Principles of GUI Design and Programming

Design Guidelines

Contents

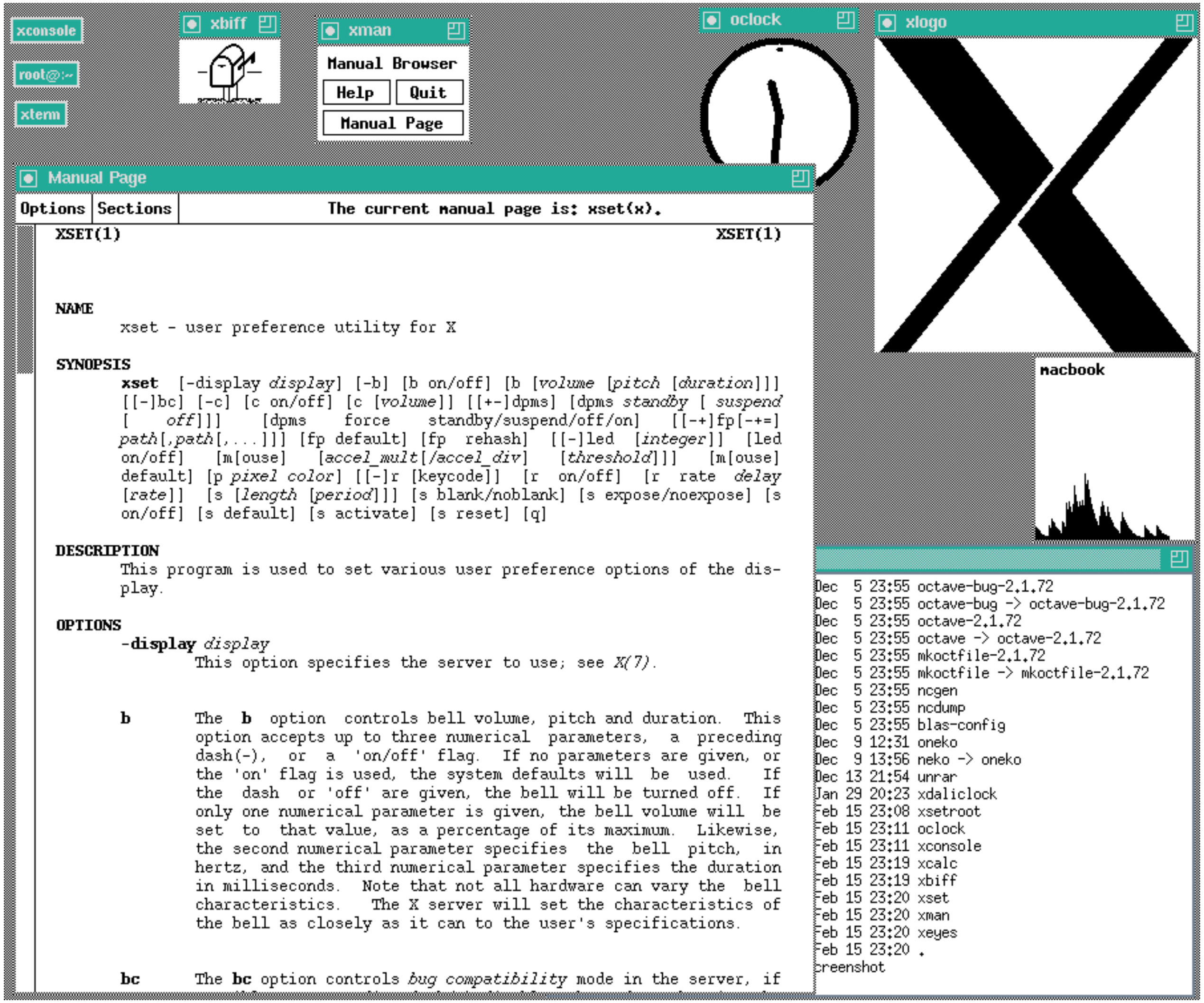
- platforms
- Platform guidelines
- Design guidelines

Platforms

- The platform on which a GUI runs is
  - The hardware on which it runs
  - The screen on which it is displayed
  - The operating system
  - The windowing system in use
  - The GUI toolkit used

- Most commercial operating systems
  - Provide a single toolkit common to all hardware on which the operating system runs

X Windows -- Athena

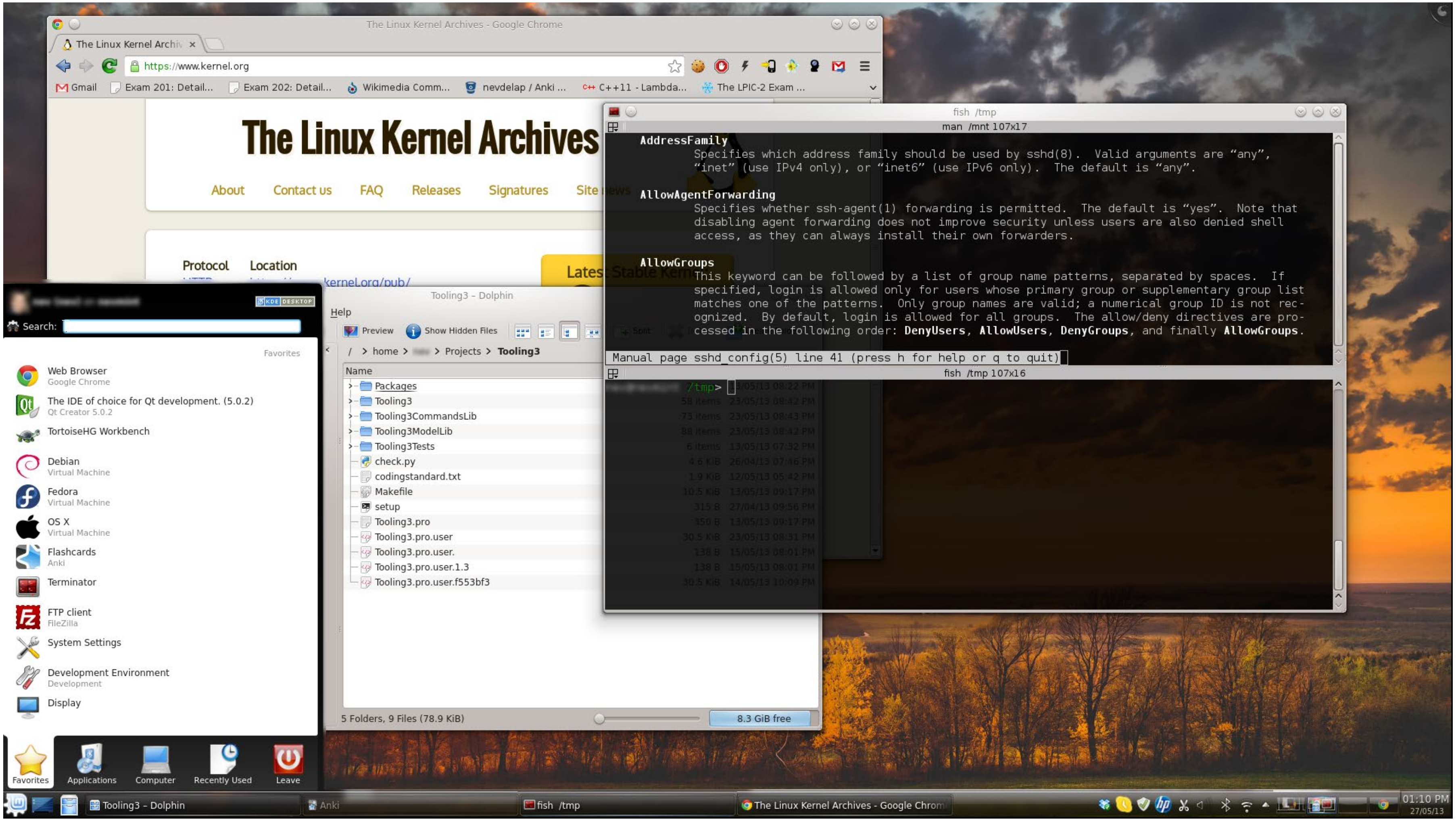


```
XSET(1)                                                         XSET(1)



NAME
       xset - user preference utility for X

SYNOPSIS
       xset  [-display display] [-b] [b on/off] [b [volume [pitch [duration]]]
       [[-]bc] [-c] [c on/off] [c [volume]] [[+-]dpms] [dpms standby [ suspend
       [    off]]]    [dpms    force    standby/suspend/off/on]    [[-+]fp[-+=]
       path[,path[,...]]] [fp default] [fp  rehash]  [[-]led  [integer]]  [led
       on/off]    [m[ouse]    [accel_mult[/accel_div]    [threshold]]]    [m[ouse]
       default] [p pixel color] [[-]r [keycode]]  [r  on/off]  [r  rate  delay
       [rate]]  [s [length [period]]] [s blank/noblank] [s expose/noexpose] [s
       on/off] [s default] [s activate] [s reset] [q]

DESCRIPTION
       This program is used to set various user preference options of the dis-
       play.

OPTIONS
       -display display
              This option specifies the server to use; see X(7).


       b      The  b  option  controls bell volume, pitch and duration.  This
              option accepts up to three numerical  parameters,  a  preceding
              dash(-),  or  a  'on/off' flag.  If no parameters are given, or
              the 'on' flag is used, the system defaults will  be  used.   If
              the  dash  or  'off' are given, the bell will be turned off.  If
              only one numerical parameter is given, the bell volume will  be
              set  to  that value, as a percentage of its maximum.  Likewise,
              the second numerical parameter specifies  the  bell  pitch,  in
              hertz, and the third numerical parameter specifies the duration
              in milliseconds.  Note that not all hardware can vary the  bell
              characteristics.  The X server will set the characteristics of
              the bell as closely as it can to the user's specifications.


       bc     The bc option controls bug compatibility mode in the server, if
```

```
Dec  5 23:55 octave-bug-2.1.72
Dec  5 23:55 octave-bug -> octave-bug-2.1.72
Dec  5 23:55 octave-2.1.72
Dec  5 23:55 octave -> octave-2.1.72
Dec  5 23:55 mkoctfile-2.1.72
Dec  5 23:55 mkoctfile -> mkoctfile-2.1.72
Dec  5 23:55 ncgen
Dec  5 23:55 ncdump
Dec  5 23:55 blas-config
Dec  9 12:31 oneko
Dec  9 13:56 neko -> oneko
Dec 13 21:54 unrar
Jan 29 20:23 xdaliclock
Feb 15 23:08 xsetroot
Feb 15 23:11 oclock
Feb 15 23:11 xconsole
Feb 15 23:19 xcalc
Feb 15 23:19 xbiff
Feb 15 23:20 xset
Feb 15 23:20 xman
Feb 15 23:20 xeyes
Feb 15 23:20 .
creenshot
```

By Liberal Classic - Liberal Classic, MIT, https://commons.wikimedia.org/w/index.php?curid=1680280

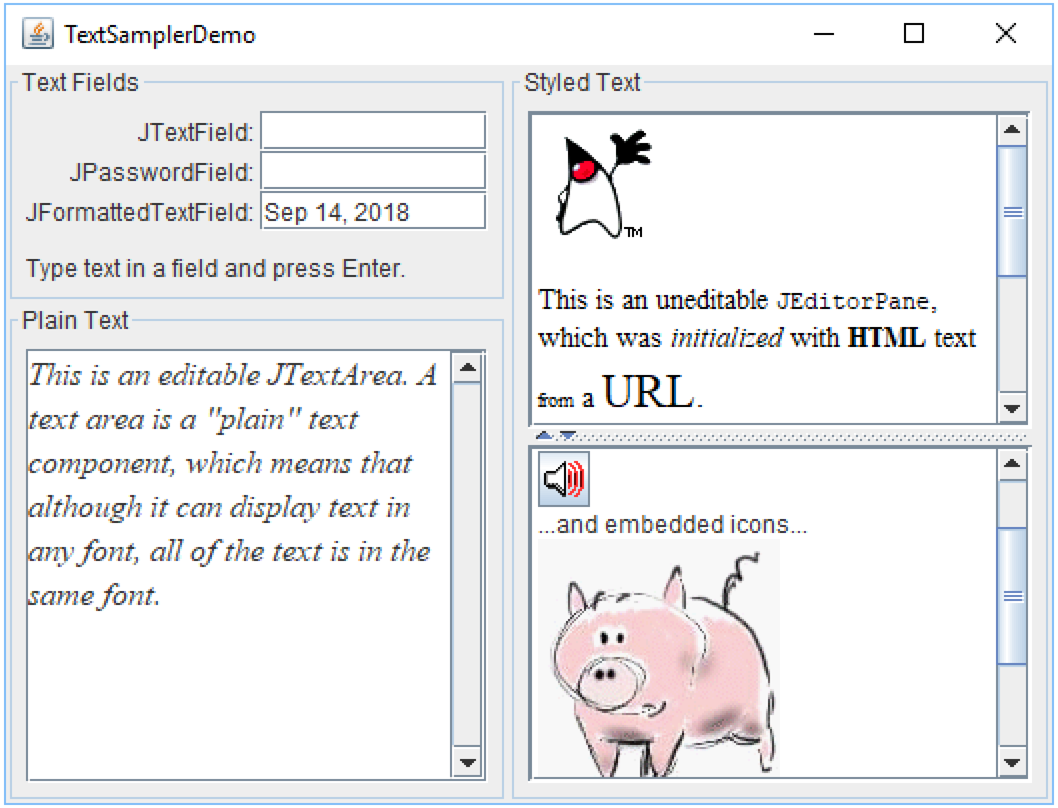
X Windows -- KDE



```
AddressFamily
        Specifies which address family should be used by sshd(8).  Valid arguments are “any”,
        “inet” (use IPv4 only), or “inet6” (use IPv6 only).  The default is “any”.

AllowAgentForwarding
        Specifies whether ssh-agent(1) forwarding is permitted.  The default is “yes”.  Note that
        disabling agent forwarding does not improve security unless users are also denied shell
        access, as they can always install their own forwarders.

AllowGroups
        This keyword can be followed by a list of group name patterns, separated by spaces.  If
        specified, login is allowed only for users whose primary group or supplementary group list
        matches one of the patterns.  Only group names are valid; a numerical group ID is not rec‐
        ognized.  By default, login is allowed for all groups.  The allow/deny directives are pro‐
        cessed in the following order: DenyUsers, AllowUsers, DenyGroups, and finally AllowGroups.
 Manual page sshd_config(5) line 41 (press h for help or q to quit)
```

```
[redacted] /tmp>
```

Java Swing



JTextField:

JPasswordField:

JFormattedTextField: Sep 14, 2018

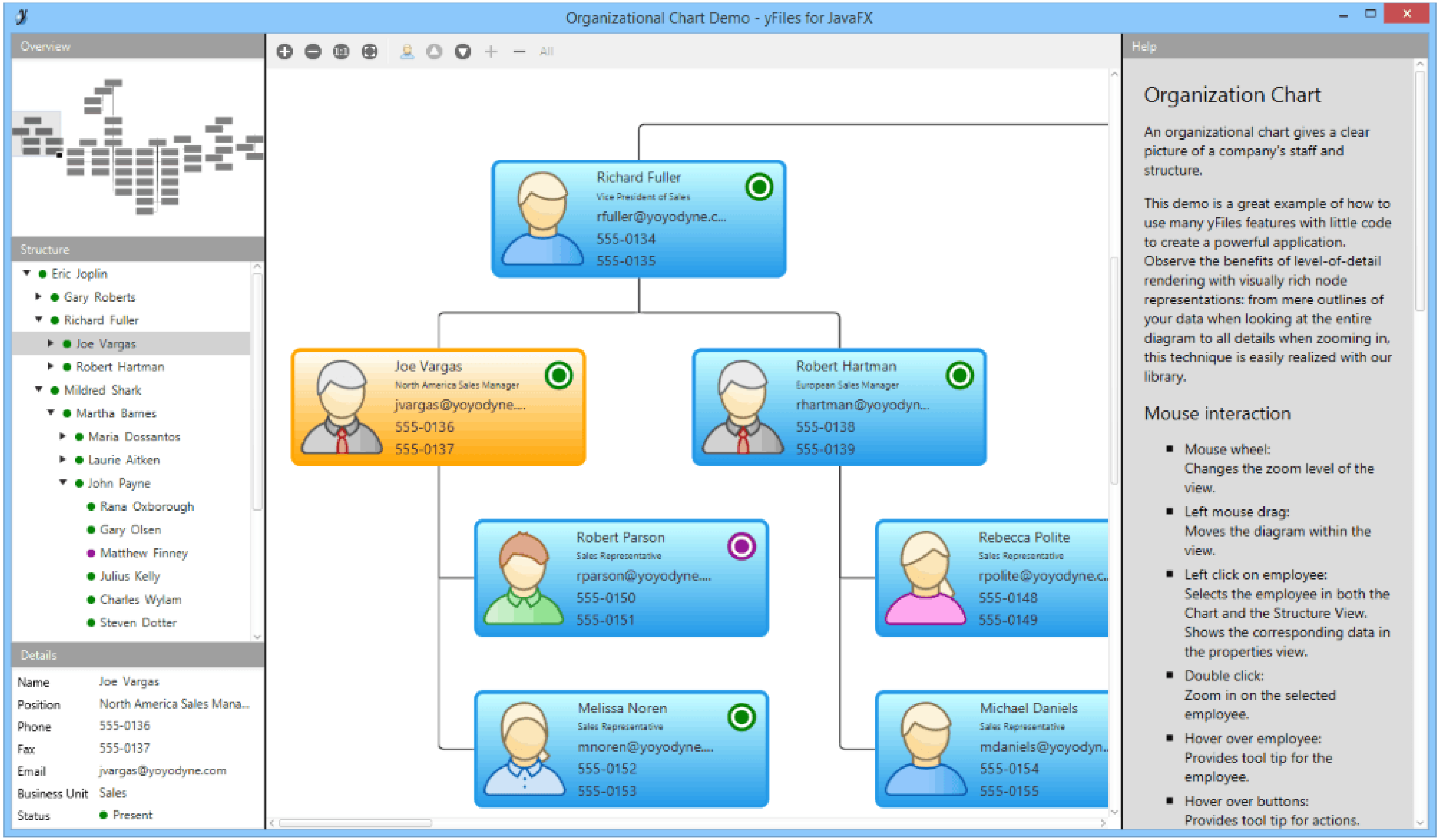
Type text in a field and press Enter.

This is an editable JTextArea. A text area is a "plain" text component, which means that although it can display text in any font, all of the text is in the same font.

This is an uneditable `JEditorPane`, which was *initialized* with **HTML** text from a URL.

...and embedded icons...

JavaFX



- ▼ ● Eric Joplin
  - ▶ ● Gary Roberts
  - ▼ ● Richard Fuller
    - ▶ ● Joe Vargas
    - ▶ ● Robert Hartman
  - ▼ ● Mildred Shark
    - ▼ ● Martha Barnes
      - ▶ ● Maria Dossantos
      - ▶ ● Laurie Aitken
      - ▼ ● John Payne
        - ● Rana Oxborough
        - ● Gary Olsen
        - ● Matthew Finney
        - ● Julius Kelly
        - ● Charles Wylam
        - ● Steven Dotter

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Business Unit	Sales
Status	● Present

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555-0135

Joe Vargas
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555-0153

Michael Daniels
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555-0154
555-0155

Organization Chart

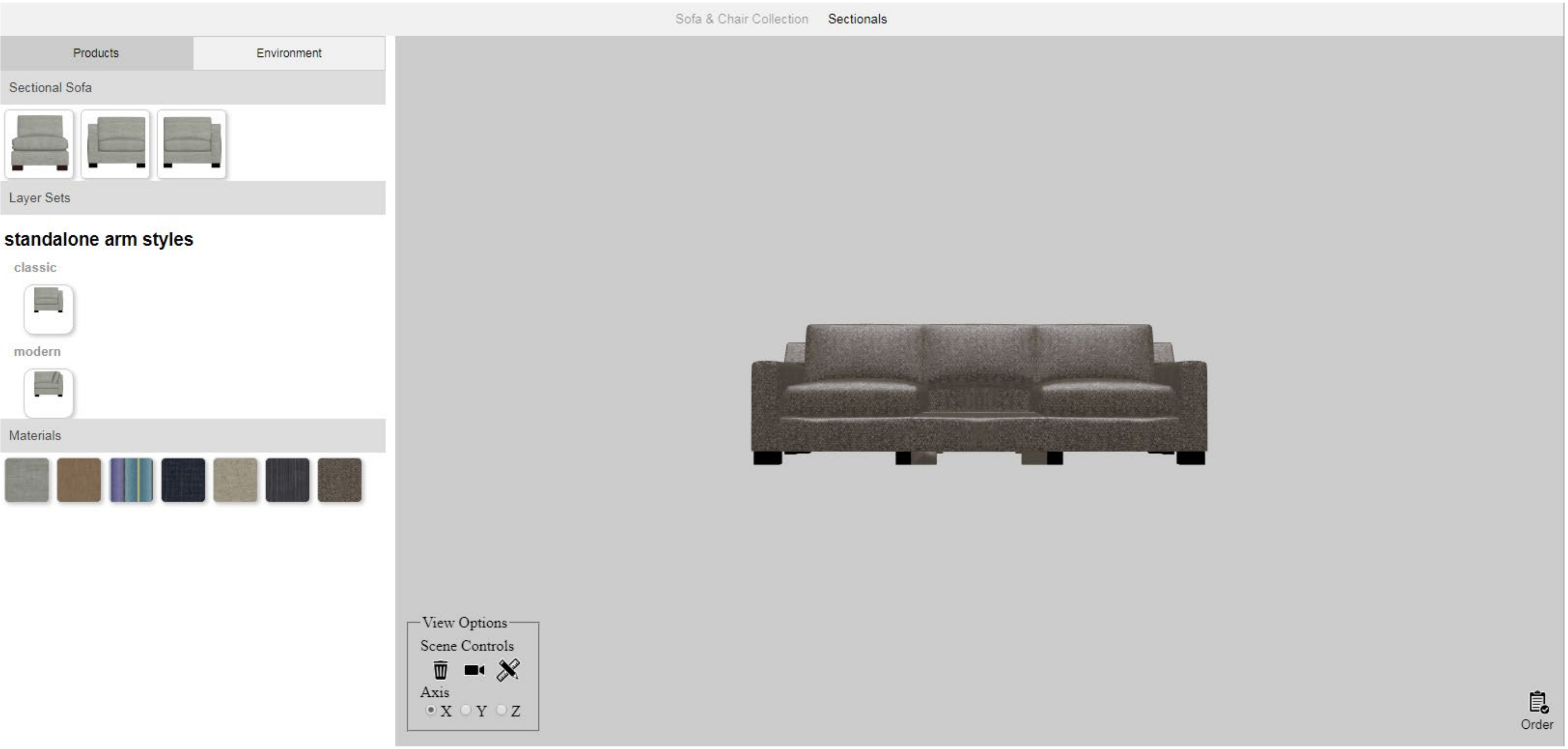
An organizational chart gives a clear picture of a company's staff and structure.

This demo is a great example of how to use many yFiles features with little code to create a powerful application. Observe the benefits of level-of-detail rendering with visually rich node representations: from mere outlines of your data when looking at the entire diagram to all details when zooming in, this technique is easily realized with our library.

Mouse interaction

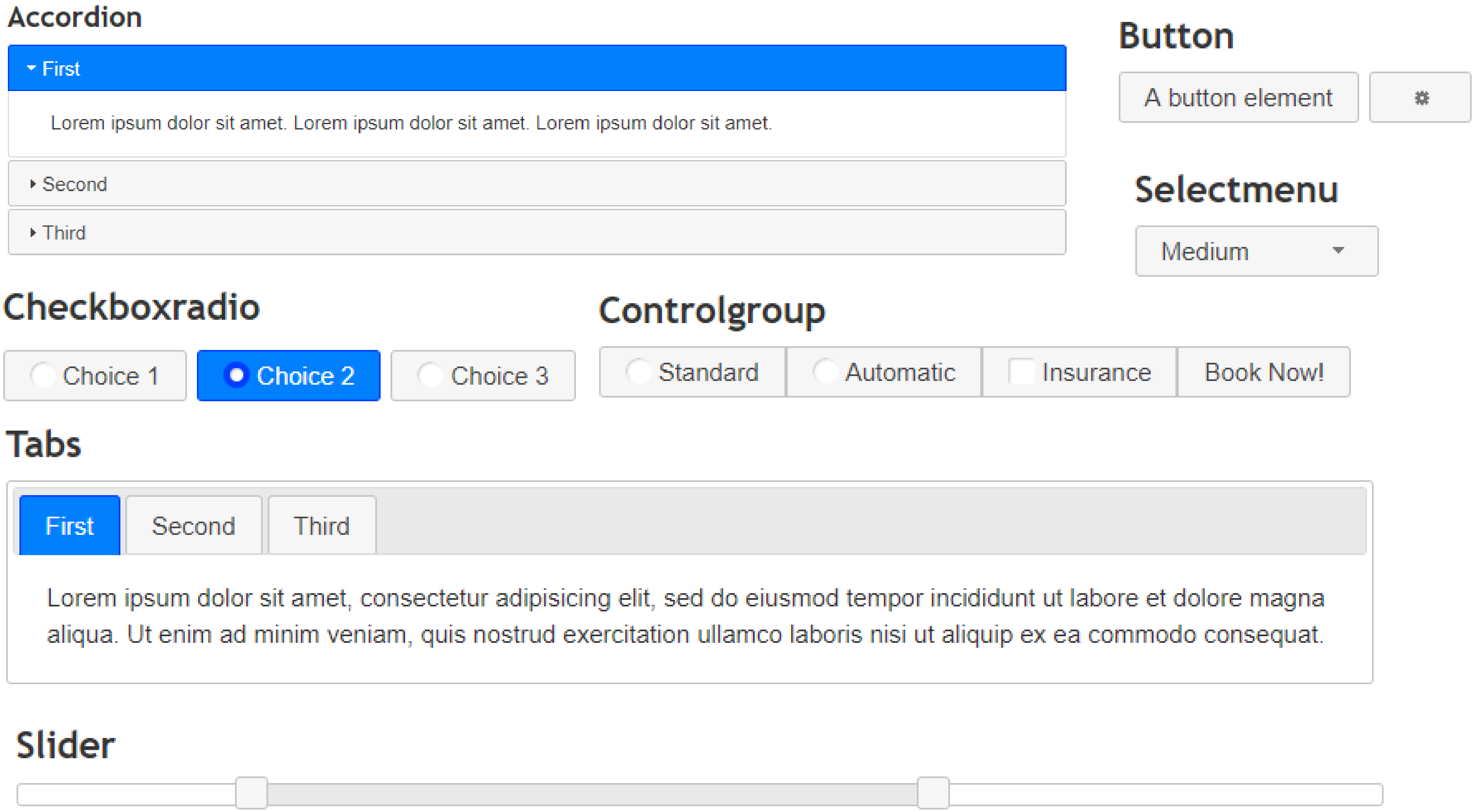
- Mouse wheel:
  Changes the zoom level of the view.
- Left mouse drag:
  Moves the diagram within the view.
- Left click on employee:
  Selects the employee in both the Chart and the Structure View. Shows the corresponding data in the properties view.
- Double click:
  Zoom in on the selected employee.
- Hover over employee:
  Provides tool tip for the employee.
- Hover over buttons:
  Provides tool tip for actions.

WebGL + JQueryUI + HTML5 + JavaScript



Axis
● X ○ Y ○ Z

JQueryUI



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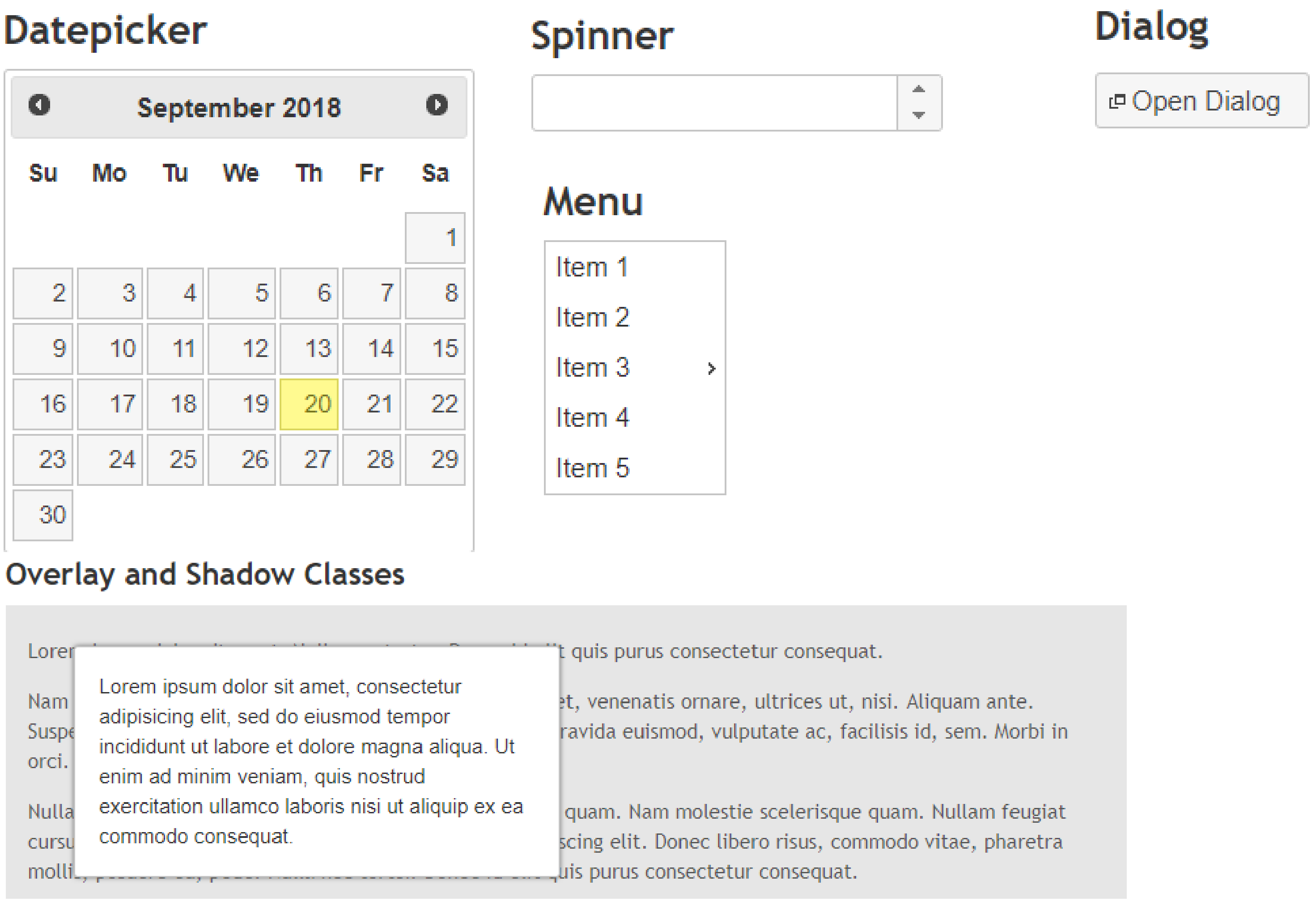
JQueryUI



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User Experience Design

User experience design (UXD or UED) is the process of enhancing customer satisfaction and loyalty by improving the usability, ease of use, and pleasure provided in the interaction between the customer and the product.

* Wikipedia

"User experience encompasses all aspects of the end-user's interaction with the company, its services, and its products."

*Don Norman

UX Design encompasses any and all interactions between a potential or active customer and a company. As a scientific process it could be applied to anything, street lamps, cars, Ikea shelving and so on.

* Emil Lamprecht

User Interface Design

User interface design focuses on the interface the user uses to interact with the product. This can strengthen branding and create an emotional experience for the user.

"… you're the tour guide that takes the user on a wonderful journey through your app. And in order to this, you have to be able to shift and move their attention from place to place guiding them."

* Harshita Arora

UI Design Measurements

- After you sketch your beautiful interface, you find
  - It is tiny and unreadable on a 4K display
  - It is so big it does not fit on a 640x480 screen
- The solution to this is to
  - Not use pixels to lay out your designs
  - Use a Device independent pixel (DPI or just DP)
  - There are then conversions from the DPI for various pixel densities found on screens
- Microsoft uses the formula
  - DIPs = pixels / (DPI/96.0)
- Android defines one inch of screen as 160 DPI and uses the pixel density of the screen to convert to pixels

UI Guidelines

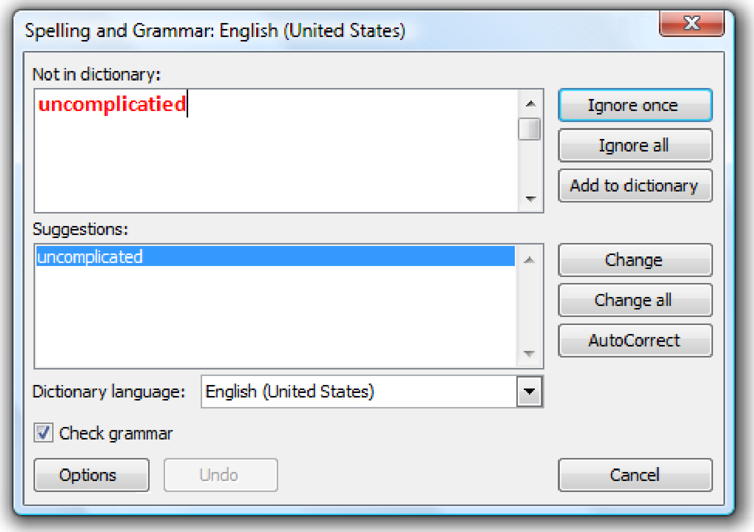
- Most of the major players has UI guidelines to use to develop on their platforms
- The goals of these guidelines are
  - To ensure that people use the right widgets
  - To ensure that interfaces built for the platform look alike and act alike

Microsoft Guidelines

- The Microsoft guidelines include
  - An overview of desirable properties of user interfaces
  - Guidelines of how to use controls
    - What they are good for
    - When to pick one over another
    - Guidelines on how to use each control

Microsoft – Powerful and Simple

Powerful:



Spelling and Grammar: English (United States)

Not in dictionary:

uncomplicatied

Suggestions:

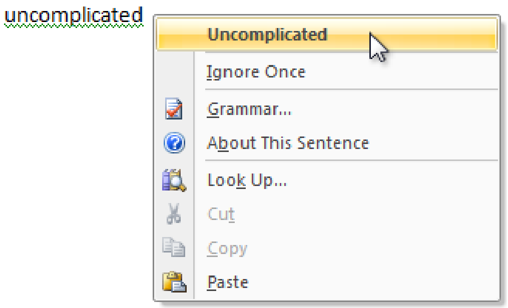
uncomplicated

Dictionary language: English (United States)

☑ Check grammar

Interfaces should be powerful and simple at the same time.

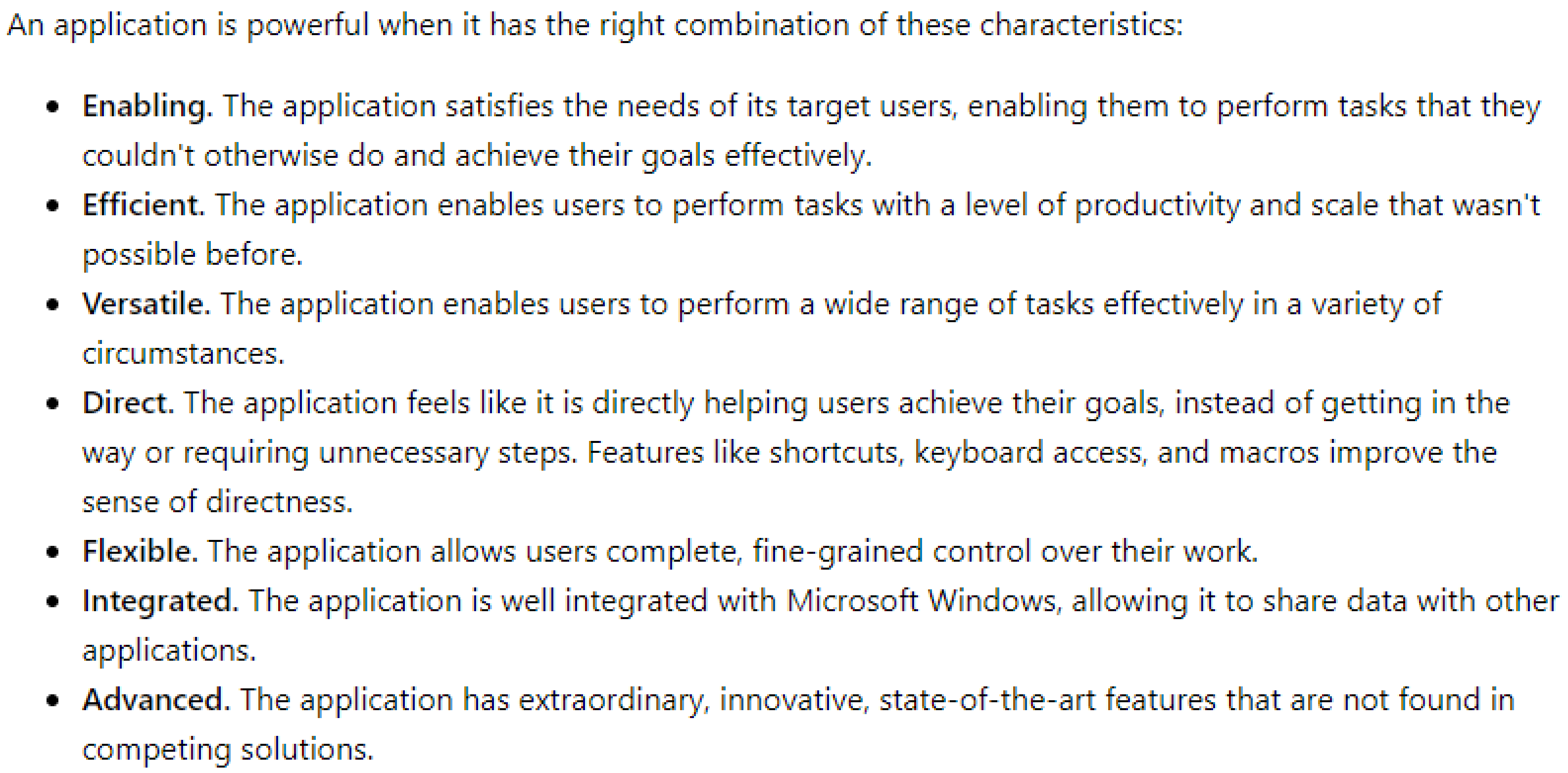
Powerful and simple:



uncomplicated

* Microsoft

Powerful Applications

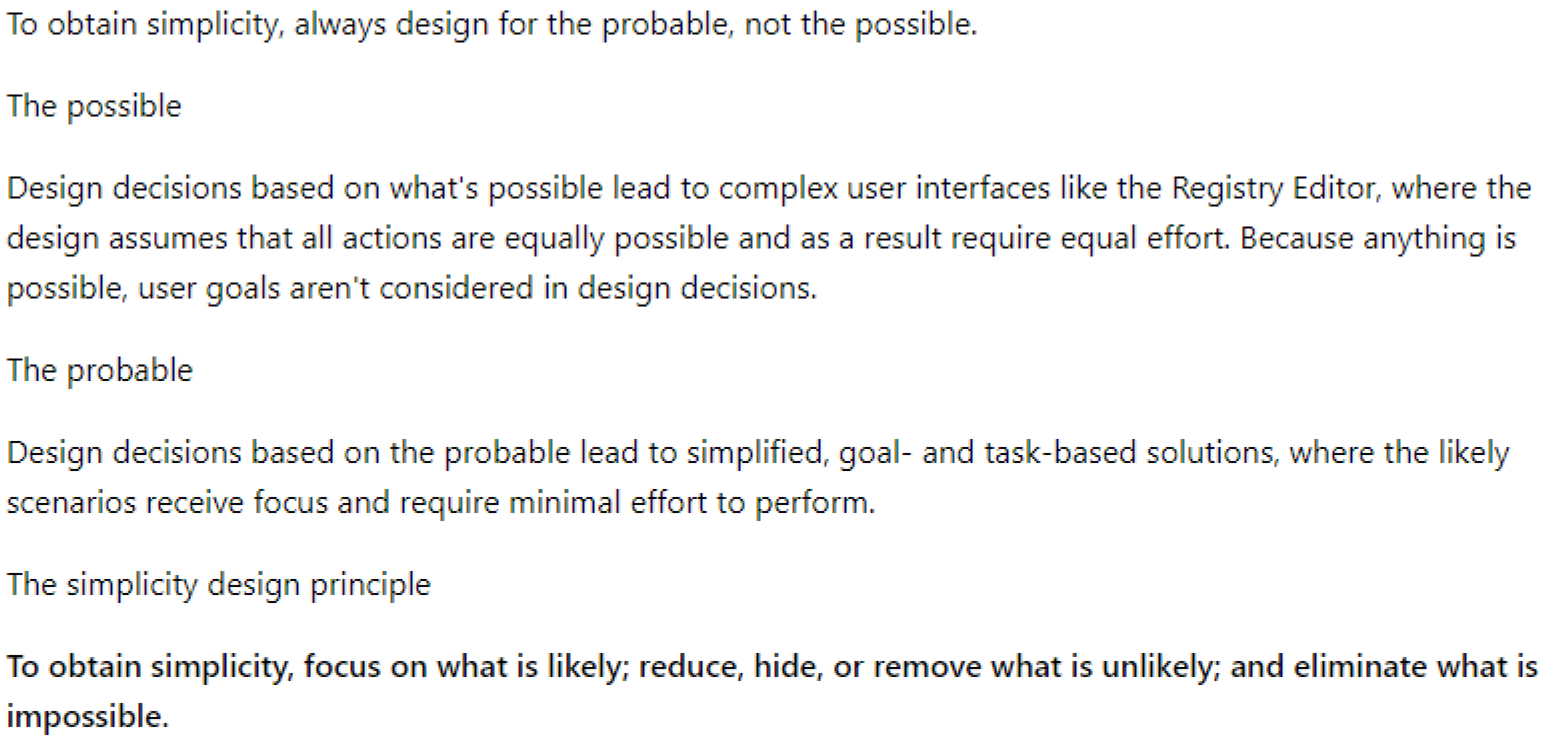


An application is powerful when it has the right combination of these characteristics:

- **Enabling.** The application satisfies the needs of its target users, enabling them to perform tasks that they couldn't otherwise do and achieve their goals effectively.
- **Efficient.** The application enables users to perform tasks with a level of productivity and scale that wasn't possible before.
- **Versatile.** The application enables users to perform a wide range of tasks effectively in a variety of circumstances.
- **Direct.** The application feels like it is directly helping users achieve their goals, instead of getting in the way or requiring unnecessary steps. Features like shortcuts, keyboard access, and macros improve the sense of directness.
- **Flexible.** The application allows users complete, fine-grained control over their work.
- **Integrated.** The application is well integrated with Microsoft Windows, allowing it to share data with other applications.
- **Advanced.** The application has extraordinary, innovative, state-of-the-art features that are not found in competing solutions.

* Microsoft

Simple Applications



To obtain simplicity, always design for the probable, not the possible.

The possible

Design decisions based on what's possible lead to complex user interfaces like the Registry Editor, where the design assumes that all actions are equally possible and as a result require equal effort. Because anything is possible, user goals aren't considered in design decisions.

The probable

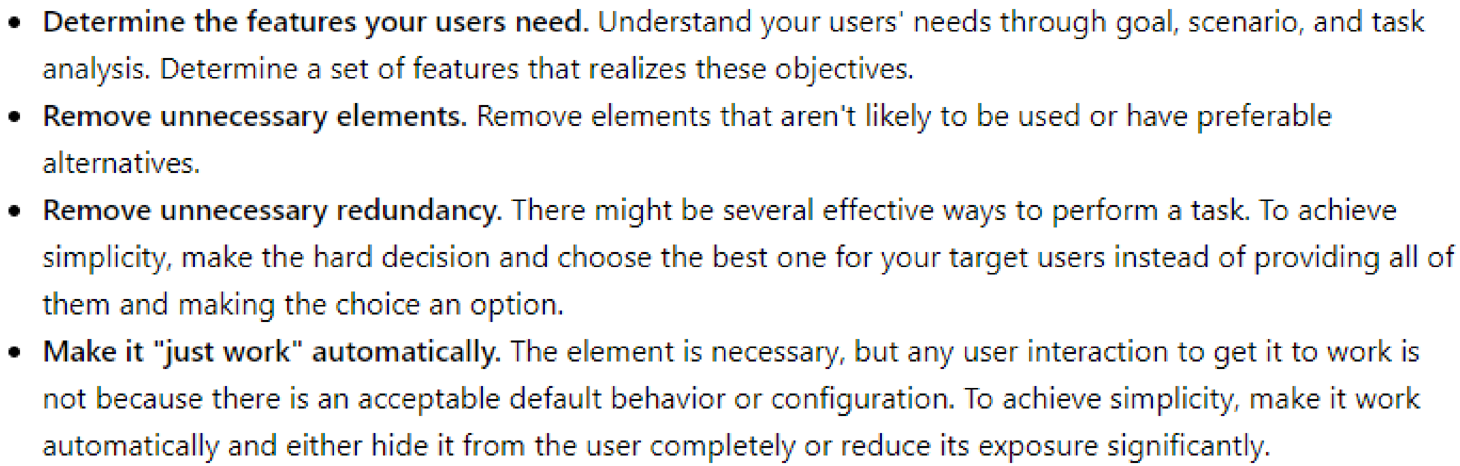
Design decisions based on the probable lead to simplified, goal- and task-based solutions, where the likely scenarios receive focus and require minimal effort to perform.

The simplicity design principle

To obtain simplicity, focus on what is likely; reduce, hide, or remove what is unlikely; and eliminate what is impossible.

* Microsoft

Simple Design Techniques



- **Determine the features your users need.** Understand your users' needs through goal, scenario, and task analysis. Determine a set of features that realizes these objectives.
- **Remove unnecessary elements.** Remove elements that aren't likely to be used or have preferable alternatives.
- **Remove unnecessary redundancy.** There might be several effective ways to perform a task. To achieve simplicity, make the hard decision and choose the best one for your target users instead of providing all of them and making the choice an option.
- **Make it "just work" automatically.** The element is necessary, but any user interaction to get it to work is not because there is an acceptable default behavior or configuration. To achieve simplicity, make it work automatically and either hide it from the user completely or reduce its exposure significantly.

* Microsoft

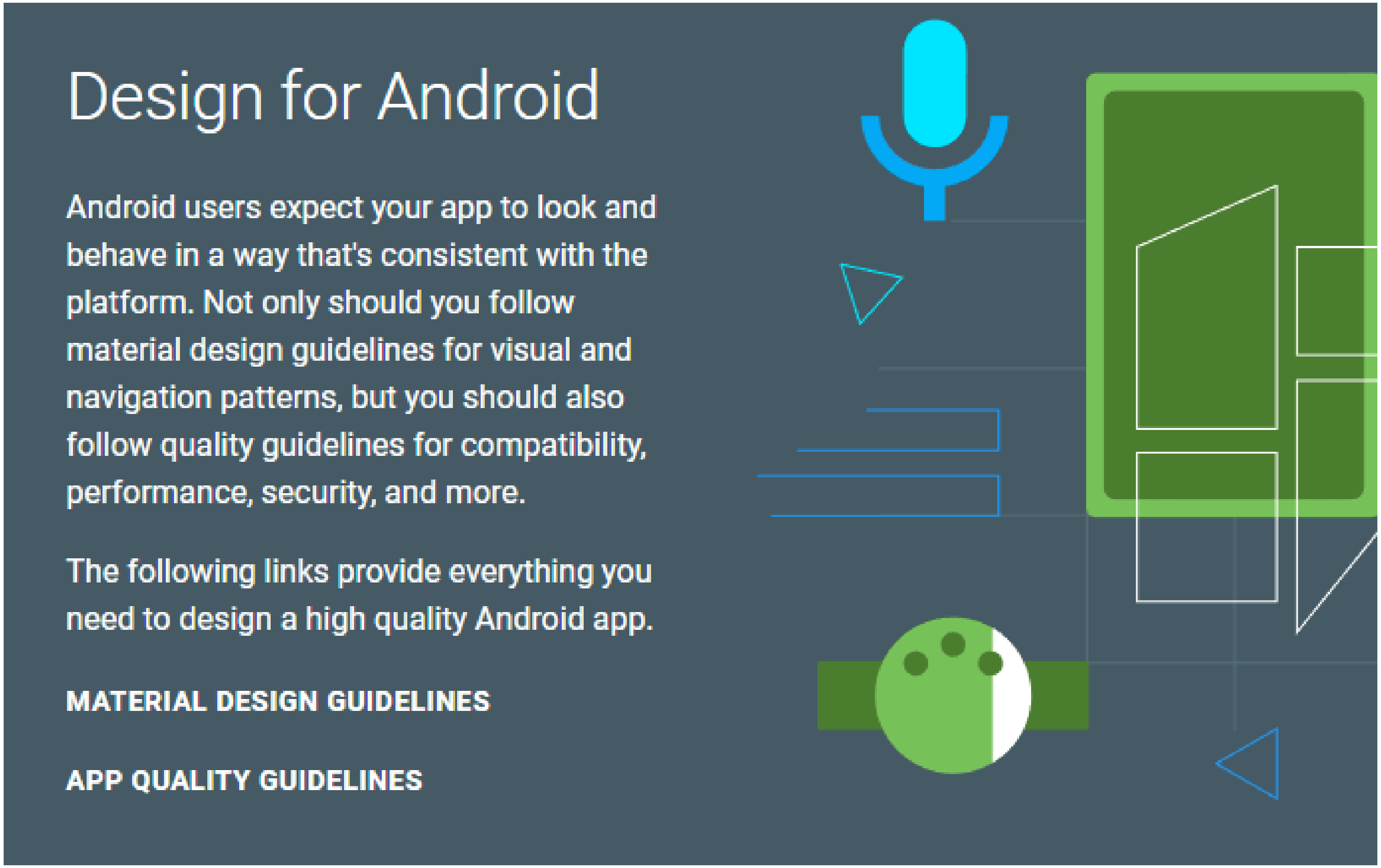
Checklist

- Windows
  - Support the minimum Windows effective resolution of 800x600 pixels.
  - Optimize resizable window layouts for an effective resolution of 1024x768 pixels
  - If a window is an owned window, initially display it "centered" on top of the owner window.
- Layout
  - Size controls and panes within a window to match their typical content.
- Text
  - Use ordinary, conversational terms when you can.
  - Use title-style capitalization for titles, and sentence-style capitalization for all other UI elements.
  - Don't use blue text that isn't a link, because users may assume that it is a link.
  - Use bold sparingly to draw attention to text users must read.

Checklist

- Controls
  - Label every control or group of controls.
  - Use controls which limit the input values, like sliders, when possible.
  - Provide at least 2 answer buttons for question dialogs and a cancel button.
  - Use tooltips for unlabeled controls.
  - Use progress bars for operations of indeterminate time.
  - Modal dialog boxes require interaction, so use them for things that users must respond to before continuing with their task.
  - Modeless dialog boxes don't require interaction, so use them when users need to switch between a dialog box and the owner window.

Android UI Guidelines



Design for Android

Android users expect your app to look and behave in a way that's consistent with the platform. Not only should you follow material design guidelines for visual and navigation patterns, but you should also follow quality guidelines for compatibility, performance, security, and more.

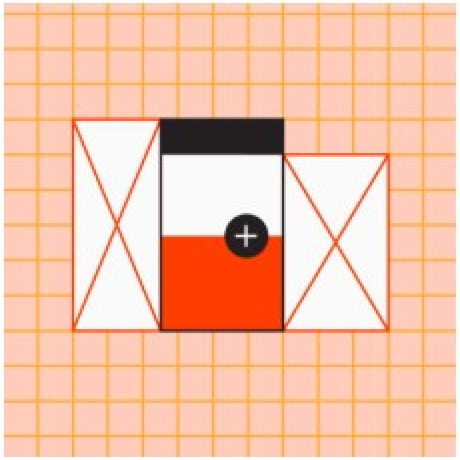
The following links provide everything you need to design a high quality Android app.

MATERIAL DESIGN GUIDELINES

APP QUALITY GUIDELINES

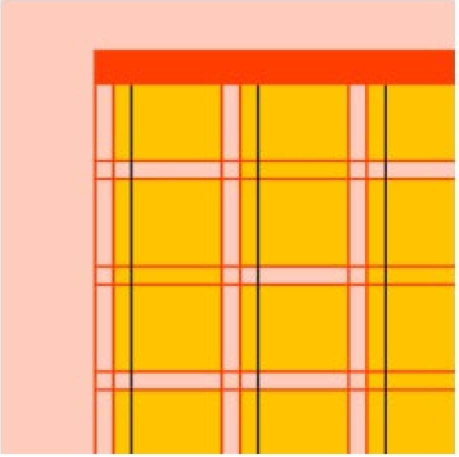
* developer.android.com

Android Principles



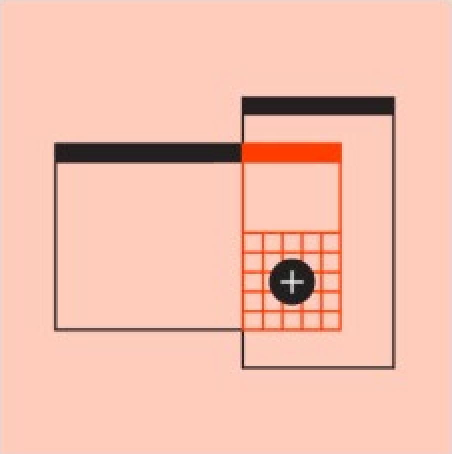
Predictable

UIs should use intuitive and predictable layouts, with consistent UI regions and spatial organization.



Consistent

Layouts should use a consistent grid, keylines, and padding.



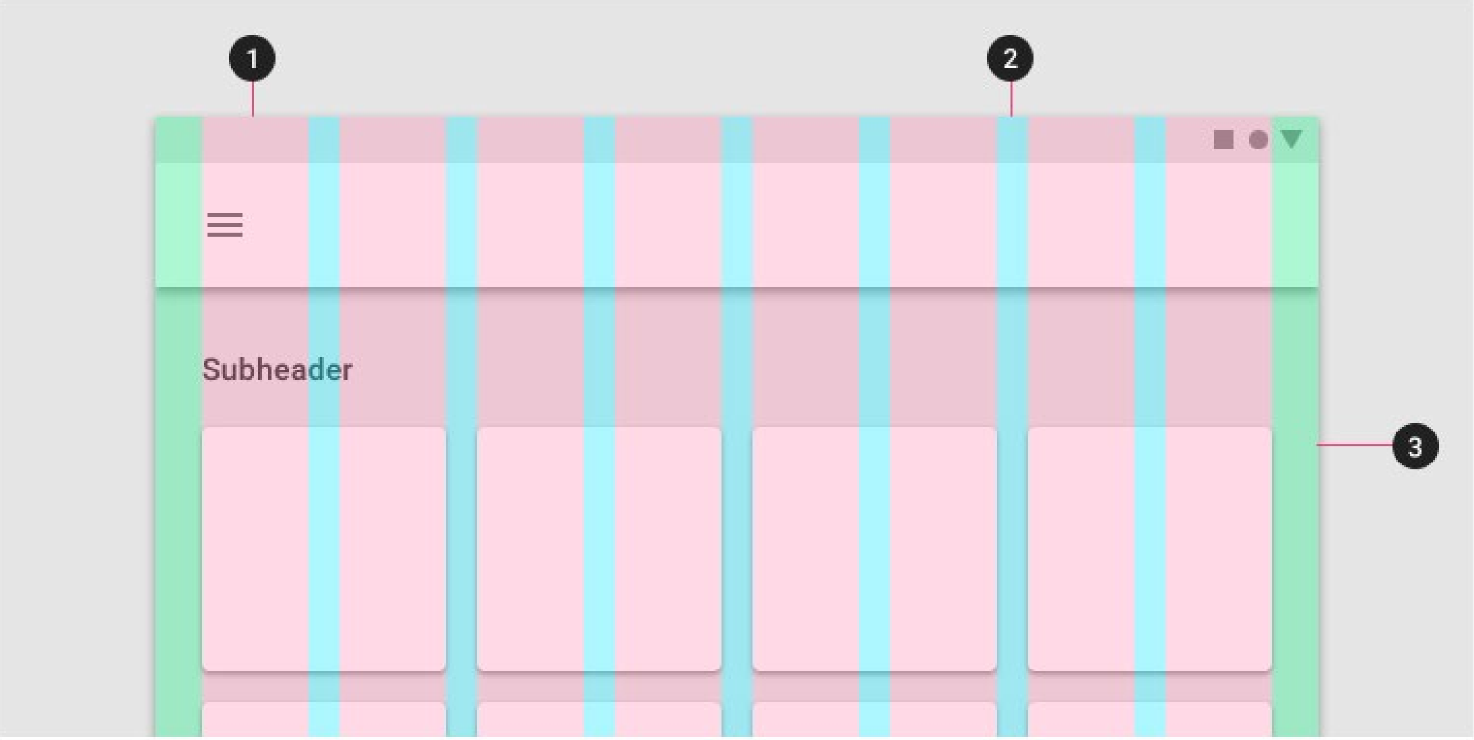
Responsive

Layouts are adaptive and react to input from the user, device, and screen elements.

* developer.android.com

Layout

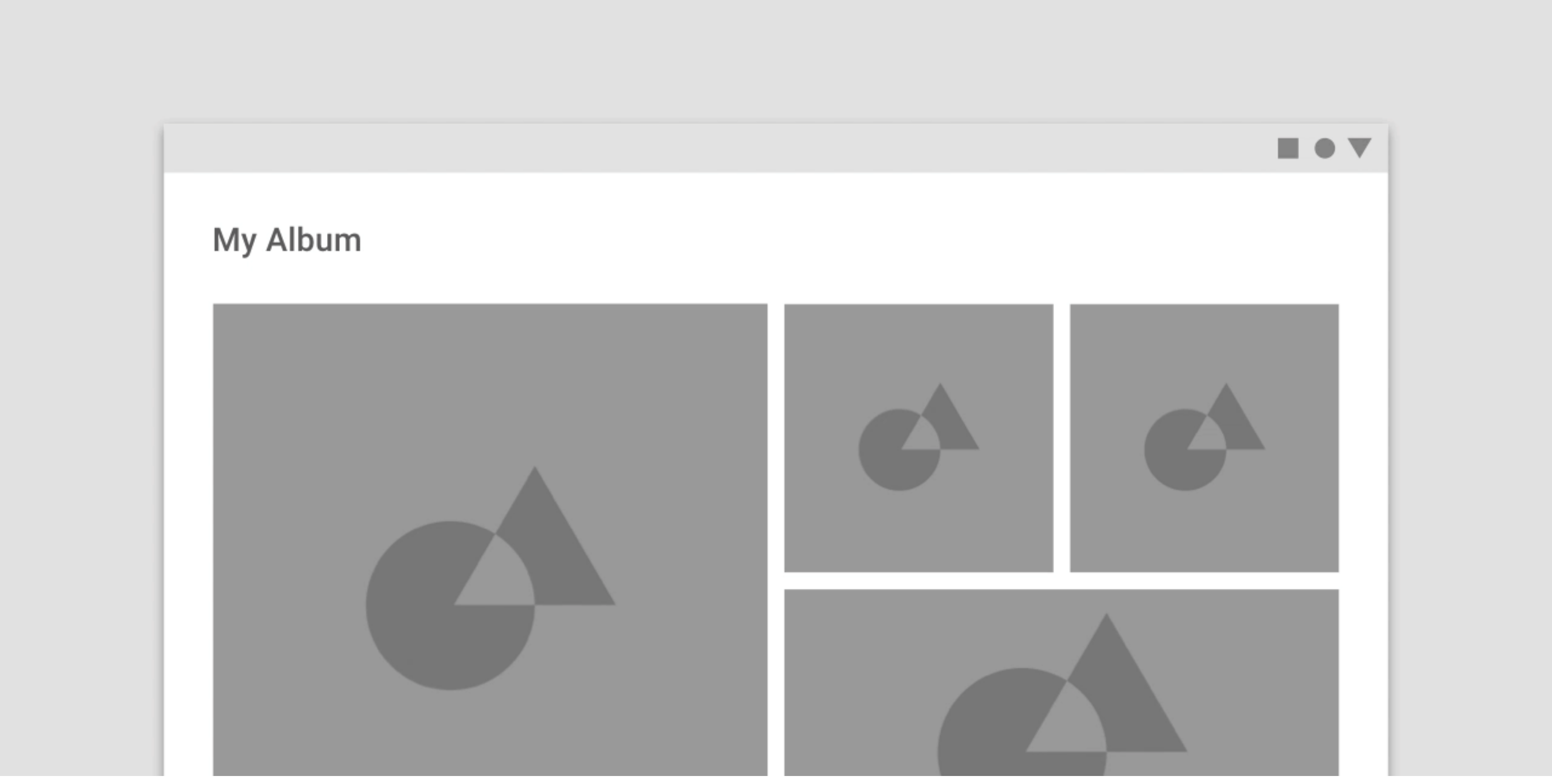
The Material Design layout grid is made up of three elements: columns, gutters, and margins.



1. Columns
2. Gutters
3. Margins

* developer.android.com

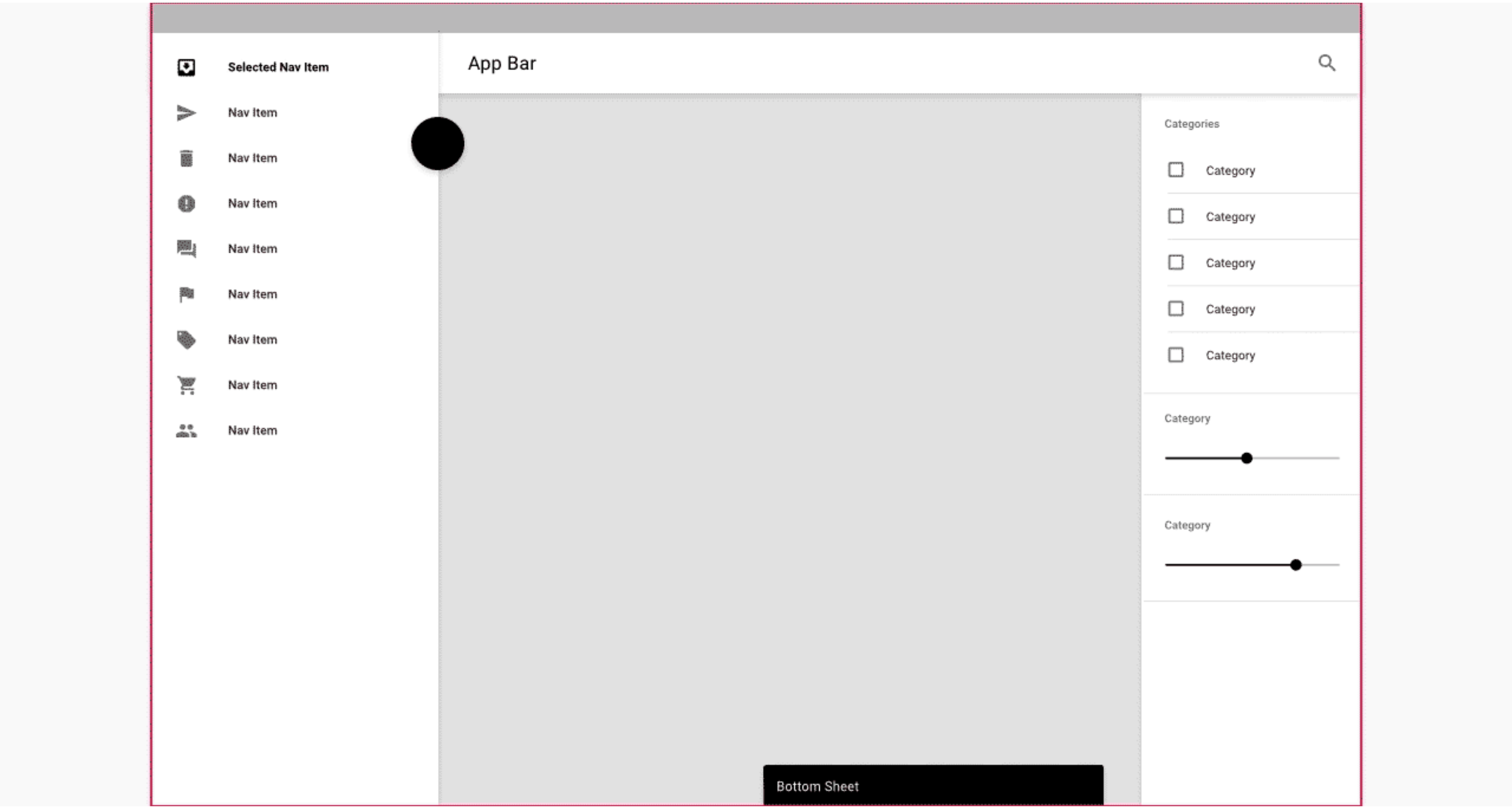
Layout



* developer.android.com

Android applications should be laid out using the grid to lay out the applications in rows and columns.

UI Regions

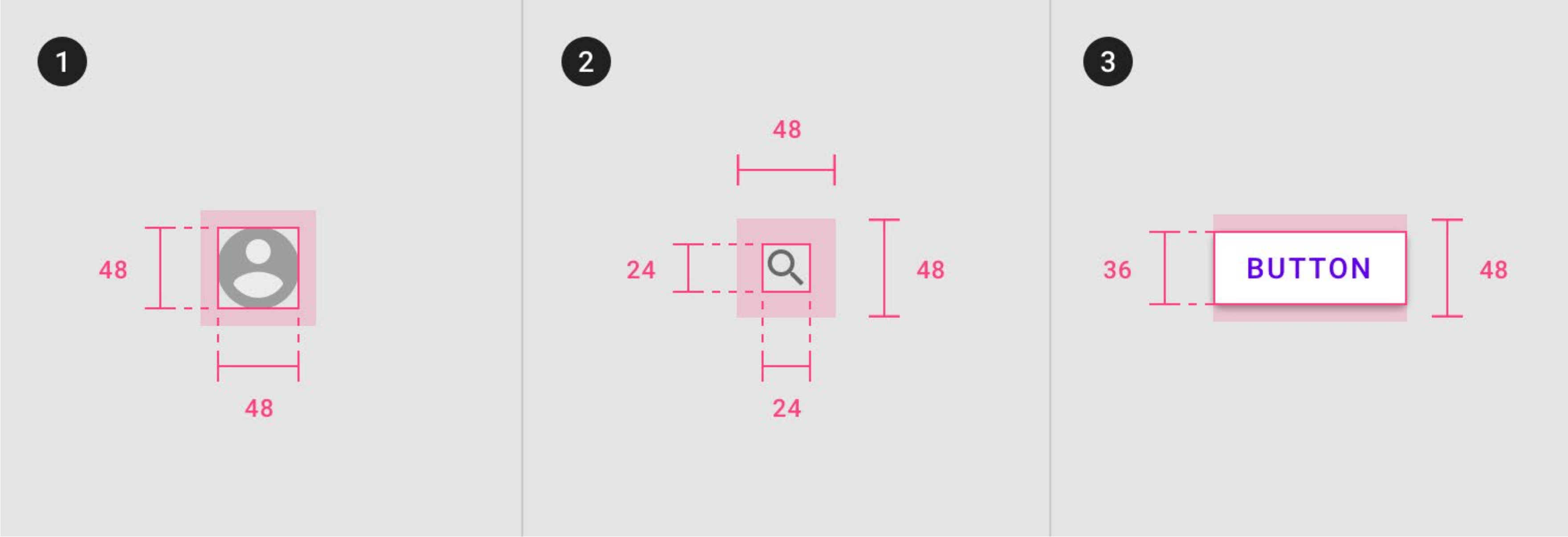


* developer.android.com

A UI is broken into:

side navigation, content and app bars.

Touch Targets



* developer.android.com

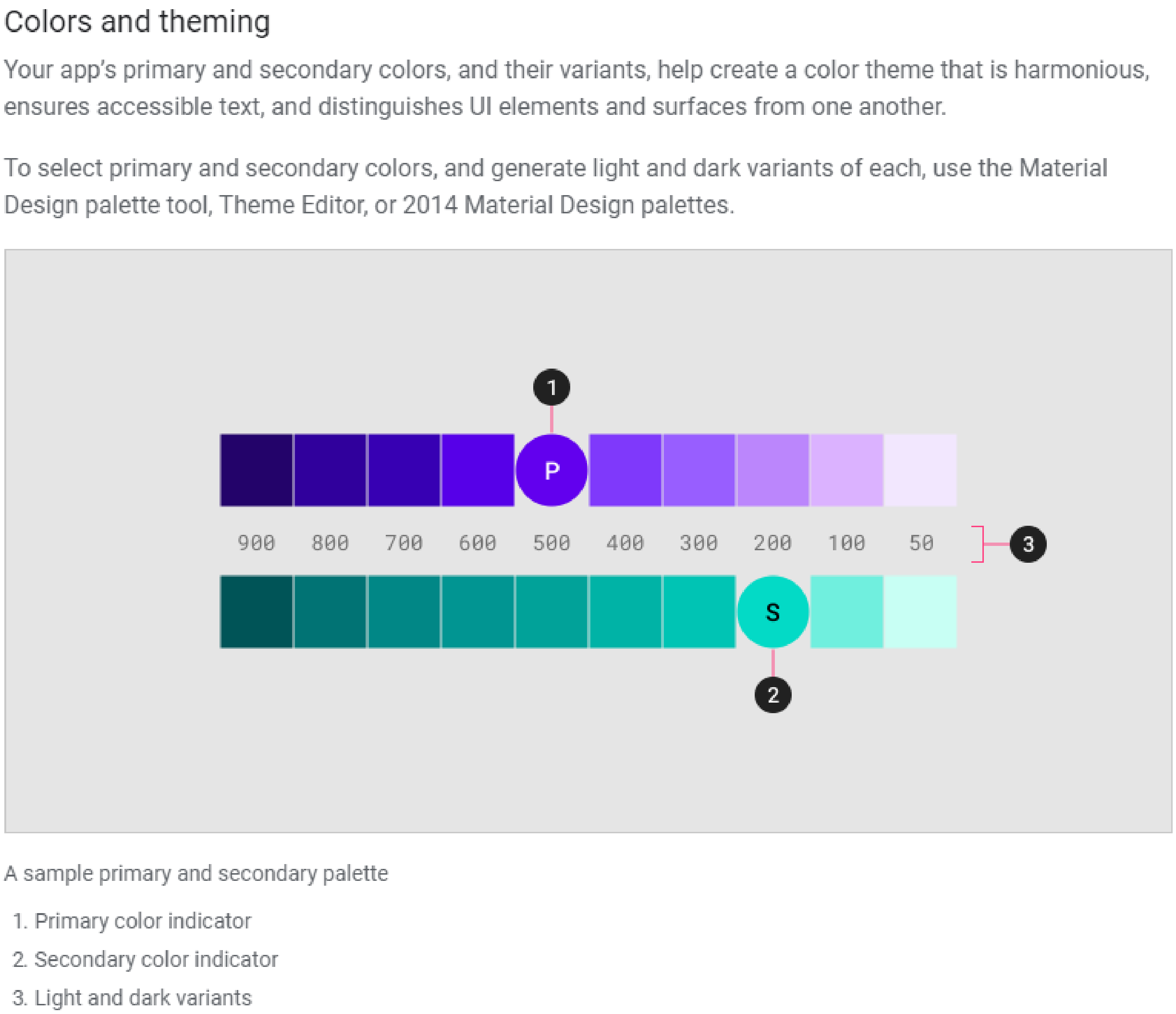
There are minimum sizes for touch targets to make them usable.

Navigation standards

- Based on your app's information architecture, a user can move in one of three navigational directions:
  - **Lateral navigation** refers to moving between screens at the same level of hierarchy. An app's primary navigation component should provide access to all destinations at the top level of its hierarchy.
  - **Forward navigation** refers to moving between screens at consecutive levels of hierarchy, steps in a flow, or across an app. Forward navigation embeds navigation behavior into containers (such as cards, lists, or images), buttons, links, or by using search.
  - **Reverse navigation** refers to moving backwards through screens either chronologically (within one app or across different apps) or hierarchically (within an app). Platform conventions determine the exact behavior of reverse navigation within an app.

* developer.android.com

Color



Colors and theming

Your app's primary and secondary colors, and their variants, help create a color theme that is harmonious, ensures accessible text, and distinguishes UI elements and surfaces from one another.

To select primary and secondary colors, and generate light and dark variants of each, use the Material Design palette tool, Theme Editor, or 2014 Material Design palettes.

A sample primary and secondary palette

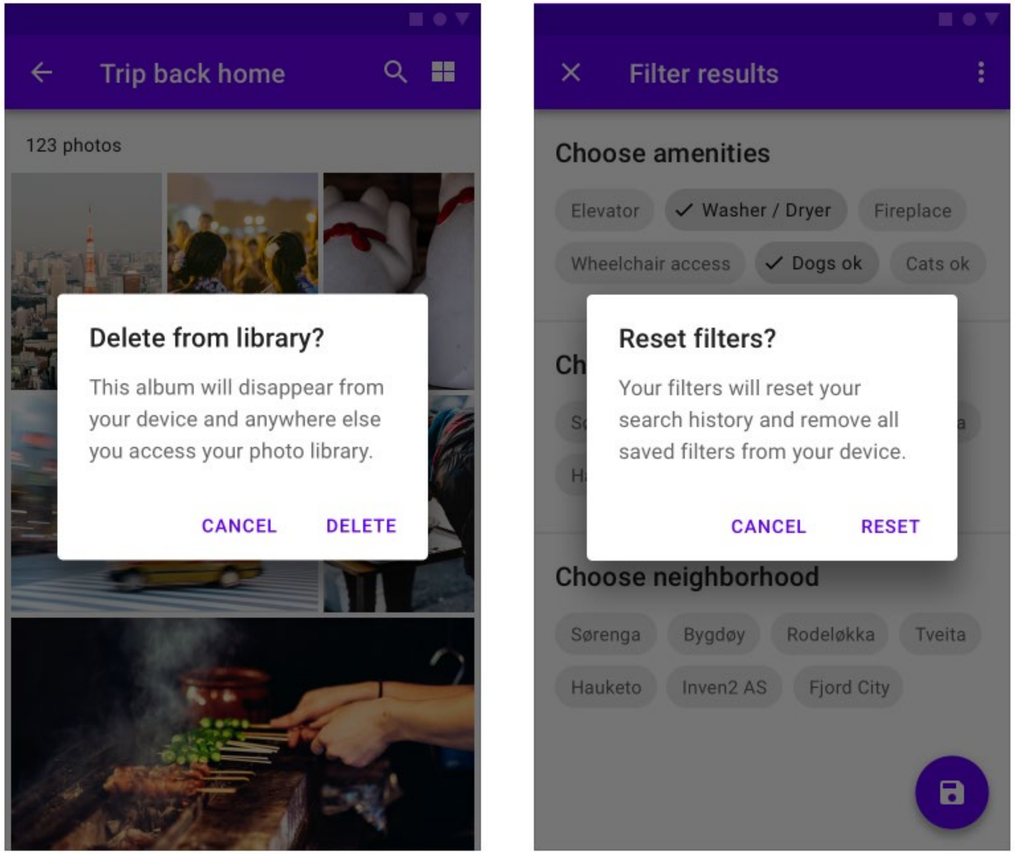
1. Primary color indicator
2. Secondary color indicator
3. Light and dark variants

* developer.android.com

Communication

Alert dialog

Confirmation is best delivered using an alert dialog.



Delete from library?

This album will disappear from your device and anywhere else you access your photo library.

CANCEL DELETE

Reset filters?

Your filters will reset your search history and remove all saved filters from your device.

CANCEL RESET

An alert dialog confirms the user action and informs the user of what will happen as a result.

* developer.android.com

Error Prevention

- When the user make an unintentional mistake using an interface
  - It is not the fault of the user, it is the fault of the designer who made it too easy for the user to make the mistake
- The user interface designer should strive to make errors
  - Impossible
  - Difficult
  - Something that can be done only after a lot of work to make it happen

Types of errors

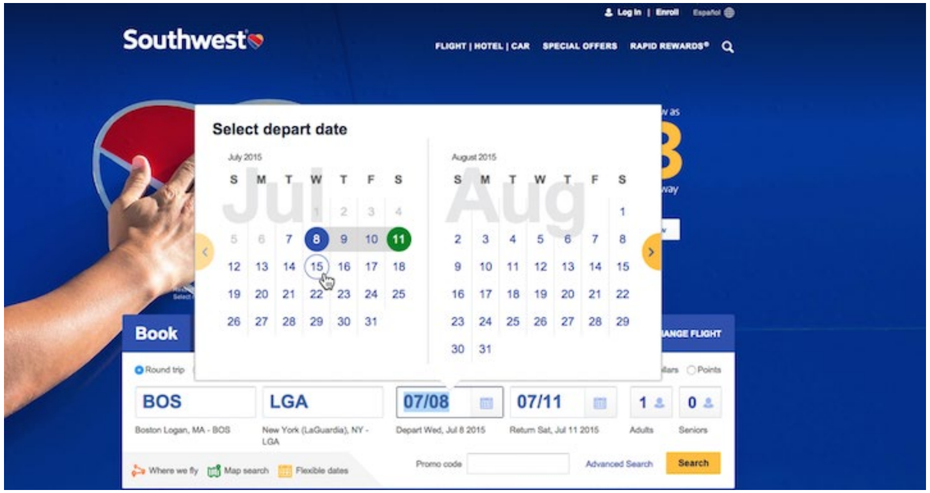
- Slips
  - This is an unconscious mistake
  - The user meant to push one button but pushed one next to it or one which looked similar
- Mistakes
  - These are conscious mistakes where the user intentionally does something believing it will do something different than it actually does
  - The oil light coms on in your car and you think it is the tire pressure light. You add air to the tires but the light stays on because you have misunderstood the problem.
  - This can result from the user having the wrong mental model of the system

Preventing slips

- Slips are when
  - You are familiar with the procedure and hit the wrong button
  - Often performed by expert users who know what they are doing but are not thinking
- Strategies for prevention include
  - Guiding users so they stay on the right path
  - Reduce the number of choices to lessen the chance of choosing the wrong one
  - Provide the needed level of precision
  - Encourage users to check for errors

Helpful constraints

- When scheduling an airline flight
  - Force them to pick departure date first
  - Only let them select a return date that is after the departure date



Select depart date

July 2015

S	M	T	W	T	F	S
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12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

August 2015

S	M	T	W	T	F	S
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2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

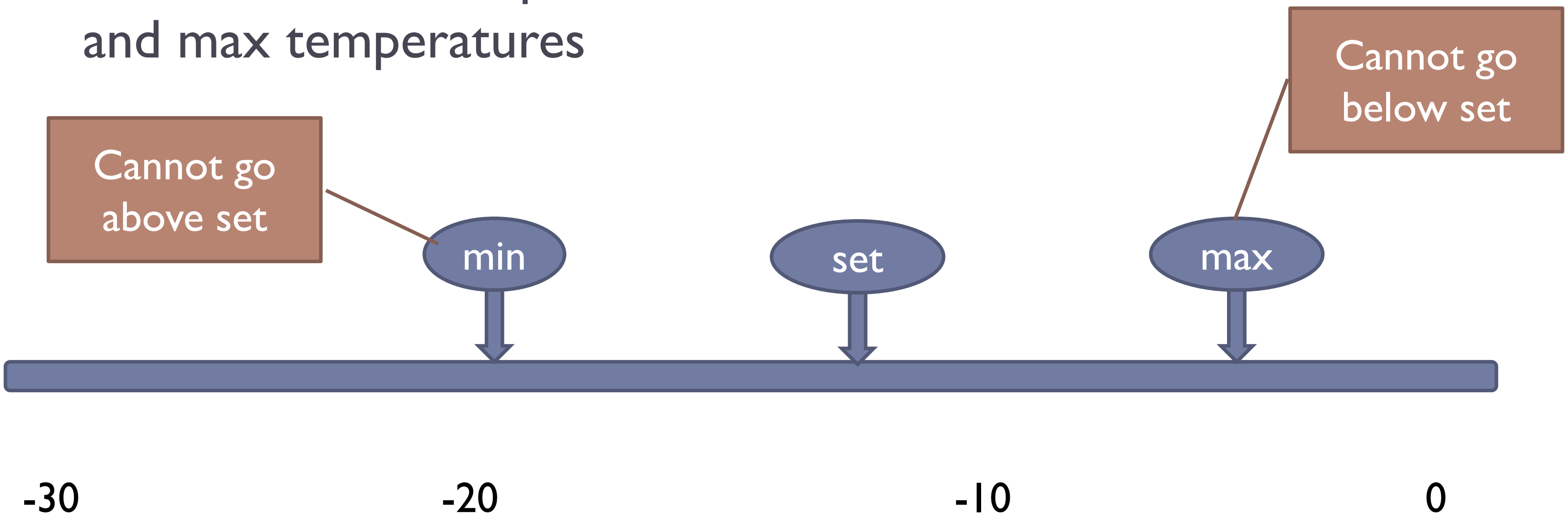
● Round trip ○ Points

BOS	LGA	07/08	07/11	1	0
Boston Logan, MA - BOS	New York (LaGuardia), NY - LGA	Depart Wed, Jul 8 2015	Return Sat, Jul 11 2015	Adults	Seniors

Promo code

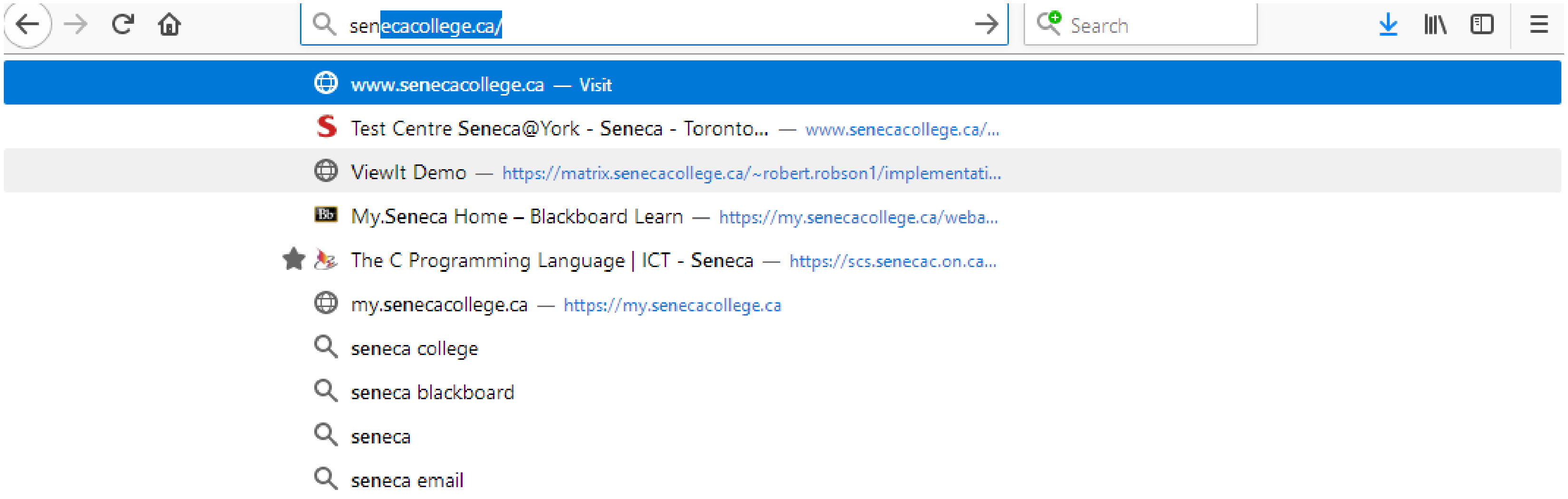
Helpful constraints

- The thermostat for a commercial freezer lets you
  - Set a minimum temperature below which an alarm will sound
  - Set a maximum temperature above which an alarm will sound
  - Set the desired temperature which must be between the min and max temperatures



Suggestions

- Providing suggestions while typing can reduce errors



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Test Centre Seneca@York - Seneca - Toronto... — www.senecacollege.ca/...

ViewIt Demo — https://matrix.senecacollege.ca/~robert.robson1/implementati...

My.Seneca Home – Blackboard Learn — https://my.senecacollege.ca/weba...

The C Programming Language | ICT - Seneca — https://scs.senecac.on.ca...

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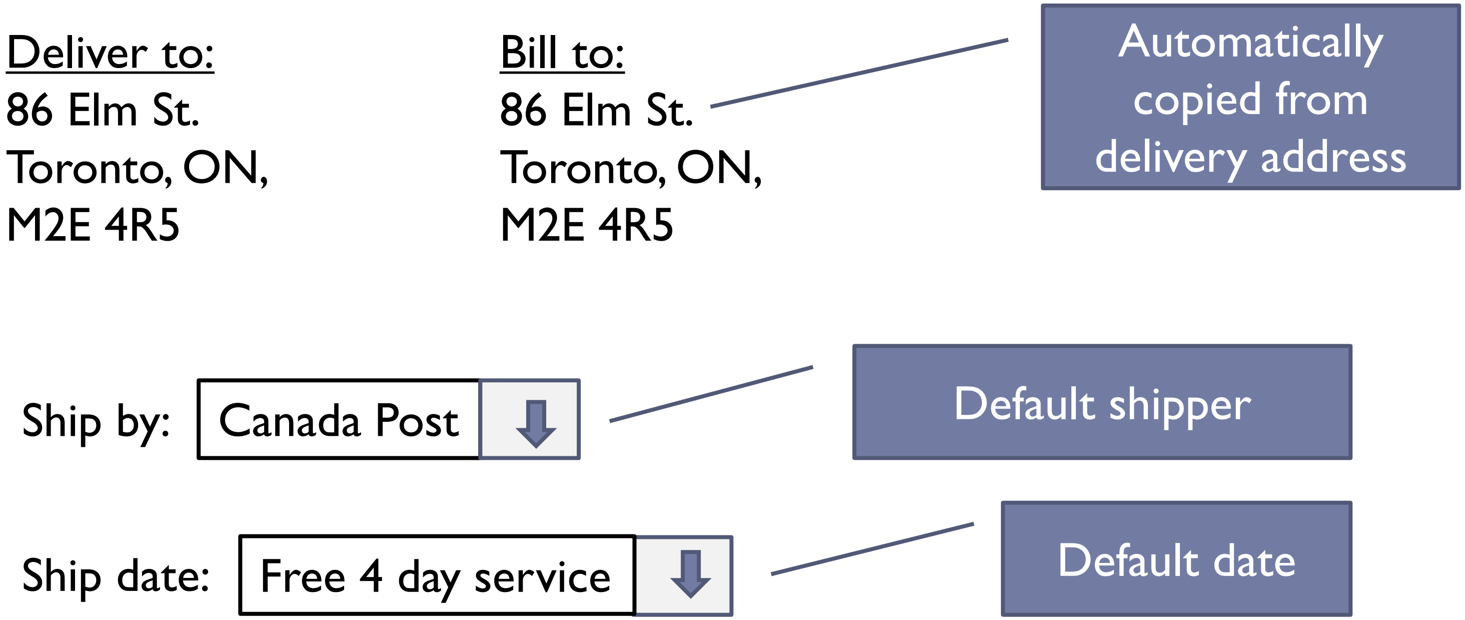
Reasonable default values

- Supply reasonable default values for fields that need to be filled in



Deliver to:
86 Elm St.
Toronto, ON,
M2E 4R5

Bill to:
86 Elm St.
Toronto, ON,
M2E 4R5

Automatically copied from delivery address

Ship by: Canada Post

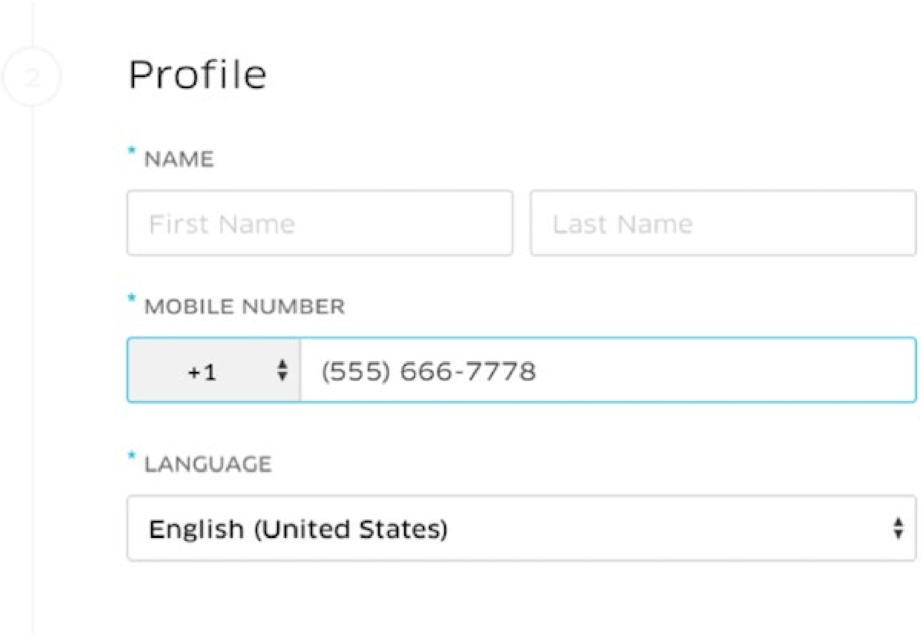
Default shipper

Ship date: Free 4 day service

Default date

Forgiving formats

- Uber’s enrolment form
  - Automatically format the phone number as you type
  - This splits into easier to read chinks, reducing errors
  - Language is selected from a list to eliminate spelling mistakes



Profile

* NAME

First Name | Last Name

* MOBILE NUMBER

+1 (555) 666-7778

* LANGUAGE

English (United States)

The two gulfs

- Conscious errors occur because of two gulfs of understanding
  - The gulf of execution
    - The user needs to have a mental model that will allow him or her to formulate an action that will accomplish a goal
  - The gulf of evaluation
    - The user needs to be able to understand how the state of the system changed so that he or she can determine if their action succeeded

- If there is a failure in the mental model in bridging either of these gulfs, errors will result

Measuring the gulfs

- You can perform experiments to determine
  - If the user's mental model is accurate
  - Where there are gaps in understanding

Follow design conventions

- Most platforms have design conventions
- Every application follows them and looks and behaves similarly
- This makes it easier for your user to understand the controls and what they will do

Affordances

- Many controls have subtle cues that the user can use to determine how they work
    - Push buttons often have subtle shading making them appear to come out of the page
    - Input text fields have shading that makes it look like they are set into the page
- These are called signifiers and provide cues as to how each of these controls work

Previews

- When a user hovers over a button you can display a small preview of the result which will decrease the gulf of evaluation
  - Image editors often have previews of editing operations
  - Text editors quickly apply font changes as a preview before the user clicks on the button to confirm the operation

Reducing memory burdens

- Reduce the load on short term memory
  - A track of how you navigated to a web page
  - A history of editing operations which can be reversed
  - Show the state of the system so the user does need to remember it

Confirm destructive actions

- While asking for confirmation can be annoying, when doing a irreversible action it is needed
- If you do not want to do that, make a copy of the surrent state so the user can go back to it.

Warn before errors are made

- If someone tweets very long text, warn them
- If someone does a very unusual sequence of operations, ask for confirmation

Negative feedback

- Computer users get negative feedback all the time
  - Dialogs telling you that you did something wrong
  - Dialogs warning you of potential hazards
  - Dialogs asking you if you really want to perform this operation
- This can cause people to want to avoid the negative feedback

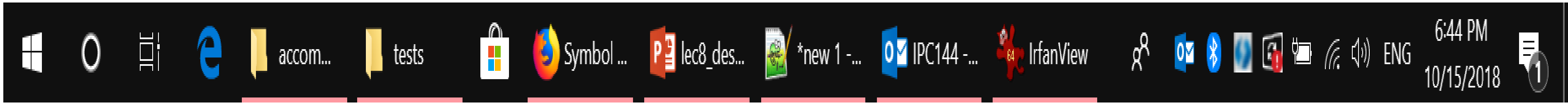
A positive approach to design

- Negative feedback causes people
  - To be afraid of computers
  - To be reluctant to explore since they will probably break something
  - To use the computer less often and less effectively
- A better approach is to
  - Facilitate the user exploring how things work
  - Provide the user with guidance and feedback to help them navigate the system

Rich modeless feedback

- This is feedback which give user information on the state of the system
- It is visual in that it displays this information on the screen so users can quickly discern what it is conveying

- The windows taskbar
  - Shows which applications are running and the one with focus
  - Status of internet and sound
  - Time and date
  - When apps are performing long operations, a progress bar moves across its icon



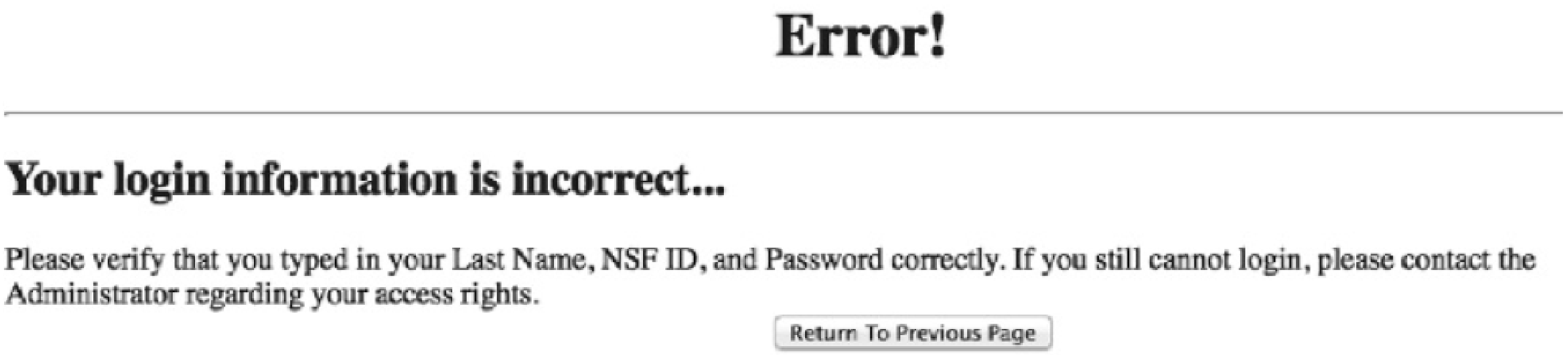
Audible feedback

- Most feedback is via the ubiquitous dialog box
- Users hate audio because it is always negative feedback and everyone within earshot can hear they made a mistake
- A better way is to provide positive audio feedback
  - When the user is typing they hear key clicks. If the clicks stop, something is wrong
  - When you drag and drop, a plunk sound will be issued. Silence indicates something went wrong
  - This means that normal sounds are good but that silence is bad

Undo and redo

- While computers might get everything wrong, humans make mistakes all the time
- Often the mistakes are made while exploring the system or while trying new ways of doing things
- We want to encourage this by
  - Providing an undo facility so you can move backwards through time undoing operations
  - Allow you to move forward and redo operations
  - Allow you to move backwards in time and then take a new branch and explore things in a new direction

Unfriendly Error messages



Error!

Your login information is incorrect...

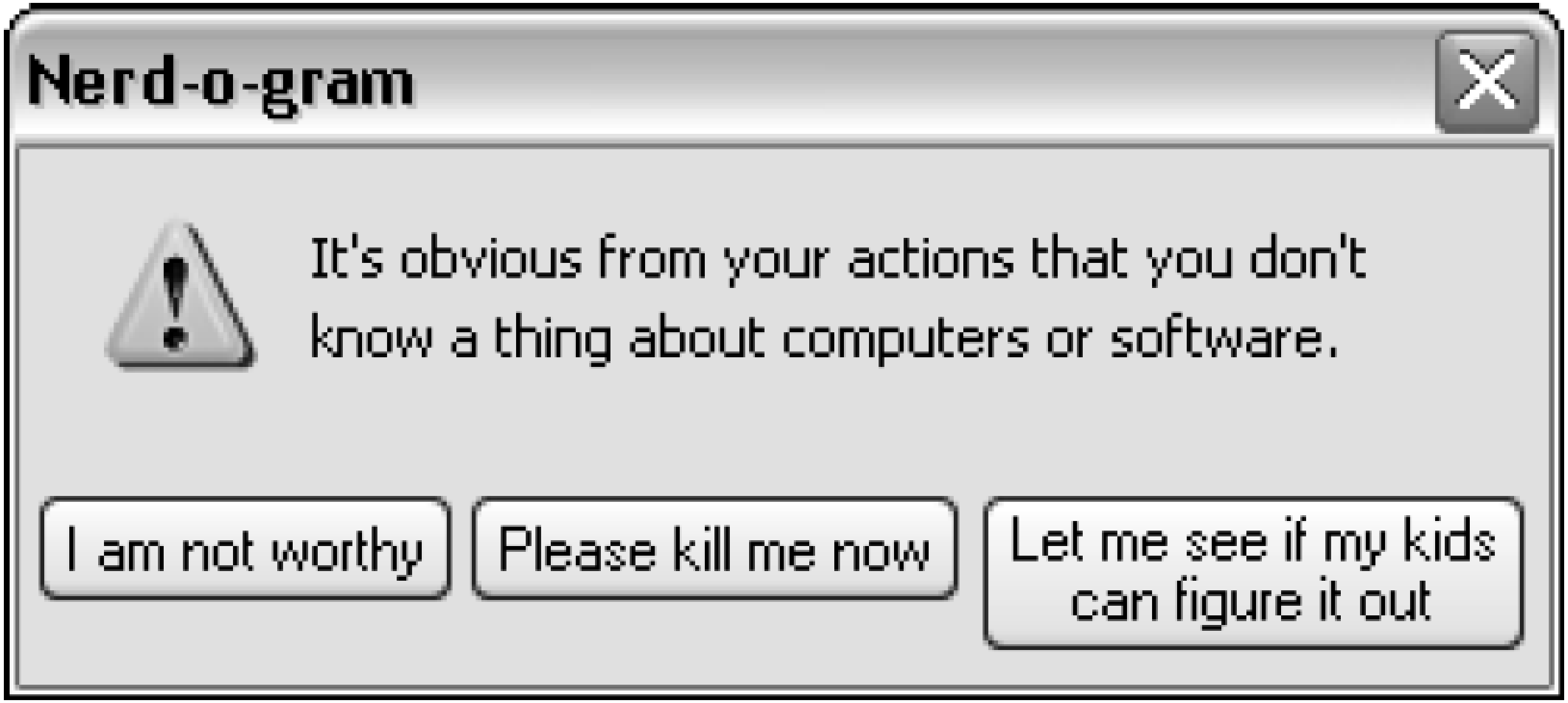
Please verify that you typed in your Last Name, NSF ID, and Password correctly. If you still cannot login, please contact the Administrator regarding your access rights.

- It is meant to get attention but is
  - Rude
  - Can cause panic
  - Anxiety
- There must be a better way

Error Messages

- Error messages should
  - Be expressed in plain language
  - Precisely indicate the problem
  - Indicate a solution
- The problem with error messages
  - They are often rude
  - They show up after the problem happened
  - Modal dialog boxes block interaction with the program and possibly the entire computer

User’s interpretation of error message



Nerd-o-gram

It's obvious from your actions that you don't know a thing about computers or software.

Whose problem is it?

- Error messages imply the user made a mistake

- In reality, the UI designer made the mistake by allowing the error to happen
- The UI should have been designed to prevent it
- It should have checked input as it was entered and guided the user or only accepted numbers in an input field
- The production of an error message indicates the failure of the UI design