, always depends on some kind of intuition. Though design is by nature imaginative and intuitive, and we could easily trust it if the designer’s intuition were reliable, as it is it inspires very little confidence.

In the unselfconscious process there is no possibility of misconstruing the situation: nobody makes a picture of the context, so the picture cannot be wrong. But the selfconscious designer works entirely from the picture in his mind, and this picture is almost always wrong.

The way to improve this is to make a further abstract picture of our first picture of the problem, which eradicates
- Dieter Rams, 1958
  pocket transistor radio T3

- Leica, 1953
  M3 rangefinder camera

- Jony Ive, 2002
  Apple iPod

- IBM, 1981
  Personal computer

- Alfonso Bialetti, 1933
  La Moka coffee maker

- Fred Bould (2011)
  Nest thermostat
from digital to physical

Fred Bould (2011)
Nest thermostat

Henry Dreyfuss (1953)
Honeywell T68 thermostat

Fuji (2013?)
Instax 90 film camera

iOS6 clock app

Swiss Federal Railways SBB clock
inclusive design

Bradley watch from Eone
design goes mass market

Michael Graves (1934-2015)

Michael Graves (1985)
Alessi 9093 tea kettle

Michael Graves (1999)
Target spinner whistle tea kettle
design consultancies

- IDEO
- Frog
  acquired by Flextronics
  (2004)
- Fjord
  acquired by Accenture
  (2013)

- 2011: GlobalLogic buys Method
- 2012: Google buys Mike and Maaike
- 2013: Facebook buys HotStudio
design schools & programs

Stanford D School founded 2004 by David Kelley and George Kembel
design thinking for business

CREATIVE CONFIDENCE
UNLEASHING THE CREATIVE POTENTIAL WITHIN US ALL.

by Tom Kelley
BESTSELLING AUTHOR OF THE ART OF INNOVATION

& David Kelley
FOUNDER, IDEO & STANFORD D.SCHOOL
coworking + maker spaces
a startup whose founders met at RISD
IBM (re)embraces design

**Eliot Noyes (1961)**
IBM Selectric Typewriter

IBM’s design studio in Austin, Texas
what is design thinking?
theories of design
what is design?

The central concern of Design is the conception and realisation of new things. It encompasses the appreciation of material culture and the application of the arts of planning, inventing, making and doing. At its core is the language of modelling... equivalent to aptitudes in the language of the sciences (numeracy) and the language of humanities (literacy).

Design has its own distinct things to know, ways of knowing them, and ways of finding out about them.

Nigel Cross (1982)
Designerly Ways of Knowing
excerpted from RCA report
user centeredness

translation:
“please load letter-sized paper into paper cassette”
diversity of contributors

anthropology

psychology

art

economics
attention to detail

That’s quite obsessive, isn’t it?
Jonathan Ive in “Objectified”

The details are not the details. These make the design.
attributed to Charles Eames by Garrett
example: signatures in Apple Preview

Sign your name in black ink on a small piece of white paper.

Hold the paper up to your Mac's camera so your signature rests on the blue line.

Save this signature for use after Preview quits

Accept
needfinding

The need itself is a perceived lack, something that is missing. Needfinding is thus a paradoxical activity—what is sought is a circumstance where something is missing. In order to find and articulate a need, this missing thing must be seen and recognized by someone.

users don’t know what they want

new recipe won blind taste tests

Aeron office chair low ratings in early tests
brainstorming

diagram from Tim Brown, IDEO
prototypes & user studies
paper prototypes
where did requirements & design go?
so what is software design?
<table>
<thead>
<tr>
<th>elements</th>
<th>designer</th>
<th>engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>door, window, wall</td>
<td></td>
<td>column, beam, truss</td>
</tr>
<tr>
<td>goals</td>
<td>comfortable, convenient, attractive</td>
<td>structural integrity, durable, sustainable</td>
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</tbody>
</table>
# Software Design & Engineering

<table>
<thead>
<tr>
<th>Elements</th>
<th>Designer</th>
<th>Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concepts</td>
<td>function, object, type</td>
<td></td>
</tr>
<tr>
<td>Criteria</td>
<td>concept/purpose correspondence</td>
<td>decoupling &amp; localization</td>
</tr>
<tr>
<td>Goals</td>
<td>learnable, effective, tolerant</td>
<td>maintainable, correct, fast</td>
</tr>
</tbody>
</table>
software
design
tools
concepts
structuring functionality
modeling concepts
focused data models
usability heuristics
well known principles
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
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
the fundamental principle

in a well-designed system
each concept is motivated by one purpose
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
organizing concepts
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
facebook concepts

reply

comment

friend

post

tag

user
tag concept

**Real purpose:** increase connectivity of friend graph?

**Purpose:** share photo with people who appear in it

**Operational principle:** if you tag a photo, then it becomes visible to the person tagged, and to their friends (in addition to your friends)

**Misfit:** suppose I get drunk at a party with strangers and one of them tags me. If my boss is my friend, she will now see the photo.
skype concepts
skype concepts

- contact list
- text
- hold

user

- call
**Hold concept**

**Why not just allow concurrent calls?**

**Purpose:** make it possible to multiplex calls

**Operational principle:** if you put a call on hold, you can answer another call, and then switch back to the first one by putting that on hold (or ending it) and resuming the first.
modeling
The central concern of Design is the conception and realisation of new things. It encompasses the appreciation of material culture and the application of the arts of planning, inventing, making and doing.

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Nigel Cross (1982)
Designerly Ways of Knowing
excerpted from RCA report
who can see the image?

all i: Image | sees.i = (posts.i).friends + (i.tags).friends

_textual constraint in Alloy_
modeling data (ie, state)

Set_1 \quad \text{relation} \quad \text{Set_2}

means that:
the state includes two sets Set1 and Set2
and a relation that associates elements of Set1 with elements of Set2
gmail labels

constraint that explains conversation labels:

\[ \text{all } c: \text{Conversation} \mid c.\text{clabels} = c.\text{msgs}.\text{mlabels} \]
search for unlabelled messages
in conversation view, shows conversations
any conversation that contains an unlabelled message
but this conversation may appear to be labelled

no ops?
deleting then adding a label
adding then deleting a label
both can modify a conversation

a puzzle
can a conversation have a Sent label?
skype data

User

? number +

Phone Number

Call

participants, pending, on hold

participants

OnHold

participants, pending, on hold

Participants

how many users/number

how many numbers/user?

can initiator change?

no special participants?

no, it’s a relation!

is OnHold a set of calls?
heuristics
sources of heuristics

Jakob Nielsen
10 Usability Heuristics

Ben Shneiderman
8 Golden Rules

Don Norman
Design of Everyday Things

Bruce Tognazzini
First Principles of Interaction Design
consensus heuristics

visibility
  of functions, state, feedback

consistency
  within app, platform, domain, culture

constraints
  prevent errors
platform consistency

design lesson: make sure same name or symbol used for a function or feature throughout

icons shown in Google Drive
cultural consistency

why is ‘History’ greyed out?
heuristic: information scent

design lesson: give good scent to aid information ‘foraging’
conclusions

design thinking
will change software development

brings good ideas
user-centeredness
incrementality
prototypes

applied to software
focused data models
usability heuristics
concepts & purposes

to learn more, see references at http://tinyurl.com/acn.refs