Information Architecture and Web Usability

Course Notes

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Preface

I first started teaching Human-Computer Interaction (HCI) at Graz University of Technology in 1993. More and more interesting material came to be integrated into my HCI course over the years, until in 2003, I decided to split the course into two. The original HCI course was streamlined into an introductory undergraduate level course covering usability and the methods of usability engineering.

The more advanced and more web-specific material moved to a new graduate level course, this course on Information Architecture and Web Usability, which I first taught in winter semester 2003.

These lecture notes have evolved over many years and have benefitted from my experiences teaching courses on User Interface Design at FH Technikum Kärnten in Villach, Web Usability and Advanced User Interfaces at FH Joanneum in Graz, Human-Computer Interaction at FH Hagenberg near Linz and numerous intensive courses at conferences and for industry.

I would like to thank all my students past and present for their many suggestions and corrections which have helped to massage these notes into their current form.

Thanks and happy reading,

Keith Andrews

Graz, Austria, 22 Oct 2024

Credits

- Figures 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, and 10.7 were kindly provided by Tom Tullis from Fidelity.
- The figures in Sections 14.1 and 14.2 were kindly provided by Jakob Nielsen from Sun Microsystems.

Chapter 1

Introduction

> *“ We take stuff, and we sort it into useful categories, and we give it names that people recognise, and we put the stuff someplace where they’re going to find it. ”*
>
> [Eric Reiss, describing what an information architect does, 22 Sep 2011, EuroIA, Prague.]

References

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++ Lisa Maria Martin; *Everyday Information Architecture*; A Book Apart, 16 Apr 2019. ISBN 193755774X (com, uk) [L. M. Martin 2019] https://abookapart.com/products/everyday-information-architecture

++ Heather Hedden; *The Accidental Taxonomist*; 3rd Edition, Information Today, 08 Nov 2022. ISBN 1573875864 (com, uk) [Hedden 2022]

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- Bonnie Nardi and Vicki O'Day; *Information Ecologies: Using Technology with Heart*; MIT Press, 2000. ISBN 0262640422 (com, uk)

Online Resources

++ Smashing Magazine; `smashingmagazine.com`

++ *A List Apart*; `alistapart.com`

++ *World IA Day*; `worldiaday.org`

+ *Boxes and Arrows*; `boxesandarrows.com` [paused in 2023]

Professional Organisations

+ American Society for Information Science and Technology (ASIS&T); `asist.org`

+ Interaction Design Association; `ixda.org`

+ User Experience Professionals Association; `uxpa.org`

+ ACM SIGCHI; `sigchi.org`

+ Interaction Design Foundation; `interaction-design.org`

Local Communities and Organisations

++ UX Graz; `uxgraz.at`, `https://twitter.com/uxgraz/`, `https://meetup.com/uxgraz/`.

++ CSS in Graz; `https://meetup.com/css-in-graz/`.

++ Graz JS; `https://meetup.com/grazjs/`.

+ UX Vienna; `uxvienna.at`

+ UX Linz; `https://meetup.com/UX-Linz/`

+ UX Salzburg; `https://meetup.com/uxsalzburg/`

+ UXPA Austria; `uxpa-austria.org`

+ UXpro Austria; `uxpro.at`

Journals

- *Journal of the American Society for Information Science and Technology (JASIST)*; ISSN 0002-8231 `https://onlinelibrary.wiley.com/journal/23301643`

- *Journal of Usability Studies (JUS)*; Usability Professionals' Association; ISSN 1931-3357 uxpajournal.org
- *Journal of Information Architecture*; ISSN 1903-7260 journalofia.org https://web.archive.org/web/20190801160235/http://journalofia.org/ [until 2013, then 2021–2022]

Conferences

- UXtweak; *Top Upcoming UX Conferences*; https://blog.uxtweak.com/top-ux-conferences/
- Information Architecture Conference; theiaconference.com [formerly IA Summit, iasummit.org]
- EuroIA; *European Conference on Information Architecture and User Experience Design*; euroia.eu [formerly European Information Architecture Summit]
- IxDA; *Interaction*; https://ixda.org/initiatives/interaction/
- ISI; *International Symposium of Information Science*; isi2023.net
- WebExpo (Prague); webexpo.net
- Beyond Tellerrand (Düsseldorf, Berlin, Munich) ; beyondtellerrand.com
- uxcon vienna; uxcon.at
- State of the Browser (London); stateofthebrowser.com
- CSS Day (Amsterdam); cssday.nl
- Smashing Conference; smashingconf.com
- World Usability Congress, Graz; worldusabilitycongress.com

Video: Abby Covert

- Abby Covert; *How to Make Sense of Any Mess*; CXL Live 2017 [Covert 2017, 00:47-15:30]. [Video: https://youtu.be/s6lXWgnTmRE?t=00m47s]

Video: Brian Miller

- Brian Miller; *Understanding Information Architecture*; HOW Interactive Design Conference 2014 [B. Miller 2014, 12:32-15:41]. [Video: https://youtu.be/Ytv21Jx0hD4?t=12m32s]

Video: Jeremy Keith

- Jeremy Keith; *Enhance!*; WebExpo Prague 2015 [Keith 2015a, 03:56-]. [Video: https://slideslive.com/38894415/enhance]

Chapter 2

User Experience and the Web

> *" Users don't visit web sites to experience the joy of navigation. "*
>
> [Jesse James Garrett, The Elements of User Experience [Garrett 2002b, page 36].]

References

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+ Jesse James Garrett; *The Elements of User Experience: User-Centered Design for the Web*; 1st Edition, New Riders, 2002. ISBN 0735712026 (com, uk) [Garrett 2002b]

Online Resources

+ UXmatters; `uxmatters.com`

- UX Magazine; `uxmag.com`

- UX Booth; `uxbooth.com`

- UX Myths; `uxmyths.com`

2.1 User Experience (UX)

The term *user experience (UX)* encompasses the entire experience of a user with a product or system, not just with its user interface.

Origins of the Term "User Experience"

- The term was first used by Whiteside and Wixon [1987] in 1987 in the context of usability engineering: "Usability, ultimately, lives in user experience. Therefore, usability engineering must be grounded in experience. Usability engineering provides tools for uncovering user experience."
- Its present day usage, embracing the entire experience of a user with a system, is usually attributed to Don Norman in Jun 1993 [Erickson 1998].

- As Don Norman explains: "I invented the term because I thought human interface and usability were too narrow. I wanted to cover all aspects of the person's experience with the system including industrial design, graphics, the interface, the physical interaction, and the manual." [Merholz and Norman 2007, 07:30]

Video: Don Norman on the Term "UX"

- Don Norman; *The Term "UX"*; UX Conference, Jun 2016, interview [Norman and Li 2016, 00:10-01:40]. [Video: https://youtu.be/9BdtGjoIN4E?t=00m10s]

2.2 Web User Experience

In the context of the web, as described by Garrett [2002b, page 33], user experience is an umbrella term which encompasses fields such as:

- user research
- content strategy
- information architecture
- interaction design
- information design
- visual design

The Five Planes of User Experience

Garrett [2002b, page 33] defines five planes, which build from bottom to top:

- **5**: *Surface Plane*: web pages made up of images and text.
- **4**: *Skeleton Plane*: the placement of buttons, tabs, images, and blocks of text.
- **3**: *Structure Plane*: abstract structure of the site.
- **2**: *Scope Plane*: features and functionality.
- **1**: *Strategy Plane*: what the owners and users of the site want to achieve.

as can be seen in Figure 2.1.

The planes have slight nuances, depending on whether the (part of the) web site under design is task-oriented or information-oriented.

Stagger Work on Planes

Stagger work on the planes:

- Do *not* wait for work on one plane to finish before starting on the next.
- There must be some degree of iteration (feedback loop).
- Work on a particular plane cannot *finish* before work on lower planes has finished.

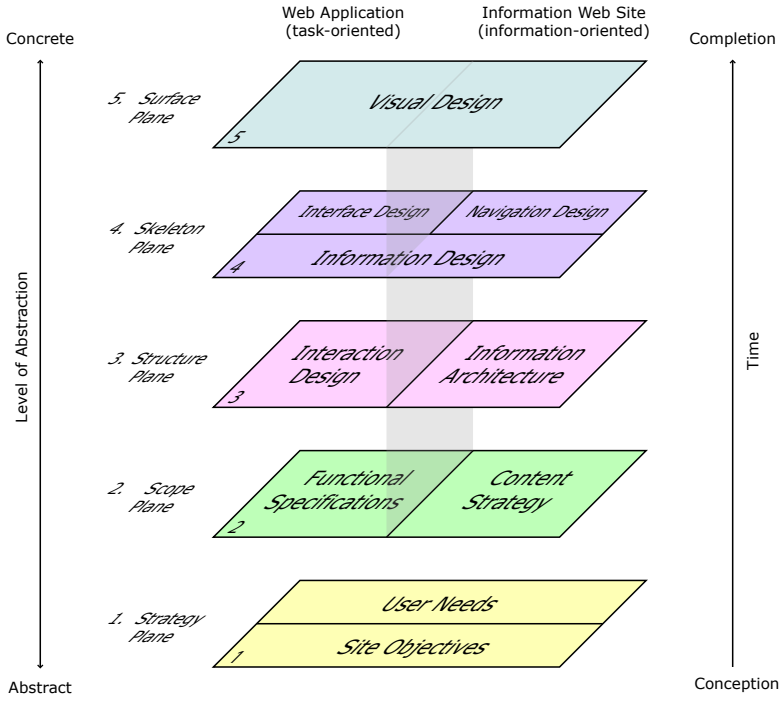

Figure 2.1: The five planes of user experience. [Adapted by Keith Andrews from the diagram in Garrett [2002b, page 33].]

Web Application Design

Task-oriented (parts of a) web site more like a traditional software application:

- **5**: *Visual Design*: visual treatment of interface elements.
- **4b**: *Interface Design*: design of interface elements, widgets, GUI.
- **4a**: *Information Design*: "content design", wording and presentation of information to facilitate understanding.
- **3**: *Interaction Design*: design of application flows to facilitate user tasks.
- **2**: *Functional Specifications*: "feature set", descriptions of functionality required to meet user needs.
- **1b**: *User Needs*: externally derived goals for the site identified through user research.
- **1a**: *Site Objectives*: business, creative, and other internally derived goals for the site.

Information Web Site Design

Information-oriented (parts of) web site:

- **5**: *Visual Design*: visual treatment of text, graphics, and navigational components.
- **4b**: *Navigation Design*: design of interface elements to facilitate navigation through information space.
- **4a**: *Information Design*: "content design", wording and presentation of information to facilitate understanding.

- **3**: *Information Architecture*: structural design of the information space to facilitate intuitive access to content.
- **2**: *Content Strategy*: definition and management of content elements required to meet user needs.
- **1a**: *User Needs*: externally derived goals for the site identified through user research.
- **1a**: *Site Objectives*: business, creative, and other internally derived goals for the site.

Big IA or Little IA

As far as information architecture (IA) goes, some people define it broadly, others more narrowly [Morville 2000]:

- "Big IA": encompassing a broad range of responsibilities (all 5 planes of information site design).
- "Little IA": narrowly focused on content organization and the structure of information spaces (plane 3 only).

I will adopt the convention of Garrett [Garrett 2002a]:

Whereas an information architect might play many roles, the disicpline of *information architecture* deals with the structuring of information spaces to facilitate navigation.

Chapter 3

Web Usability

> *“ Don’t make me think!*
> . . .
> *It means that as far as is humanly possible, when I look at a Web page it should be self-evident. Obvious. Self-explanatory. ”*
>
> [Steve Krug’s first law of usability [Krug 2000, First Edition, page 11].]

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◦ James Kalbach; *Designing Web Navigation: Optimizing the User Experience*; O’Reilly, 07 Sep 2007. ISBN 0596528108 (com, uk) [Kalbach 2007]

Resources in German

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◦ Johannes Ippen ; *Web Fatale: Wie Du Webseiten und Web-Apps gestaltest, denen niemand widerstehen kann*; Rheinwerk Design, 29 Mar 2016 ISBN 3836238985 (com, uk) [Ippen 2016]

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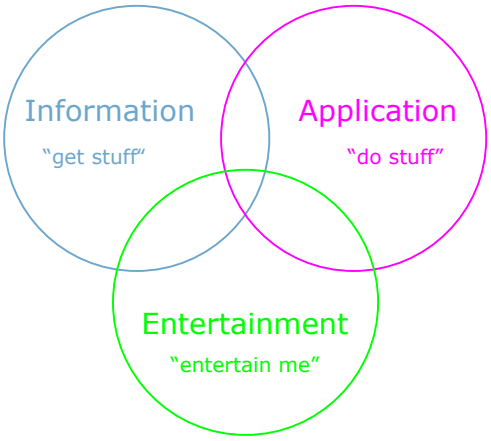

Figure 3.1: Three kinds of web site, based on the purpose behind the site.

Online Resources

++ Steve Krug; *Advanced Common Sense*; `sensible.com`.

\+ Nielsen Norman Group; *Topic: Web Usability*; `https://nngroup.com/topic/web-usability/`.

++ Jared Spool, User Interface Engineering; `uie.com`.

\+ David Travis; *247 Web Usability Guidelines*; `http://userfocus.co.uk/resources/guidelines.html`.

\+ Adam Silver; *Articles*; `https://adamsilver.io/articles/`.

3.1 Three Kinds of Web Site

[This section is loosely based on ideas from Siegel [1995] and Archibald [2012].]

There are three different kinds of web site, based on the purpose behind the web site:

a) *Information*: "get stuff" web sites.

b) *Application*: "do stuff" web sites.

c) *Entertainment*: "entertain me" web sites.

as shown in Figure 3.1.

The design criteria for each of these purposes are *different*!

Information Web Sites

- "get something" web sites.
- Structured content.
- The basic unit of interaction is the *fact*.
- Content, publishing.
- Books, papers, articles, reference material, specifications.

- Information sites are often large and are generated or maintained at least semi-automatically.
- The realm of *information architects*.
- For an information web site, the goal of the designer is to *minimise* the amount of time a user spends to find a specific piece of information.

Application Web Sites

- "do something" web sites.
- Structured tasks, dialogues.
- The basic unit of interaction is the *task*.
- Transactions, ordering, banking, planning, etc.
- Ordering, booking, form-filling, workflow.
- Web applications usually require some backend processing and often generate pages dynamically from a database.
- The realm of *interaction designers*.
- For an application web site, the goal of the designer is to *minimise* the amount of time a user spends to complete a specific task.

Entertainment Web Sites

- "be entertained" web sites.
- Enthralling content.
- The basic unit of interaction is the *experience*.
- Entertainment, marketing, promotion.
- Image, mindshare, building community.
- Entertainment web sites are typically carefully hand-crafted by graphic designers for a specific look and experience ("form vs. content").
- The realm of *games designers* and *experience designers*.
- For an entertainment web site, the goal of the designer is to *maximise* the amount of time a user spends on the site.

Mixing Purposes within a Site

Many larger web sites have a mixture of purposes, as shown in Figure 3.2.

However, the design criteria remain different for each corresponding area of the site.

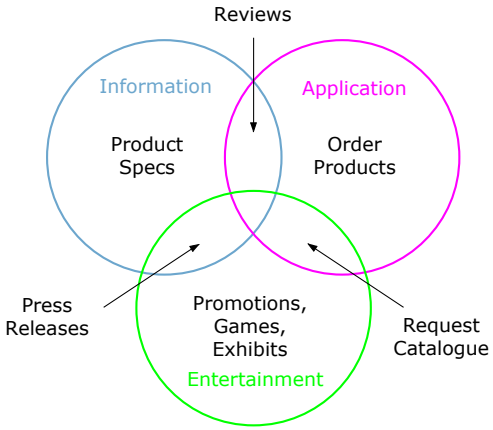

Figure 3.2: Larger web sites often mix all three purposes within a single site.

3.2 Typical Cost of Building a Web Site

- AllBusiness [AllBusiness 2006] estimated in 2006 that a "larger site with publishing tools, database connectivity and other advanced features" can cost $ 250,000 to build.
- In 2007, Guy Kawasaki described how he built Truemors (`truemors.com`) for $ 12,107.09 [Kawasaki 2007]
- In 2016, the cost of building a web site ranged from around $ 7,000 to $ 40,000 and up, depending on a variety of factors, according to the excellent analysis of Parr [2016].
- Pozin [2013] and WebFX [2020] provide alternative analyses.
- The student union (HTU) of Graz University of Technology published a breakdown of the € 50,000 or so cost of their 2011–2013 website redesign [Ellmaier and Stachel 2013], following some criticism [Kogelnik 2014].
- Former Austrian finance minister Karl-Heinz Grasser's web site `karlheinzgrasser.at` cost between € 220,000 and € 245,948, according to an independent expert assessment for the court [APA 2004].
- ThinkMobiles estimate the median cost of making an app at around $ 171,450 [Geletska 2021].

Video: Paul Boag on Website Usability

- Paul Boag; *Website Usability*; TemplateMonster, 2015 [Boag 2015]. [Video: `https://youtu.be/STrcoYZIYb4`]

3.3 Indicators of Web Usability

Success Rates

From Nielsen and Loranger [2006, pages 22–25]:

- Ask users to perform specific tasks on a particular web site (which are possible on that web site).
- In the 1990s, success rates of around 40%.

Visit	*Time on Home Page*	*Users Who Scrolled*	*Screenfuls Scrolled*
1st	31 s	23 %	0.8
2nd	25 s	16 %	0.8
3rd	22 s	16 %	0.8
4th+	19 s	14 %	0.5

Table 3.1: On repeat visits to a web site's home page, users spend even less time looking around. They go straight to the navigation and onward. [Data from Nielsen and Loranger [2006, page 32]]

- In 2006, success rates average around 66%.
- Nielsen uses a fuzzy measure, taking partial success into account, rather than a binary measure of success or failure.

Linger Time

In Nielsen and Loranger [2006, page 27]'s study:

- Given a web-wide task, such as researching a new product.
- Users visited an average of 3.2 sites, in addition to any search engine they may have used.
- Users spent an average of 1 minute 49 seconds visiting a web site, before deciding to move on.
- A site only had a 12% probability of being revisited (for that task).

Time Spent on the Home Page of a Site

In Nielsen and Loranger [2006, page 32]'s study (see Table 3.1):

- Given a web-wide task, such as researching a new product.
- Users spent an average of only 31 seconds on the home page of a web site on their first visit.
- Decreased to an average of 25, 22, and 19 seconds on the second, third, and fourth visits.
- Only 23% of users scrolled down the home page (for those home pages which had multiple screenfuls) of a web site on the first visit.
- Only 16%, 16%, and 14% scolled the home page on the second, third, and fourth visits.

  Gone in 30 secs.: so much to say and so little time to say it!

Time Spent on Initial Visit Page

From Nielsen and Loranger [2006, page 33]:

- Web users who first entered a web site on an interior page (say by following a deep link from a search engine), spent longer on that page than web users who entered at the home page spent there.
- More experienced web users spent less time than less experienced web users.
- Support deep linking to your site.

Experience	*Time if Home Page*	*Time if Interior Page*
Low	35 s	60 s
High	25 s	45 s

Table 3.2: The time a user spends on the first page they see of a web site depends on whether they first see the home page or an interior page. More experienced web users spend less time than less experienced web users. [Data from Nielsen and Loranger [2006, page 33]]

Most Disliked	*%*
Waiting for slow pages to load	46%
Being shown interstitials	16%
Encountering unplayable videos	14%
Getting redirected to the homepage	13%
Other	11%

Table 3.3: Responses to the question "What do you dislike the most when browsing the web on your mobile device?" from 570 respondents, as reported by [Google 2015].

See Table 3.2.

Page Load Time

Waiting for web pages to load irritates people the most, as shown in Table 3.3.

- In 1998, people were prepared to wait around 15 seconds for a web page to load, as shown in Table 3.4.
- In 2016, the BBC reported that nearly 50% of users will not even wait 3 seconds [M. Wall 2016].

Track Page Views not Unique Visitors

- Tracking the number of unique visitors to a site is now irrelevant [Nielsen and Loranger 2006, page 39], since many of those visitors only sample a single page and then leave again.
- Instead, track the number of page views (or number of active daily users).

Reasons for Return Visits

Table 3.5 shows what users cite as the main reasons for returning to a site.

Note: never believe entirely what users tell you!

Video: Jakob Nielsen on Web UX

- Jakob Nielsen; *Web UX 2016 vs 2004*; UX Conference, London, 2016 [Nielsen 2016, 17:51-19:45]. [Video: `https://youtu.be/xKOlga_xkKA?t=17m51s`]

% Still Waiting	*Load Time (secs.)*
84	10
51	15
26	20
5	30

Table 3.4: The time users are prepared to wait for a web page to load before giving up. Reported by BrowserNews [Upsdell 2001], quoting eMarketer (Nov. 1998).

% of Users	*Factor*
75	High-quality content
66	Ease of use
58	Quick to download
54	Updated frequently
14	Coupons and incentives
13	Favourite brands
13	Chat and BBS
12	Cutting-edge technology
12	Games
11	Purchasing capabilities
10	Customisable content
6	Other

Table 3.5: The main reasons users give for returning to a site. Reported by BrowserNews [Upsdell 2001], quoting Forrester Research (Feb. 1999).

Chapter 4

Mobile Usability

References

+ NN Group; *User Experience for Mobile Applications and Websites*; 4th Edition, Research Report, NN Group, 2019? $298. https://nngroup.com/reports/mobile-website-and-application-usability/

+ Jakob Nielsen and Raluca Budiu; *Mobile Usability*; New Riders, 10 Oct 2012. ISBN 0321884485 (com, uk) [Nielsen and Budiu 2012]

+ Rachel Hinman; *The Mobile Frontier: A Guide for Designing Mobile Experiences*; Rosenfeld Media, 11 Jun 2012. ISBN 1933820551 (com, uk) [Hinman 2012]

+ Luke Wroblewski; *Mobile First*; A Book Apart, 18 Oct 2011. ISBN 1937557022 (com, uk) [Wroblewski 2011]

° Adrian Mendoza; *Mobile User Experience*; Morgan Kaufmann, 31 Oct 2013. ISBN 0124095143 (com, uk) [Mendoza 2013]

Online Resources

++ Luke Wroblewski; lukew.com.

+ Nick Babich; *Basic Patterns For Mobile Navigation: Pros And Cons*; Smashing Magazine, 10 May 2017. https://smashingmagazine.com/2017/05/basic-patterns-mobile-navigation/

+ Justin Mifsud; *Usability Testing Of Mobile Applications: A Step-By-Step Guide*; UsabilityGeek, 21 Mar 2016. http://usabilitygeek.com/usability-testing-mobile-applications/

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+ Tania Lang; *Eight Lessons in Mobile Usability Testing*; http://uxmag.com/articles/eight-lessons-in-mobile-usability-testing [Lang 2013]

+ Raluca Budiu and Kara Pernice; *Mobile First Is NOT Mobile Only*; NN Group, 24 Jul 2016. https://nngroup.com/articles/mobile-first-not-mobile-only/

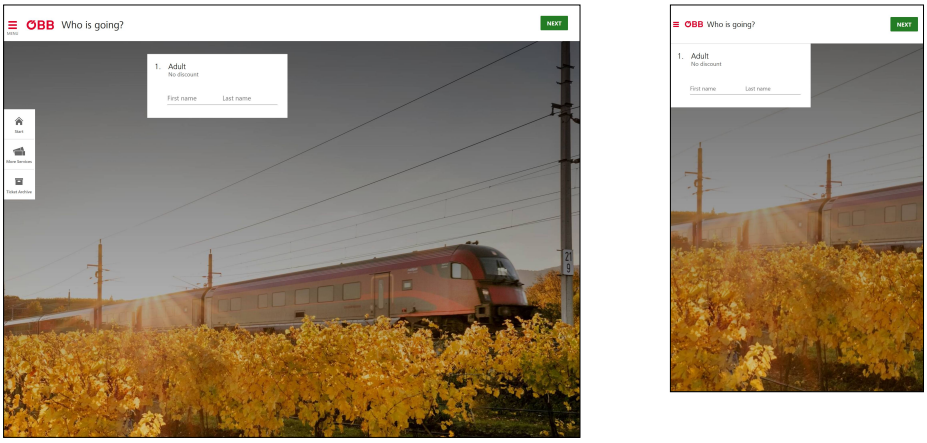

Figure 4.1: The Austrian Rail web site `oebb.at` is optimised for mobile use on narrower screens. When booking a ticket on a wider screen, the Next button in the top right corner is far away from the user's centre of attention in the middle of the window and is easy to overlook.

\+ Google; *Mobile-Friendly Test*; `https://google.com/webmasters/tools/mobile-friendly/`

4.1 Mobile Usage Has Long Overtaken Desktop

- Sales of new smartphones overtook sales of new PCs (desktop + laptop) in Q4 2010 [Ferguson 2011].
- As of 01 May 2017 over 2 billion active Android devices [Popper 2017].
- In 2015, US adults spent on average 2.8 hours per day (51%) on the internet on mobile devices, compared to 2.4 hours per day (42%) on desktop/laptop [Meeker 2015, slide 14].
- The vast majority of twitter users (82%) in Q2 2016 accessed the service from a mobile device [Yeung 2016].
- ≈ 58.8% of page impressions (to ÖWA web sites) in Austria (Aug 2023) are from mobile web browsers, 41.2 % from desktop web browsers [ÖWA 2024]
- See Luke Wroblewski's talks [Wroblewski 2023] and book "Mobile First" [Wroblewski 2011].

4.2 Mobile First is *Not* Mobile Only

- Do not design your responsive web site *exclusively* for mobile devices.
- Mobile patterns can pretty irritating and sometimes unusable on other devices!
- Prime example: the Austrian Rail web site `oebb.at`, shown in Figure 4.1.

Video: Luke Wroblewski on Mobile Planet

- Luke Wroblewski; *Mobile Planet*; Google Conversions 2018, Dublin, 11 Apr 2018 [Wroblewski 2018]. Slides are at `https://dropbox.com/s/tuz2fj0qieiw1ov/Mobile%20Planet%2004182018.pdf`
  [01:01:23-01:05:20] web app (reach) vs. native app (rich) [Video: `https://youtu.be/EbbjEY-TyhU?t=01h01m23s`]

[01:08:20-01:25:10] need for speed [Video: https://youtu.be/EbbjEY-TyhU?t=01h08m20s]

Video: Luke Wroblewski on Mind the Gap

- Luke Wroblewski; *Mind the Gap*; Google Conversions 2019, Los Angeles, 15 Oct 2019 [Wroblewski 2019].

  [00:02:40-00:08:48] app install banners [Video: https://youtu.be/jbRfQOP9wR0?t=02m40s]

  [00:10:41-00:16:00] gap between company and customer [Video: https://youtu.be/jbRfQOP9wR0?t=10m41s]

Chapter 5

Web Accessibility

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+ Sarah Horton and Whitney Quesenbery; *A Web for Everyone: Designing Accessible User Experiences*; Rosenfeld, 2014. ISBN 1933820977 (com, uk) [Horton and Quesenbery 2014]

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- NVDA [Win]; NV Access; nvaccess.org. Free, open-source product for Windows.
- Narrator [Win]; Microsoft; nvaccess.org. https://support.microsoft.com/en-us/windows/complete-guide-to-narrator-e4397a0d-ef4f-b386-d8ae-c172f109bdb1 Built-in to Windows 10 and 11.
- VoiceOver [macOS, iOS]; Apple; https://apple.com/accessibility/mac/vision/. Built-in on Apple devices (macOS, iOS, tvOS, and watchOS).
- TalkBack [Android]; Google; https://support.google.com/accessibility/android/topic/3529932 Built-in to some Android versions, otherwise part of Android Accessibility Suite on Play Store.
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Most Common Accessibility Issues

From WebAIM Million Report 2022 https://webaim.org/projects/million/:

- Low contrast text. [83.9%]
- Missing alternative text for images. [55.4%]
- Empty links. [50.1%]
- Missing form input labels. [46.1%]
- Empty buttons. [27.2%]
- Missing document language. [22.3%]

Video: Léonie Watson on Web Accessibility

- Léonie Watson; *Bag of Spanners*; Beyond Tellerrand Dusseldorf, 02 May 2022 [Watson 2022, 03:24-]. [Video: https://youtu.be/ixdTM8UGoIo?t=03m24s]

Video: Vitaly Friedman on Inclusive Design Patterns

- Vitaly Friedman; *Inclusive Design Patterns for 2025*; Smashing Workshop, 24 Sep 2024 [Friedman 2024]. [Video: https://youtu.be/xEtKkLdAnvI]

Checking a Web Site for Accessibility

- Turn images and JavaScript off.

- Use the keyboard to navigate through your site (tab, arrow keys, space, return).
- Use a text-only web browser such as Lynx to browse your site `lynx.invisible-island.net`.
- Try out with different screen readers such as JAWS, NVDA, or VoiceOver.
- Do an accessibility audit with Google Lighthouse [Google 2022] or axe DevTools [Deque 2022].
- Include Lighthouse or axe into your build process.
- Use an accessibility evaluation service such as WAVE `wave.webaim.org`.

Chapter 6

Site Objectives and User Needs

> *“ We need to design for a world where Google is our home page, Wikipedia [DBpedia] is our content management system, and humans and robots are our users. ”*
>
> [Mike Atherton, talk at City University 06 Mar 2012 [Atherton 2012, 13:48].]

6.1 Site Objectives

Site Objectives: business, creative, and other internally derived goals for the site.

6.2 Web Site User Needs and Characteristics

As with any kind of usability engineering, when designing web sites it is imperative to know your *target users* and their *typical tasks*.

User Needs: externally derived goals for the site identified through user research.

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\+ Bernard Jim Jansen; *Understanding User-Web Interactions via Web Analytics*; Morgan Claypool, 2009. ISBN 1598298518 (com, uk) [Jansen 2009]

\+ Louis Rosenfeld; *Search Analytics for Your Site*; Rosenfeld Media, 2011. ISBN 1933820209 (com, uk) [Rosenfeld 2011]

6.2.1 Web Users in General

Statistics about web users in general. Not specific to any one site.

Demographics

- Pew Internet; *Internet/Broadband Fact Sheet*; 07 Apr 2021. https://pewresearch.org/internet/fact-sheet/internet-broadband/
- Pew Internet; *Mobile Fact Sheet*; 07 Apr 2021. https://pewresearch.org/internet/fact-sheet/mobile/

Browser Statistics

- Wikipedia; *Usage Share of Web Browsers*; https://wikipedia.org/wiki/Usage_share_of_web_browsers
- StatCounter; *Global Statistics*; gs.statcounter.com [press Edit Chart Data, then select Desktop or Mobile.]

Connection Speeds

- Ookla; *Speedtest Global Index*; https://speedtest.net/global-index/
  Measured connection speeds, aggregated from millions of users of speedtest.net.
- Cable; *Worldwide Broadband Speed League 2023*;
  https://cable.co.uk/broadband/speed/worldwide-speed-league/

Austrian Data

- Österreichische Webanalyse (ÖWA); https://oewa.at/ [ÖWA 2024]
- Integral; *Austrian Internet Monitor Consumer (AIM-C)*; H1 2024. https://integral.co.at/media-center/studien/austrian-internet-monitor-consumer-1-hj-2024 [Integral 2024]
- Statistik Austria; *ICT Usage in Households*; https://statistik.at/en/statistics/research-innovation-digitalisation/digital-economy-and-society/ict-usage-in-households [Statistik Austria 2023]

6.2.2 Know Your Own Users

- Server logs
  - Browser demographics:
    - OS
    - Browser version
    - Colours
    - Resolution
  - Page view logs:
    - Most popular pages
    - Most frequent paths
  - Search logs:
    - What is searched for most?
    - Which popular searches are unsuccessful?

- Bug reports, feedback
  - Problems, issues, and concerns.
- Online survey, competition.
  - User demographics
  - Connection speed

Web Analytics Tools

- Garenne Bigby; *35 Amazing Web Analytics Tools that Rival Google Analytics*; 11 Sep 2023. https://dynomapper.com/blog/21-sitemaps-and-seo/436-35-amazing-web-analytics-tools-that-rival-google-analytics
- Scott Nesbitt; *Top 5 open source alternatives to Google Analytics*; 08 Oct 2020. https://opensource.com/article/18/1/top-5-open-source-analytics-tools
- Himanshu Sharma; *Matomo vs Google Analytics vs Piwik Pro – Best Google Analytics Alternative*; 12 Jul 2023. https://optimizesmart.com/introduction-to-piwik-best-google-analytics-alternative/
- Matomo (formerly Piwik); matomo.org
  https://github.com/matomo-org/matomo
  Open-source (also paid hosted plans), PHP and JavaScript (Vue). Your analytics data stays private.
- Open Web Analytics; openwebanalytics.com
  https://github.com/Open-Web-Analytics/Open-Web-Analytics
  Open-source, PHP-based.
- Offen; offen.dev
  https://github.com/offen/offen
  Open-source, Go-based.
- Google Analytics; https://developers.google.com/analytics
  Free to use, but data resides with Google.
- Piwik Pro; piwik.pro
- and many, many other free and commercial tools.

Real User Monitoring (RUM)

Track, record, and play back individual user sessions (in addition to aggregate analysis).

- Michael Higham; *9 Best Real User Monitoring Tools and How to Choose One*; 06 Jan 2023.
  https://sematext.com/blog/real-user-monitoring-tools/
- Heap Analytics; heap.io
  Real-time, event-based analytics (commercial, with limited free plan).
- Clarity; clarity.microsoft.com
  Replay user sessions and explore heatmaps. (free to use).
- Hotjar; hotjar.com
  (commercial, with limited free plan).

- dynatrace; https://dynatrace.com/news/blog/what-is-real-user-monitoring/
- Inspectlet; inspectlet.com
- Fullstory; fullstory.com
- and many, many other commercial tools.

Chapter 7

Content Strategy

> *" Content is King. "*
>
> [Title of an essay by Bill Gates, 03 Jan 1996. [Gates 1996]]

Content Strategy: "Content strategy plans for the creation, publication, and governance of useful, usable content." [Halvorson 2008]

Content Strategy

Content strategy deals with the:

- creation and sourcing,
- modeling,
- management,
- governance, and
- delivery

of content.

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+ Margot Bloomstein; *Content Strategy at Work*; Morgan Kaufmann, 04 Dec 2012. ISBN 0123919223 (com, uk) [Bloomstein 2012]

∘ Erin Kissane; *The Elements of Content Strategy*; A Book Apart, 08 Mar 2012. ISBN 0984442553 (com, uk) [Kissane 2011]

- ◦ Karen McGrane; *Content Strategy for Mobile*; A Book Apart, 05 Nov 2012. ISBN 1937557081 (com, uk) [McGrane 2012]
- ◦ Sara Wachter-Boettcher; *Content Everywhere*; Rosenfeld, 12 Dec 2012. ISBN 193382087X (com, uk) [Wachter-Boettcher 2012]
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- \+ Rachel Lovinger; *Content Strategy: The Philosophy of Data*; Boxes and Arrows, 27 Mar 2007 [Lovinger 2007]. https://boxesandarrows.com/content-strategy-the-philosophy-of-data/
- \+ Steve Fisher; *Responsive Content Modeling*; Republic of Quality, 29 Sep 2014 [Fisher 2014]. https://republicofquality.com/responsive-content-modeling/
- \+ Kristina Halvorson; *The Content Strategy Podcast*; contentstrategy.com
- ++ Larry Swanson; *Content Strategy Insights Podcast*; https://ellessmedia.com/csi/

Conferences

- \+ Confab confabevents.com
- \+ Button, Content Design Conference buttonconf.com
- ◦ ContentEd contentedlive.com
- ◦ LavaCon lavacon.org
- ◦ Design & Content Conference content.design https://content.design/blog/videos

Video: Kristina Halvorson on Content Strategy

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  [01:12-06:48] [Video: https://youtu.be/fZRcJNrYlEs?t=01m12s]

  [11:09-15:42] [Video: https://youtu.be/fZRcJNrYlEs?t=11m09s]

Chapter 8

Information Architecture

" IA is the means by which we get from a pile of stuff to a structured experience. "

[Adaptive Path, Designing the Complete User Experience, course slides.]

Information Architecture (IA) is the structural design of an information space to facilitate intuitive access to its contents. See Figure 8.1.

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∘ Abby Covert; *How to Make Sense of Any Mess: Information Architecture for Everybody*; CreateSpace, 04 Nov 2014. ISBN 1500615994 (com, uk) [Covert 2014]

∘ Geoffrey C. Bowker and Susan Leigh Star; *Sorting Things Out: Classification and its Consequences*; MIT Press, 28 Aug 2000. ISBN 0262522950 (com, uk) [Bowker and Star 2000]

Figure 8.1: Information architecture: getting from a pile of stuff to a structured experience.

° Robert J. Glushko (Ed.); *The Discipline of Organizing*; MIT Press, 17 May 2013. ISBN 0262518503 (com, uk) [Glushko 2013]

° George Lakoff; *Women, Fire, and Dangerous Things: What Categories Reveal About the Mind*; New Edition, University of Chicago Press, 1990. ISBN 0226468046 (com, uk) [Lakoff 1990]

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ing Magazine, 03 Dec 2013. https://smashingmagazine.com/2013/12/efficiently-simplifying-navigation-information-architecture/

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- Peter Morville; *Understanding Information Architecture*; Prezi presentation, 27 Jun 2012. https://prezi.com/aafmvya6bk7t/understanding-information-architecture/

Video: Paul Otlet

- Francoise Levie; *The Man Who Wanted to Classify the World*; 60-minute documentary, 2002. [Levie 2002].
  [09:56-13:32] UDC, 3x5" index cards [Video: https://youtu.be/L9jgnU3V944?t=09m56s]
  [16:00-17:41] 1905, LoC [Video: https://youtu.be/L9jgnU3V944?t=16m00s]
  [34:46-35:36] 12 million index cards [Video: https://youtu.be/L9jgnU3V944?t=34m46s]
- The Mundaneum museum in Mons, Belgium is devoted to the work of Paul Otlet and Henri La Fontaine mundaneum.org.
- See Wright [2014] for much more detail.

Video: Michael Wesch Information R/evolution

- Michael Wesch; *Information R/evolution*; 2007. [Wesch 2007]. [Video: https://youtu.be/-4CV05HyAbM]

Uses of Information Architecture

Information architecture typically involves creating and maintaining:

- *Information hierarchies*: groups and sub-groups for content and their labels (used in navigation).
- *Metadata*: structured data attached to individual items (used for search and faceted browsing).

Figure 8.2 illustrates how these are used on a typical product web site.

Information Seeking Behaviour

Users seeking information typically follow one of the following patterns of behaviour:

- *Known-Item Search*: The user knows exactly what they are looking for and how to describe it.
- *Exploratory Search*: The user knows broadly what they are interested in, and hopes to discover a few useful items or pointers.
- *Exhaustive Search*: The user is looking for everything available on a particular topic.
- *Refinding*: The users remembers having seen a particular item, but now wants to find it again.

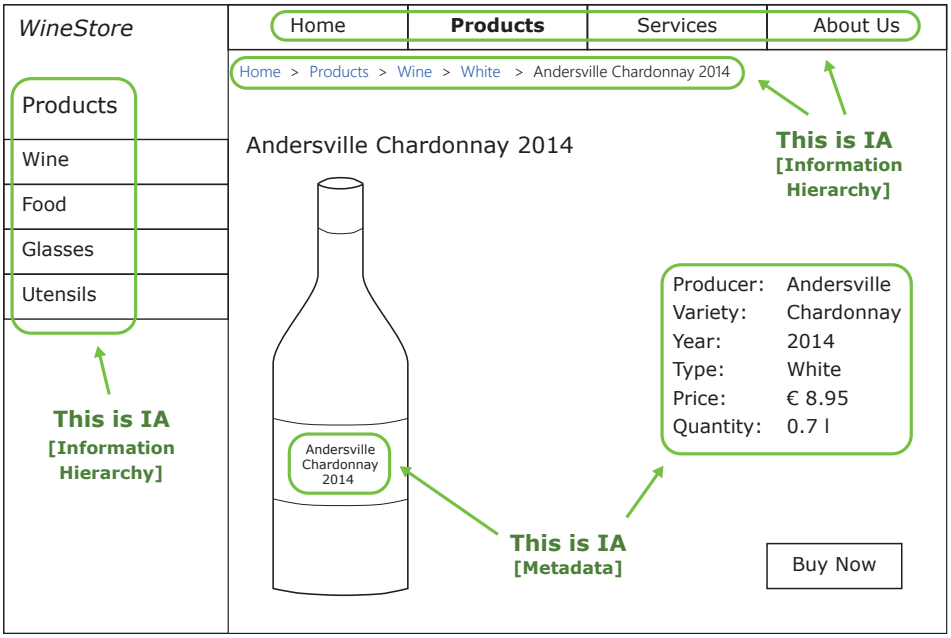

Figure 8.2: Using IA on a typical product web site. Information hierarchies are used in navigation, metadata is used for search and faceted browsing. [Adapted by Keith Andrews from Figure 2-2 of Spencer [2014, page 28].]

Pace of Change

In traditional architecture, Brand [2010] describes how buildings comprise six layers, which change over time at different rates ("shearing layers"):

- *Site*: the geographical location. [changes the slowest]
- *Structure*: the skeleton of the building, including foundations, columns, support elements.
- *Skin*: the exterior surface of the building.
- *Services*: the internal infrastructure, such as heating, ventilation, plumbing, and wiring.
- *Space plan*: internal layout, room partitions, doors.
- *Stuff*: furnishings and appliances. [changes the fastest]

Similarly, a website's visual design may change relatively frequently, while its underlying information architecture remains relatively stable, and its domain name should rarely change at all.

8.1 Organisation Schemes

Homogeneity

An old-fashioned library card catalog is fairly *homogeneous*:

- It organises and provides access to books (and only books).
- It does not provide access to chapters of books or collections of books.

- All the objects are at the same level of *granularity*.
- Each record (index card) contains the same fields: author, title, and subject.

Heterogeneity

Most web sites, in contrast, are *heterogeneous*:

- Web sites may provides access to objects of different types in different formats.
- Objects might be accessible at different levels of granularity: collections of journals, journals, articles.

It does not make sense to classify objects at varying levels of granularity (say, journals and articles) side by side.

Exact Organisation Schemes

Exact organisation schemes divide information up into well-defined, mutually exclusive sections, such as:

- Alphabetical: for example, residential telephone book (white pages) sorted by surname then first names.
- Chronological: for example, press releases sorted by date of announcement.
- Geographical: for example, weather forecasts sorted by country and region.

A *facet* is an attribute along which items can be organised, for example name of person or date of press release.

Known-item search: if you know the facet value of the item you are looking for, the path to it along that facet is unambiguous and obvious.

Ambiguous Organisation Schemes

Sometimes categories are overlapping or items fall into multiple categories.

Common ambiguous organisation schemes include:

- Topical: for example, product categories, newspaper articles, Open Directory.
- Task-based: for example, browse, sell, search, sign in (limited number of high priority tasks).
- Audience-based: for example, novice or expert.
- Metaphor-based: for example, desktop or sketch map.

Often, a selection of organisation schemes is provided.

Topical Organisation Schemes

In a library, you can typically search for books by:

- Author (exact),
- Title (exact), or

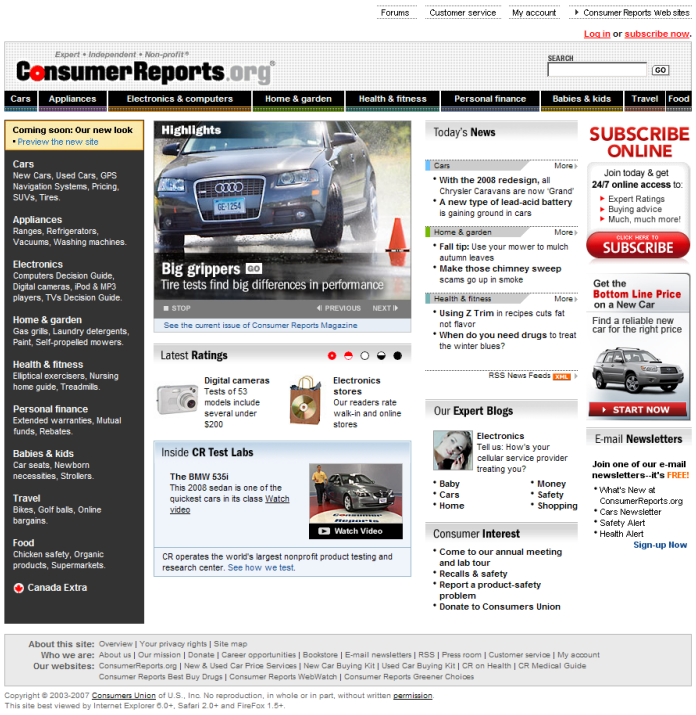

Figure 8.3: Topical organisation scheme at ConsumerReports in 2007.

- Subject (ambiguous).

  Library patrons use subject-based schemes *much* more often than author or title, because:

- often do not know exactly what they are looking for
- can browse serendipitously among groups of topically related items.

  Examples include the site index at About.com `about.com` or the product categories at Amazon `amazon.com` or Geizhals `geizhals.at`.

  Figure 8.3 shows the topical organisation scheme at ConsumerReports `consumerreports.org` in 2007.

Task-Based Organisation Schemes

- Limited number of high priority tasks.
- For example: Browse, Search, and Sell, and Pay, Register, and Sign In on Ebay `http://ebay.com/` in 2003, as shown in Figure 8.4.

Audience-Based Organisation Schemes

- Invite customers to self-select which category they fit into.
- Repeat visitors can bookmark their section.
- For example: Home & Home Office, Small & Medium Business, Large Business, and Government at Dell `dell.com`, as shown in Figure 8.5.

Figure 8.4: Task-based organisation scheme at the Ebay web site in 2003.

- However, research shows that users are not very good at self-identifying and think they are missing out on good content in the other sections.

Metaphor-Based Organisation Schemes

- Hard to get right.
- If it is to succeed, metaphor must be familiar to users.
- Do not stretch or break the metaphor.
- For example: users of a virtual airport might expect a check-in clerk to be on hand to answer questions.
- In 1996 the Lufthansa web site featured a Virtual Airport with a metaphor-based organisation scheme, as shown in Figure 8.6.

Multiple Organisation Schemes

Where multiple schemes are presented on the same page:

- Preserve the integrity of each organisation scheme.
- Do not mix and match schemes at the same level.

  The Stanford University web site provides multiple organisation schemes, as shown in Figure 8.7.

  Dell has in fact a geographical, an audience-based, and a topical organisational scheme.

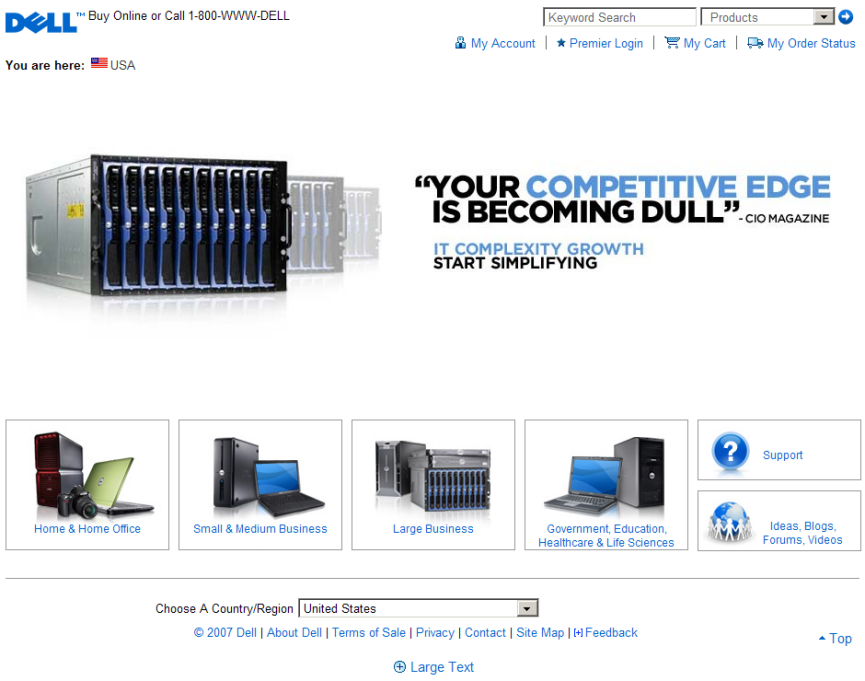

Figure 8.5: Audience-based organisation scheme at the Dell web site.

Figure 8.6: Metaphor-based organisation scheme at the Lufthansa web site in 1996.

Figure 8.7: Multiple organisation schemes at Stanford University web site: topical, audience, and alphabetical.

Mixed Up Library	
Adult	audience-based
Arts and Humanities	topical
Community Centre	metaphor-based
Get a Library Card	task-based
Learn About Our Library	task-based
Science	topical
Social Science	topical
Teen	audience-based
Youth	audience-based

Figure 8.8: A mixed-up hybrid organisational scheme. [From Morville and Rosenfeld [2006, page 67]]

Metadata-Based Organisation Schemes (Database Model)

An alternative, bottom-up approach, based on every individual item having structured metadata attributes (records with fields, like in a database), for example:

author:	Louis Rosenfeld and Peter Morville and Jorge Arango
title:	Information Architecture: For the Web and Beyond
publisher:	O'Reilly
edition:	4
date:	2015-10-11
isbn:	1491911689
pagetotal:	488

In this example, it is possible to search for and sort items using any (combination) of these fields.

The metadata fields for all items within a particular (sub)collection must be homogeneous and must (largely) be filled out.

8.2 Taxonomies and Hierarchies

A taxonomy (in our sense) is a hierarchical arrangement of categories.

At each level of a hierarchy, categories should be:

- *Mutually exclusive*: use non-overlapping categories, so users know where to look (scent).
- *Comprehensively exhaustive*: completely partition the parent category, so users do not suspect a category is missing.
- *Equivalently granular*: it is confusung to encounter neighbouring categories which appear to cover different levels of granularity.

Analysts at McKinsey use the MECE (mutually exclusive, collectively exhaustive) rule when they are breaking down business problems [Rasiel and Friga 2001].

Category Labels

As far as possible, category labels should be:

- Phrased in the user's language.
- Unambiguous.

Check your choice of labels by tree testing, or running a thinking aloud test on a working prototype.

Managing Change

An information hierarchy typically changes over time:

- Entirely new categories may appear, and obsolete ones disappear.
- Categories may grow too large, requiring subdivision, or become too small to justify remaining.

- Some items or subcategories may move elsewhere.
- Changes to category labels and category members are *interdependent*:
  - When changing a category label, check that the new label still accurately describes the category's contents.
  - When changing a category's members, ensure that the category label still accurately describes the category's contents.

Navigation Label Audit

An existing web site's navigation labelling system can be audited:

- Choose a starting point (say, the home page or a representative content page), such as the one in Figure 8.9.
- Systematically check every local (within-site) navigation link on the page.
- For each such link, enter the following into a spreadsheet:
  - *Label text*: the text which the users sees and clicks.
  - *Destination heading*: A (typically bold) main heading in the destination page content.
  - *Destination* `<title>` *text*: the text inside the `<title>` element of the link destination (typically shown in the browser window or tab bar). [Use View Source and search for `<title>` to determine the title text.]
  - *Destination URL*: the URL of the page to which the user is taken.

  as shown in Figure 8.10.
- Once the spreadsheet is complete, check the labels for consistency.
- Sort by Destination URL and cross-check.

  An further example can be found in Rosenfeld et al. [2015, pages 158–160].

Polyhierarchies

If the categories are not mutually exclusive (i.e. if items may appear in multiple places), the taxonomy is *polyhierarchical*.

Sometimes it makes sense to crosslist items in multiple locations:

- Do tomatoes belong to fruit, vegetable, or berries?
  Probably all of them [Morville and Rosenfeld 2006, page 56].
  [The tomato is technically a berry and thus a fruit, although it is usually used as a vegetable.]
- Are toner cartrides best listed under laser printers or printer supplies? Probably both.

Breadth versus Depth

- If a hierarchy is too narrow and deep, users have to click through too many levels.
- If a hierarchy is too broad, users must choose between a large number of subcategories at each level.

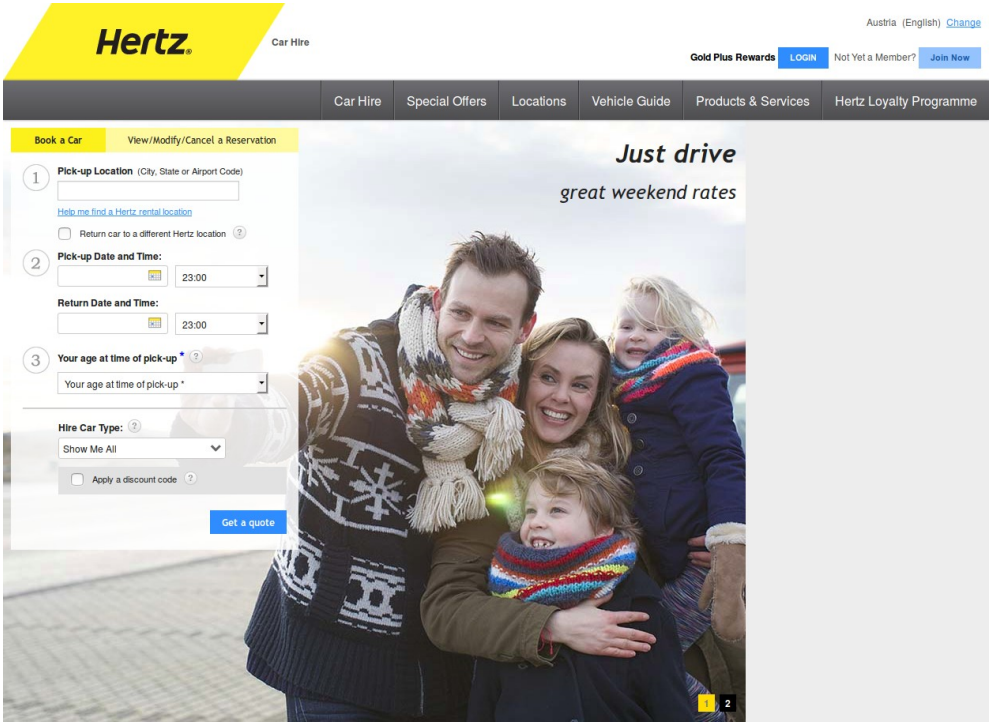

Figure 8.9: The Hertz web site (`hertz.com`) in Oct 2016. [Used with kind permission of Matthias Stefan.]

	A	B	C	D	E	F
1	**Label**	**Text / Iconic**	**Destination Heading**	**Destination <title>**	**Destination URL**	**Notes**
2						
3	***Header Nav Labels***					
4	Hertz	t	Hertz	Hertz Car Hire: Car rental in Austria, Europe, Worldwide:	https://www.hertz.com/rentacar/reservation/	
5	I Forgot My Member Number	t	Retrieve Your Member Number		https://www.hertz.com/rentacar/emember/reset/memberNumberRetriev	empty title tag
6	I Forgot/Need Password	t	Member Number - Please enter a valid member		https://www.hertz.com/rentacar/member/login?curPage=input	empty title tag
7	Join Now	t	Hertz Gold Plus Rewards	Hertz Gold Plus Rewards	https://www.hertz.com/rentacar/member/enrollment	
8	Submit	t	Hertz	Hertz Car Hire: Car rental in Austria, Europe, Worldwide:	https://www.hertz.com/rentacar/reservation/	
9	Get a Quote...Reserve a Car	t	Hertz	Hertz Car Hire: Car rental in Austria, Europe, Worldwide:	https://www.hertz.com/rentacar/reservation/home?startRes=Y&forceResHomePage=Y&defaultT	
10	View/Modify/Cancel a Reservation	t	Hertz	Hertz Car Hire: Car rental in Austria, Europe, Worldwide:	https://www.hertz.com/rentacar/reservation/#search	
11	Online Check-In	t	ONLINE CHECK-IN		https://www.hertz.com/rentacar/onlinecheckin/index.jsp?targetPage=onl	empty title tag
12	Qualifications & Requirements	t	Hertz Car Hire Locations		https://www.hertz.com/rentacar/location?processName=rentalQualificati	empty title tag
13	Special Offers	t	Special Offers	Hertz Special Offers	https://www.hertz.com/rentacar/rental-car-deals	
14	Locations	t	Hertz Car Hire Locations		https://www.hertz.com/rentacar/location	empty title tag
15	Vehicle Guide	t	Hertz	Hertz - Vehicle Guide	https://www.hertz.com/rentacar/vehicleguide/index.jsp?targetPage=vehicleGuideHomeView.jsp&	
16	Products & Services	t	Hertz		https://www.hertz.com/rentacar/productsandservices/productsandservic	empty title tag
17	Overview / Join	t	Hertz Gold Plus Rewards	Hertz Gold Plus Rewards	https://www.hertz.com/rentacar/member/enrollment	
18						
19						
20	***Body Nav Labels***					
21	Help me find a Hertz rental location	t	Hertz Car Hire Locations		https://www.hertz.com/rentacar/location?search=&triggerSearch=tru	empty title tag
22	Get a quote / OK	t	Choose a Car	Hertz Car Hire: Car rental in Austria, Europe, Worldwide:	https://www.hertz.com/rentacar/reservation/#vehicles	If correct filled in 'Get a
23	Continue	t	?	?	?	Redirection can not be
24	„Background Picture 1"	i	Enjoy your weekend in Austria	Weekend rentals	https://www.hertz.com/rentacar/rental-car-deals/Austrian-weekend-renta	you see this one if the
25	„Background Picture 2"	i	Fun Collection - Austria	Hertz Fun Collection	https://www.hertz.com/rentacar/productservice/index.jsp?targetPag	you see this one if the
26						
27	***Footer Nav Labels***					
28	Sign Up	t	Receive E-Mail Offers from Hertz	Join Hertz eMail	https://email.hertz.com/apps/JoinMarketing?lang=en&pos=AT	
29	Facebook	i	Road Work Ahead		https://www.hertz.com/rentacar/misc/index.jsp?targetPage=facebook.jsp	empty title tag & Seem
30	Twitter	i	Hertz CorporationVerifizierter Account	Hertz Corporation (@Hertz) | Twitter	https://twitter.com/Hertz	
31	YouTube	i	Hertz	Hertz – YouTube	https://www.youtube.com/user/hertzcarrental	
32	Google+	i	Hertz	Hertz - Google+	https://plus.google.com/+hertz	
33	Hertz Mobile	i	Hertz Mobile	Hertz Mobile	https://www.hertz.com/rentacar/productservice/index.jsp?targetPage=hertzmobilesite.jsp	
34	Reservations	t	Hertz	Hertz Car Hire: Car rental in Austria, Europe, Worldwide:	https://www.hertz.com/rentacar/reservation/gaq/index.jsp?targetPage=reservationOnHomepage	
35	Special Offers	t	Special Offers	Hertz Special Offers	https://www.hertz.com/rentacar/rental-car-deals	
36	Locations	t	Hertz Car Hire Locations		https://www.hertz.com/rentacar/location	empty title tag
37	Vehicle Guide	t	Hertz	Hertz - Vehicle Guide	https://www.hertz.com/rentacar/vehicleguide/index.jsp?targetPage=vehicleGuideHomeView.jsp&	
38	Products & Services	t	Hertz		https://www.hertz.com/rentacar/productsandservices/productsandservic	empty title tag
39	Gold Plus Rewards Overview	t	Hertz Gold Plus Rewards	Hertz Gold Plus Rewards	https://www.hertz.com/rentacar/member/enrollment	
40	Contact us	t	Contact Us	Hertz – Contact Us	https://www.hertz.com/rentacar/customersupport/index.jsp?targetPage=contactUsTypeSelection	
41	Request an Invoice	t	Request a Rental Receipt		https://www.hertz.com/rentacar/receipts/request-receipts.do	empty title tag
42	Frequent Traveler Credit	t	Retroactive Credit Request Form	Hertz – Retrocrative Credit Request Form	https://www.hertz.com/rentacar/partner/index.jsp?targetPage=ftRetroFormView.jsp	
43	Login	t	Login		https://www.hertz.com/rentacar/member/login?curPage=input	empty title tag

Figure 8.10: A manually created navigation label audit of the Hertz web site in Oct 2016. [Used with kind permission of Matthias Stefan.]

- A medium balance of breadth and depth provides the best results, according to Larson and Czerwinski [1998].
- If you expect the hierarchy to grow, tend towards broad-and-shallow (it is less problematic to add items to secondary levels of the hierarchy).

Note: The famous 7 plus or minus 2 study [G. A. Miller 1956] investigated the number of items retained in short-term memory. It *does not* apply to choices which are visible!!

Top-Down and Bottom-Up Design

- *Top-down*: Start with the broadest categories and work down.
- Top-level categories come from user and task analysis.
- *Bottom-Up*: Start grouping content items into low-level categories and work up.
- Content chunks come from content audit of client and competitive analysis.
- Meet in the middle.

8.3 Card Sorting

Construct a hierarchical structure from the users' perspective by conducting card sorting tests.

References

++ Donna Spencer; *Card Sorting: Designing Usable Categories*; Rosenfeld Media, 2009. ISBN 1933820020 (com, uk) [Spencer 2009]

++ Anthony Coxon; *Sorting Data: Collection and Analysis*; Sage Publications, 1999. ISBN 0803972377 (com, uk) [Coxon 1999]

++ William Hudson; *Everything You've Always Wanted to Know About Card Sorting*; `http://syntagm.co.uk/design/cardsort.pdf` [Hudson 2005]

Concept Cards

- Make a list of concepts which should be present on your site (brainstorming, user interviews, content audit).
- Each concept corresponds to a chunk or set of information.
- Around 50–100 concepts are manageable in practice.
- Make one notecard for each concept. I use cards of size 12cm × 8cm (I print out 4 per sheet of A4 card).
- Use a large font, so the label can be read on the video recording.
- Number each card to better keep track of the concepts.

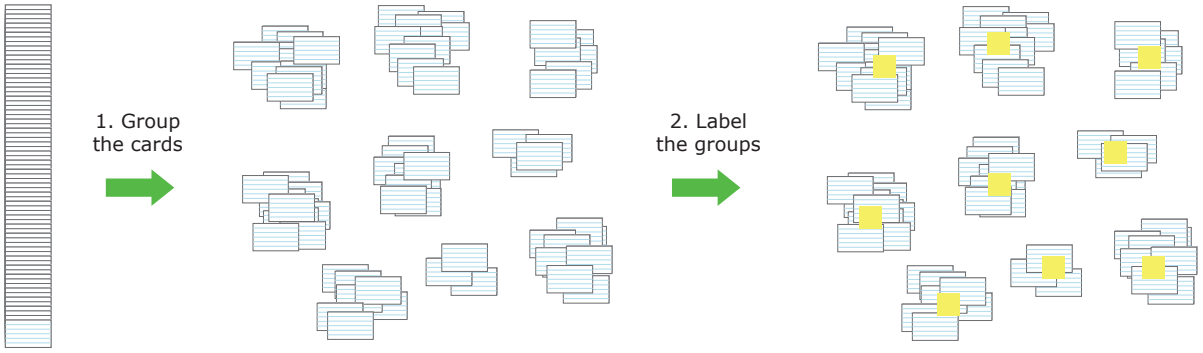

Figure 8.11: Open card sorting. Given a set of cards with concepts, the user first groups the cards into categories. Then, the user labels the categories with post-it notes. [Adapted by Keith Andrews from Figure 26 of Schilb [2006, page 40].]

(Open) Card Sorting

In an *open* card sorting test:

- Users group concept cards into their own categories (and potentially sub-categories), which they then label themseleves, as shown in Figure 8.11.
- Too few concept cards and you will not get two levels of a hierarchy, only one.
- Used in early phases of research to help build a concept hierarchy.

Closed and Hybrid Card Sorting

In a *closed* card sorting test:

- Users sort concept cards into a *predefined* category hierarchy.
- At the start, you can ask users what they think each category means.
- Once a hierarchy has been built, closed card sorting is used to check where users would *place* concepts.

In a *hybrid* card sorting test:

- Like closed card sorting, but users are allowed to add rename, and delete categories as well.

[I am not a fan of closed or hybrid card sorting. To check where users would *look for* concepts, there are better techniques, such as tree testing (see Section 8.4) or thinking aloud testing of a working prototype. When I say card sorting, I always mean *open* card sorting, unless otherwise stated.]

Face-to-Face (Open) Card Sorting

Like a thinking aloud usability test:

- Prepare the set of numbered concept cards.
- Prepare a small set of demo concept cards.
- Reserve a quiet room with a large table. [The table should have a plain surface, so as not to distract from the cards. A glass surface or a multi-coloured tablecloth are not ideal. . .]

- Organise a video camera, tripod, and microphone.

Running a Face-to-Face Card Sorting Study

Step-by-step recipe for running a face-to-face card sorting study.

1. Preparation

- Shuffle both sets of concept cards (random order).
- Start the recording.

2. Opening

- Greet the user.
- Go through the orientation script.
- Ask the user to read and sign the consent form.
- Explain thinking aloud: "I would like you to talk out loud while you are working, so that I can follow your thought process when I watch the video back later."
- Give a demo of card sorting while thinking aloud with the small set of demo concepts.
- Ask if the user has any questions at this point.

3. Card Sorting Session

- Give the user the pack of real concept cards.
- Ask the user to look through the cards to see if any concept is unclear. See Figure 8.12.
- If a concept is unclear, ask the user what they think it means (for feedback), then explain what was actually intended. See Figure 8.13.
- Ask the user to sort the cards into piles or categories (ideally, not too small and not too large) according to perceived similarity. See Figure 8.14.
- Make sure you prompt and encourage the user to keep talking out loud the whole time.
- Ask the user to name the piles using Post-it notes, as shown in Figure 8.15.
- If there are many fairly small piles, the user should group the piles into larger groups of similar piles.
- If a single pile contains many (>10–12) cards, ask the user to spilt it into subgroups.
- The user names each group using Post-Its. Use a different colour Post-It for each level of the hierarchy.
- About 30–60 minutes per user.

Figure 8.12: A card sorting test. The concept cards are first scattered randomly over the table.

Figure 8.13: The test facilitator explains any concepts which are unclear. Note the observers sitting in the background.

Figure 8.14: The test user is in the process of grouping the cards into categories.

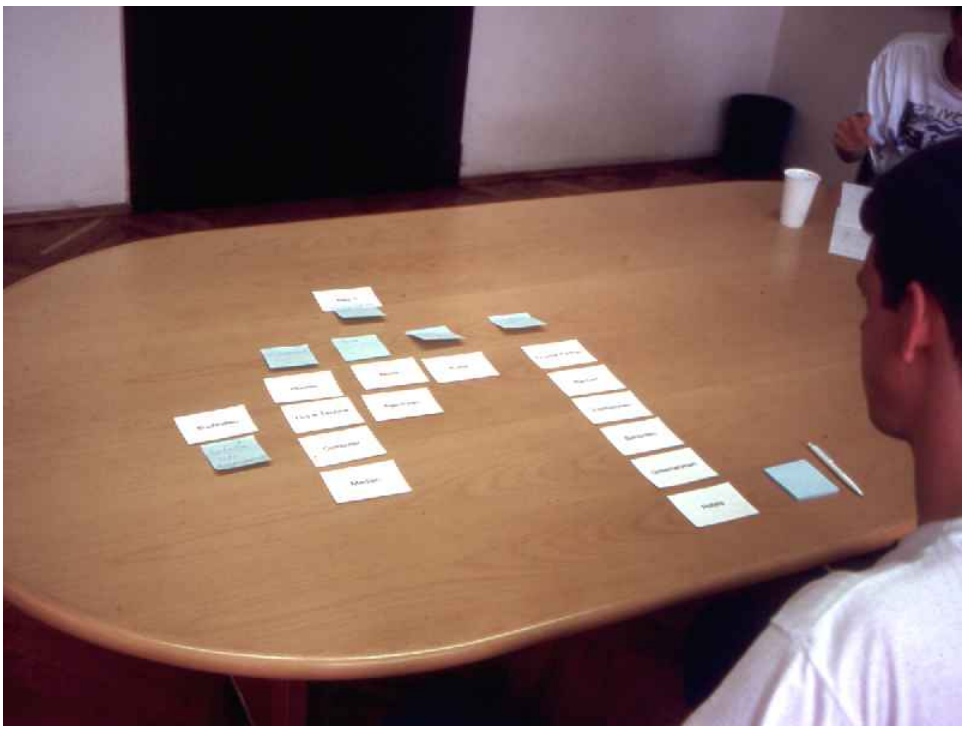

Figure 8.15: Finally, the categories or piles are labeled with Post-It notes.

4. Closing

- Make sure you have understood the names given by the user to each group.
- Ask the user to explain any strategy they used to group the cards (to discover their organising principle): "How did you proceed? Did you have some kind of principle in mind while you were grouping the cards?"
- Thank the user and escort them to the door.

5. Clean-Up

- Stop the recording. Check the audio quality. Save and rename the video file appropriately.
- Take photographs of this user's cards and groups for documentation.
- Capture the contents of each pile and group (this user's two-level hierarchical structure) on paper.
  [A quick way of doing this is to write the number of each card in a group onto that group's Post-It.]
- Take more photographs of the groups with Post-Its (after writing down the member card numbers) for documentation.
- Prepare for the next user.

How Many Users for Card Sorting?

- To gain some insight into user thinking, 3 to 5 users are probably enough.
- To discover alternative organising principles and for statistical analysis, many more users (50, 100, or more) are needed → use an online tool.

Commercial Tools to Help Run a Card Sort

- Proven By Users; `https://provenbyusers.com/provenbyusers-cardsort.php`
- OptimalSort; `https://optimalworkshop.com/optimalsort/`
- UserZoom; `https://userzoom.com/card-sorting/`
- UXtweak; `https://uxtweak.com/card-sort-tool/`
- Useberry; `https://useberry.com/card-sorting/`
- UXArmy; `https://uxarmy.com/use-cases/card-sorting`
- and many more.

Free Tools to Help Run a Card Sort

- Diamond; `https://github.com/tugraz-isds/diamond`
- Card Sorter; `https://usability.csd.auth.gr/card-sorter/`
- kardSort; `kardsort.com`

Categorising Sorts by Mindset

Before you can do any meaningful analysis, you must categorise your sorts by "mindset", the organising principle each user used to create their groups:

- Different users will often have different ways of grouping concept, using different organising principles (or mindsets).
- For example, when grouping supermarket items, each of these organising principles may appear:
  - Supermarket: by the item's (shelf) location in a supermarket.
  - Recipe: by how the item is used with other items.
  - Region: by where the item originates.
  - Kitchen: by where the item will be stored at home.
- In face-to-face card sorts, when users are thinking aloud, they can usually explain their organising principle (mindset) to you.
- In online card sorts, you should ask the user to explain their organising principle (mindset) in a feedback field at the end of the sort. You need all the help you can get.
- It makes no sense to aggregate sorts from users who have used different mindsets.

Manual Analysis of Card Sorting Results

- Analyse data using an analysis spreadsheet (see Donna Spencer's book [Spencer 2009]).
- If users came up with several different names for (more or less) the same group of cards, choose the best name (even a new name) for that group.
- Come up with an aggregate suggestion for two-level hierarchy of information, *the way users would expect to find things organised*.
- Also come up with suggestions for naming every group (menus), but treat these only as suggestions, which should then be usability tested.
- Translate this into equivalent web site structure.
- Repeat card sorting at higher or lower levels of granularity.

Statistical Analysis of Card Sorting Results

All of the statistical tools presume a one-level hierarchy as input, i.e. a simple list of groups all at the same level. [If some users produce a multi-level hierarchy, it has to be flattened before it can be input to the tool.]

The most common measure for similarity between two concepts is based on how often the two concept cards are placed in the same group:

- Say there were 8 users and hence 8 different groupings.
- For every pair of concepts: count the number of times these two concepts were placed in the same group (a number bewteen 0 and 8).
- Normalise by the number of users (i.e. divide by 8).

- That gives a number indicating the similarity between every pair of concepts, ranging between 0 (never in the same group, so highly dissimilar) and 1 (always in the same group, so highly similar).

This similarity matrix (triangular matrix) is used as input for the statistical tools (hierarchical clustering).

Statistical Tools for Analysis of Open Card Sorting Results

Some tools to help with statistical analysis of open card sorting data include:

- Casolysis; https://cs.uni-paderborn.de/en/mci/forschung/anwendungensoftware/casolysis
- SynCaps; https://syntagm.co.uk/design/cardsortdl.shtml
- Sortpac; https://methodofsorting.com/sortpac.htm
- EZCalc (part of IBM EZSort); No longer available, archive copy at: https://web.archive.org/web/20040205000418/http://www-3.ibm.com/ibm/easy/eou_ext.nsf/Publish/410

8.4 Tree Testing

Tree testing (hierarchy validation, or reverse card sorting) is used to validate a navigation hierarchy:

- Take an existing or candidate navigation hierarchy.
- Present it in a plain, bare-bones way.
- Ask users where they would expect to find certain items (known-item search).

Tree testing tests the basic hierarchy, stripping out any influence of visual or navigation design.

Tree Testing Benefits

Tree testing can check the following:

- Are the labels making sense to users?
- Is the content grouped logically?
- Do users look where expected? Why not?

Types of Tree Testing

- Paper-based with index cards.
- Computer-based tree testing tool (locally installed or online).
- Face-to-face (supervised) or unsupervised.

Paper-Based Tree Testing with Index Cards

Described by Donna Spencer [Spencer 2003]:

- Model each node in the hierarchy on an index card, as illustrated in Figure 8.16.

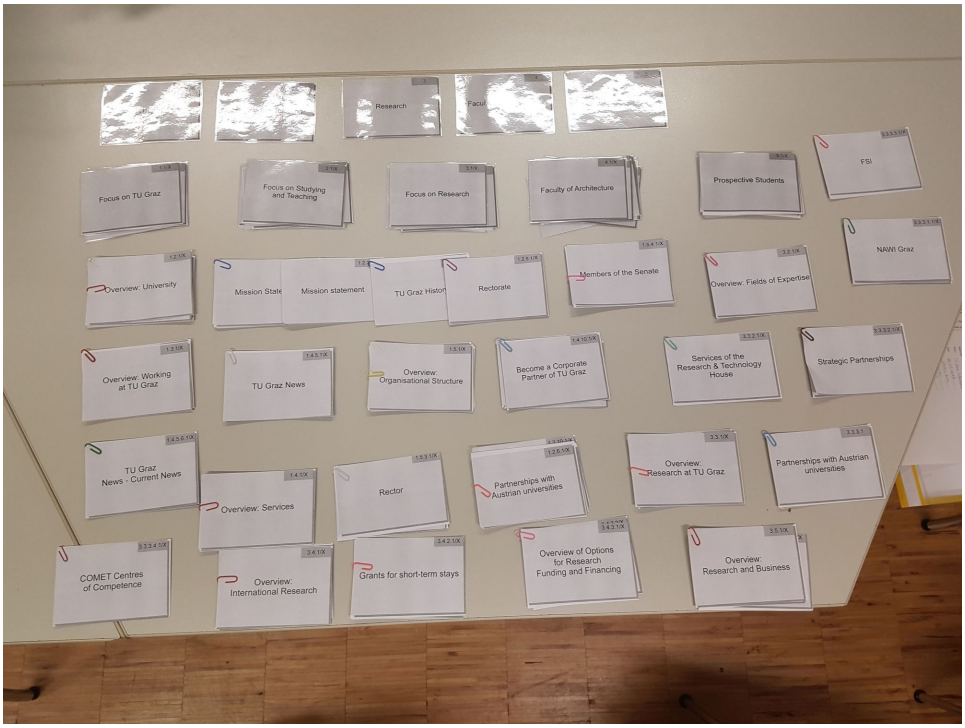

Figure 8.16: Modelling the information hierarchy of a university web site (`tugraz.at`) with a set of paper cards. [Photo courtesy of Pablo Borreguero Llorente, Anna Lickl, Michael Planitzer, and Daniel Sudy. Used under the terms of Creative Commons Attribution 4.0 International (CC BY 4.0).]

- Number each card within the hierarchy level (e.g. 1.1.2).
- Prepare some task scenarios on separate index cards.
- Arrange for an assistant (scribe) to take notes and/or record the session on video.
- For each test user:
  - Place the choices at the top level on the table and ask the user where they would look, as shown in Figure 8.17.
  - Mark their chosen card with a coloured sticker.
  - Place the children of the chosen card on the table and ask the user where they would look, and so forth.
  - Repeat for each task.
  - Debrief the user.
- Afterwards, transfer the results into a spreadsheet for analysis.

Online Tree Testing

- Treejack `treejack.com` [OW 2020; OBrien 2009].
- UserZoom Tree Testing; `https://userzoom.com/tree-testing/` [UserZoom 2020].
- UXtweak; `https://uxtweak.com/treetest-tool` [UXtweak 2020].

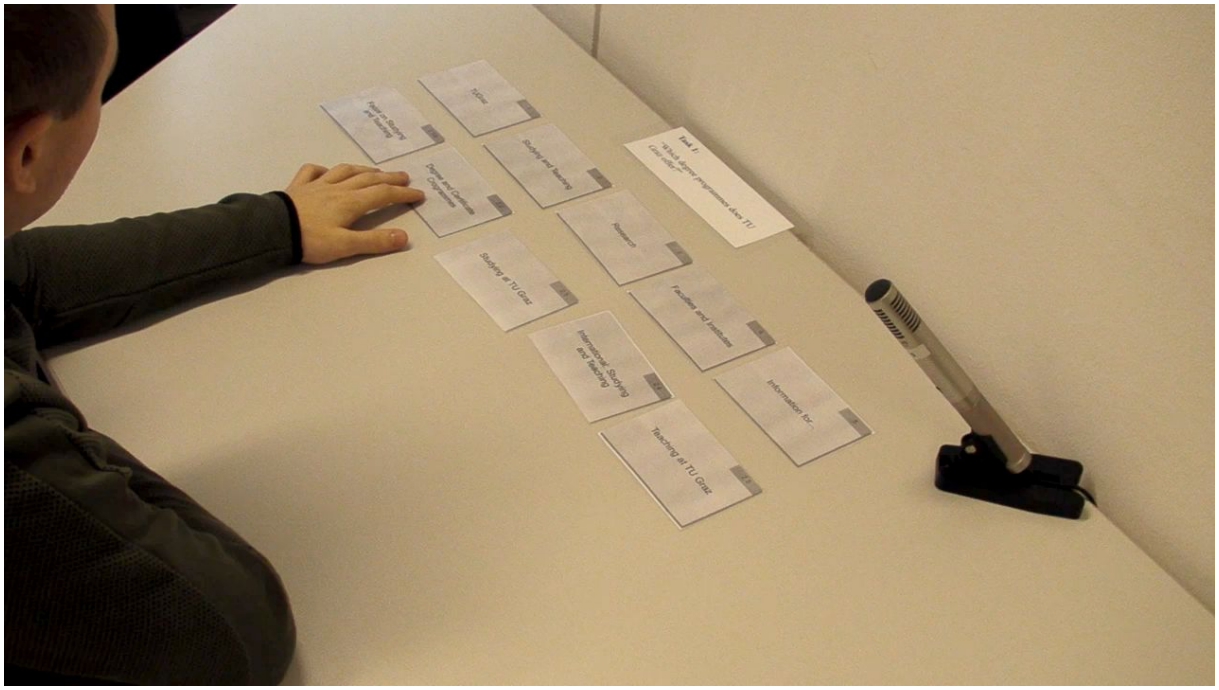

Figure 8.17: A test user participating in a paper-based tree test. The task sheet is placed above the tree. After the user has chosen a card at one level, the facilitator lays out the children for that choice. [Still from a paper-based tree test video. Courtesy of Pablo Borreguero Llorente, Anna Lickl, Michael Planitzer, and Daniel Sudy. Used under the terms of Creative Commons Attribution 4.0 International (CC BY 4.0).]

- Proven By Users; `https://provenbyusers.com/provenbyusers-treetest.php`
- Naview `naviewapp.com` [discontinued] [Volkside 2016].
- C-Inspector `c-inspector.com` [discontinued] [Schilb 2016].

Treejack

- First, the study manager creates the tree testing study, including importing the tree and defining various tasks, as shown in Figure 8.18.
- Next, users are invited to participate in the study, and look for the various items in the tree, as shown in Figure 8.19.
- Finally, the study manager analyses the results. Treejack provides a number of analysis tools, including a pietree summarising the paths taken by users for a particular task, as shown in Figure 8.20.

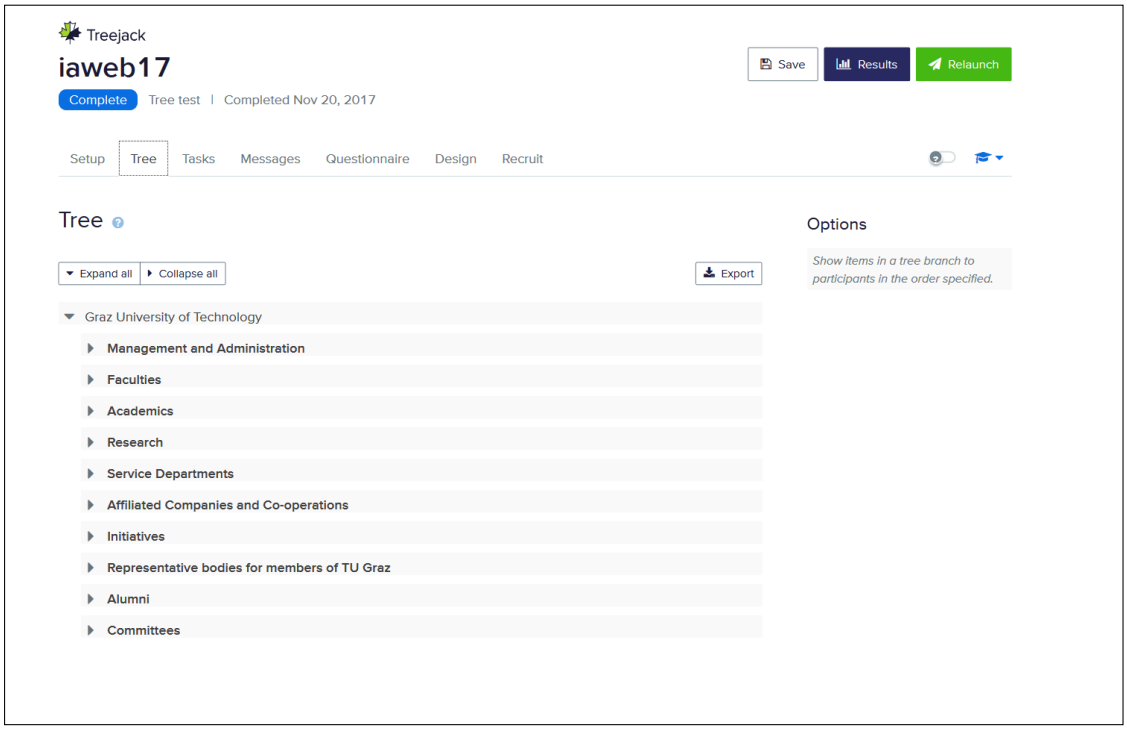

Figure 8.18: Creating a study with Treejack. The study manager imports a tree structure (information hierarchy) and specifies a number of tasks (items to look for).

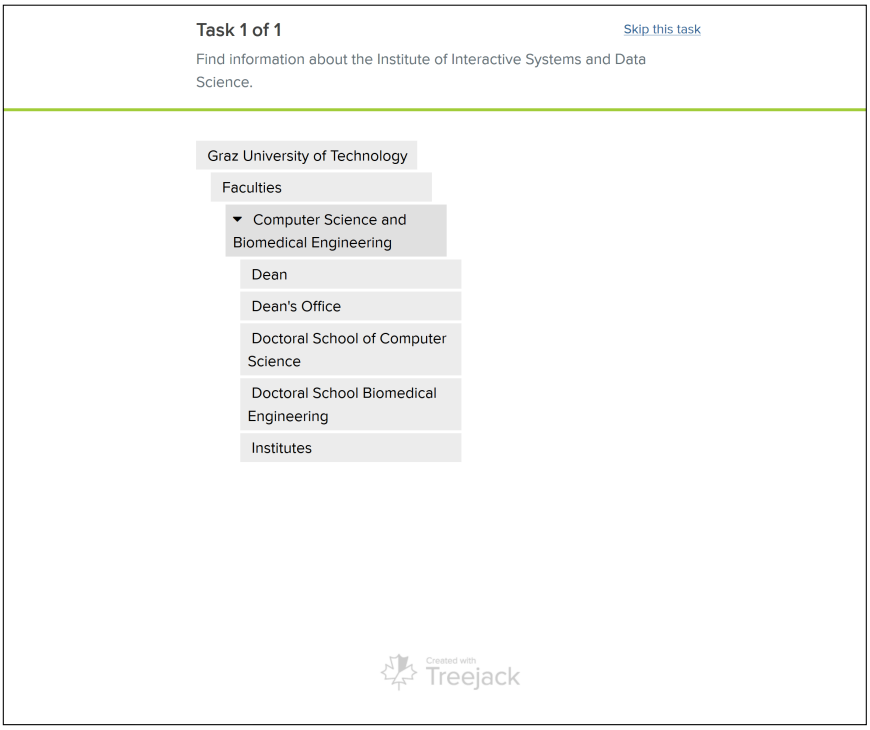

Figure 8.19: Participating in a study with Treejack. The user selects where they would expect to find information about a particular topic.

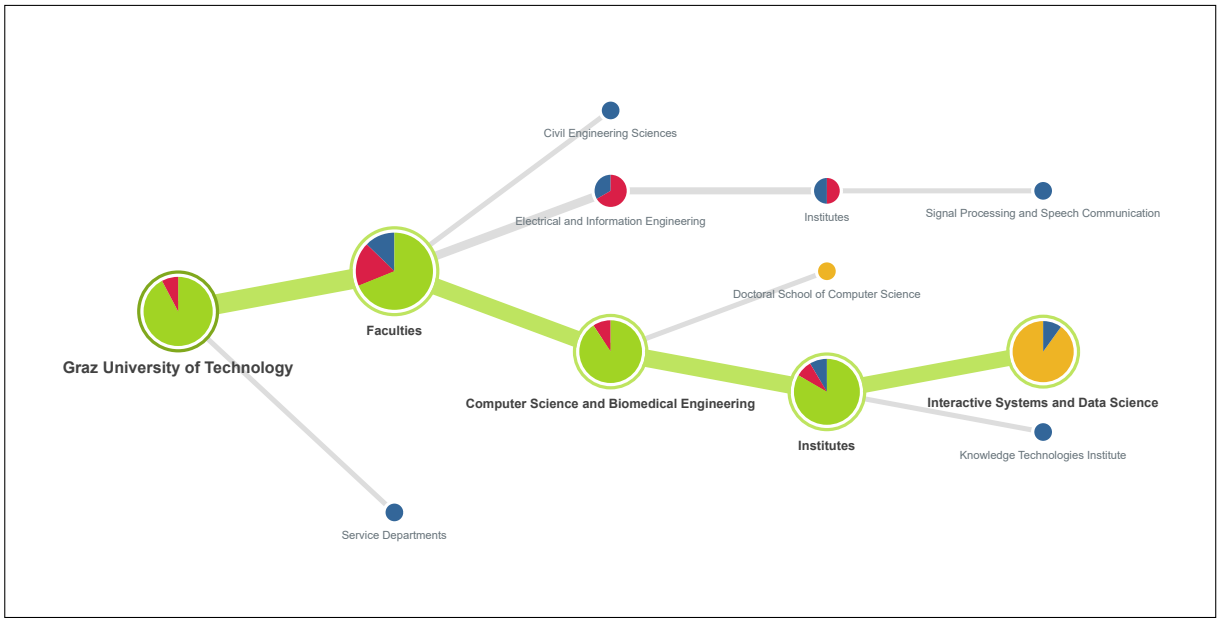

Figure 8.20: Treejack's pietree summarises the various paths taken by users for a particular task.

8.5 Controlled Vocabularies

A *controlled vocabulary* (CV) is a set of standard terms to be used on a site.

Different flavours, from simple to complex:

- *Synonym Ring*: simple list of equivalent terms.
- *Authority File*: list of preferred terms.
- *Classification Scheme*: includes hierarchical relationships (broader, narrower) between terms.
- *Thesaurus*: includes associative relationships (see related) between terms.

See [Fast et al. 2002] for more information.

Synonym Rings

```
food processor = blender = mixer = cuisinart = kitchenaid
```

- A synonym ring connects phrases which are equivalent for retrieval purposes.
- There may not be a single preferred term.

Authority Files

An authority file lists a single *preferred term* for each concept, together with a list of *variant terms*:

- The preferred term is often indicated by USE.
- Variant terms are often indicated by UF (for Used For).
- For example:

```
USE CT
  UF Connecticut
  UF Conneticut
  UF Constitution State
```

CT is the preferred term, the others are equivalent terms.

- Variant terms can also be used to catch spelling mistakes.

Classifcation Schemes (Taxonomies)

A full blown hierarchy, showing:

- the broader terms (BTs),
- the narrower terms (NTs), and
- the variant terms (UFs).

```
USE Jeans
  BT Pants
  NT Levis
  NT Wranglers
  UF Dungarees
  UF Waist Overalls
```

Thesaurus

The "Rolls Royce of controlled vocabularies" (Peter Morville) also including related terms.

```
USE Jeans
  BT Pants
  NT Levis
  NT Wranglers
  UF Dungarees
  UF Waist Overalls
  RT Denim
  RT Overalls

USE Denim
  BT Fabrics
  NT Ring Spun
  NT Dark Indigo
  NT Stonewash
  RT Jeans
```

Using CVs with Search

A CV can be integrated with a web site's search engine to handle the following situations:

- Synonyms: two words with the same meaning, like "jeans" and "dungarees".
- Homonyms: words that sound the same, but have different meanings, like "bank" the financial institution and "bank" the side of a stream or river.
- Broaden or narrow a search.
- Take account of common misspellings.
- Changes in content: for example, countries that change their name or have multiple spellings.
- "Best Bets": identifying the most popular pages associated with a certain term.
- Connecting a woman's married name to her maiden name.
- Connecting abbreviations to the full word: for example, NY and New York, the chemical symbol Si with the element Silicon.

Internal Use of CVs

As well as helping the user with search, CVs can:

- help keep your categories distinct.
- help establish a site's navigation.
- be the basis for personalisation.
- help prepare for CMS or knowledge management projects.
- get the organisation using the same language as the users.
- help the organisation (and the user) understand what concepts the site covers. The CV is in fact a "concept map" of what is on the site.

Technology for Maintaining CVs

- Excel spreadsheet.
- Multites `multites.com`
- Term Tree `termtree.com.au`
- Protégé `protege.stanford.edu`
- PoolParty `poolparty.biz`

See also `http://en.wikipedia.org/wiki/Ontology_editor` and `http://techwiki.openstructs.org/index.php/Ontology_Tools`.

8.6 Faceted Classification

References

++ Daniel Tunkelang; *Faceted Search*; Morgan Claypool, Jun 2009. ISBN 1598299999 (com, uk) doi:10.2200/S00190ED1V01Y200904ICR005 [Tunkelang 2009]

◦ Shiyali Ranganathan; *Colon Classification*; First Edition, Madras Library Association, 1933. [Ranganathan 1933]

◦ Shiyali Ranganathan; *Colon Classification*; Sixth Edition, Ess Ess Publications, 2006. ISBN 8170004233 (com, uk) [Ranganathan 2006]

Online Resources

++ Daniel Tunkelang; *Faceted Search*; Query Understanding blog, 24 Jan 2018. https://queryunderstanding.com/faceted-search-7d053cc4fada

+ Jeffery Callender and Peter Morville; *Design Patterns: Faceted Navigation*; A List Apart, 20 Apr 2010. https://alistapart.com/article/design-patterns-faceted-navigation

Colon classification

Ranganathan [Ranganathan 1933] introduced *faceted classification* under the name colon classification in 1933:

- Originally, five fundamental categories (or facets): personality, matter, energy, space, and time (PMEST).
- Ranganathan called the facets *isolates*.
- Each facet is hierarchically subdivided.
- The set of allowable values for each facet is determined in advance.
- A compound subject or topic is described (placed) along one or more of the facets (dimensions).
- The facets are notationally separated by colons (:).

Example of Colon classification

To use an example from Tunkelang [2009, page 8], originally found in Ranganathan [1950, pages 35–38]:

```
L2153:4725:63129:B28
```

represents the statistical study of the treatment of cancer of the soft palate by radium:

- Medicine (L) → Digestive System (L2) → Mouth (L21) → Palate (L215) → Soft Palate (L2153).
- Disease (4) → Structural Disease (47) → Tumour(472) → Cancer (4725).
- Treatment (6) → Treatment by Chemical Substances (63) → Treatment by a Chemical Element (631) → Treatment by a Group 2 Chemical Element (6312) → Treatment by Radium (63129).

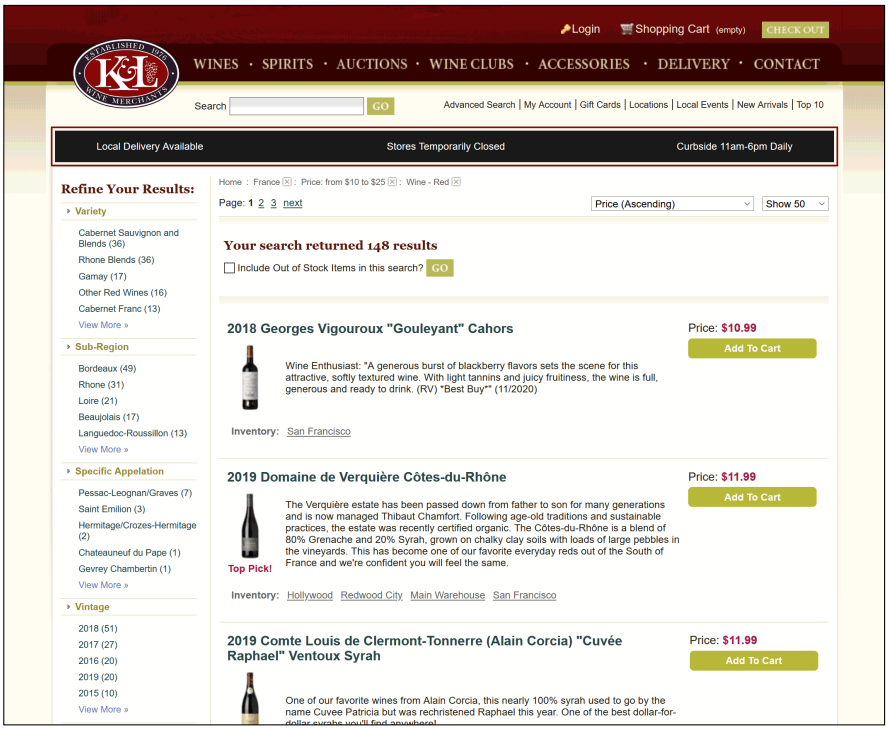

Figure 8.21: Faceted navigation at K&L Wines. France has been chosen on the Country facet, $ 10 to $ 25 on the Price Range facet, and Red on the Type facet. 148 bottles of wine match the current criteria.

- Mathematical Study (B) → Algebraical Study (B2) → Statistical Study (B28).

Faceted Navigation

- The user specifies a query progressively, narrowing down along one facet at a time.
- The system can display the remaining number of items matching current facet values.
- Dead-ends can be eliminated by not offering choices which would lead to 0 items.

Faceted Search

- A full text search generates an initial set of matching items.
- These are then narrowed down using facets.

Faceted Search Examples

- Endeca did much of the early work to popularise faceted search `endeca.com`.
- K&L Wines; `klwines.com` has 11 facets along which to select bottles of wine, including Variety, Country, Price Range, Vintage, Type, and Bottle Size, as can be seen in Figure 8.21.
- Ebags; `ebags.com`.
- geizhals.at; `http://geizhals.at/?cat=dcamsp`.

Figure 8.22: A well-trodden emergent path from the lecture theatres to the canteen at Graz University of Technology in Aug 2004. [Photo used with kind permission of Martin Pirker.]

Video: David Weinberger on Everything is Miscellaneous

- David Weinberger; *Rattling the Foundations*; Enterprise 2.0 conference, 19 Jun 2007 [Weinberger 2007b, 03:44-16:13]. No longer online.

8.7 User-Generated Structures

Sometimes, a workable strategy is to allow users to generate their own structures.

Emergent Paths

- The University of California at Irvine supposedly used a deliberate organic design approach, where pathways between buildings were only paved after seeing where users were actually walking [L. Wall 1999].
- This idea of watching user behaviour and then supporting it is also known as “paving the cowpaths”.
- Figure 8.22 shows a well-frequented emergent path to the university canteen (Inffeldgasse) at Graz University of Technology. Users did not want to follow the pre-ordained pathways, so the university relented and paved the cowpath, as shown in Figure 8.23.
- Peter Merholz describes another example at UC Berkeley [Merholz 2003].
- Emergent paths are sometimes also known as “desire paths”, “desire lines”, or “social trails” [Kohlstedt 2016; Bramley 2018].

Figure 8.23: The university authorities bowed to the wishes of their users and paved the cowpath. The same scene photographed in Aug 2008.

Social Tagging and Folksonomies

- Web 2.0 [O'Reilly 2005] and the rise of user-generated content sparked a new form of emergent structure: *social tagging*.
- Also called free tagging, collaborative categorisation, mob indexing.
- Users tag objects with one or more free-form keywords from their own vocabulary.
- Nothing inherently new in that, simply the difference in scale (the number of people assigning tags). [The network effect of "harnessing collective intelligence" [O'Reilly 2006].]
- Systems like del.icio.us allowed people to tag collections of URLs (bookmarks) and share those tags with others.
- Users could browse all the bookmarks tagged with a particular tag by a single or by a collection of users.
- Flickr allows photo owners to tag their photographs and users can search by tag `https://flickr.com/photos/tags/dog`.
- Thomas Vander Wal suggested in 2004 that a user-created tagging structure be called a "folksonomy" [Vander Wal 2007].
- Specialist maintained, top-down taxonomies are too expensive to build and maintain in many cases. ["The advantage of folksonomies is not that they are better than controlled vocabularies, it is that they are better than nothing." Clay Shirky, 2005.]

8.8 Site Search

Providing search functionality for a web site.

References

++ Tony Russell-Rose and Tyler Tate; *Designing the Search Experience: The Information Architecture of Discovery*; Morgan Kaufmann, 01 Aug 2012 . ISBN 0123969816 (com, uk) [Russell-Rose and Tate 2012]

+ Peter Morville and Jeffery Callender; *Search Patterns: Design for Discovery*; O'Reilly, 01 Jan 2010 . ISBN 0596802277 (com, uk) [Morville and Callender 2010]

+ Marti Hearst; *Search User Interfaces*; Cambridge University Press, 01 Oct 2009 . ISBN 0521113792 (com, uk) [Hearst 2009]

Online Resources

- Slashdot; *Alternatives to OpenSearch*; `https://slashdot.org/software/p/OpenSearch/alternatives`
- Euan Clark; *11 Small Search Platforms: Powerful Alternatives to Elasticsearch, OpenSearch, and Solr*; 04 Jul 2023. `https://sematext.com/blog/elasticsearch-opensearch-solr-alternatives/`

Self-Hosted Site Search

++ OpenSearch; `opensearch.org`
Open-source (fork of ElasticSearch).

+ Typesense; `typesense.org` `https://github.com/typesense/typesense`
Open-source, C++.

- MeiliSearch; `meilisearch.com` `https://github.com/meilisearch`
Open-source and hosted, Rust-based.
- Sphinx; `sphinxsearch.com`
Free binaries, open-source for older versions.
- Solr; `solr.apache.org`
- YaCy; `yacy.net` `https://github.com/yacy/`
Open-source, Java-based.
- and many others...

Cloud-Based Site Search

- Algolia; `algolia.com`
- SearchIQ; `searchiq.co`
- Cludo Site Search; `cludo.com`

Search-dominant	>50%
Link-dominant	≈ 20%
Mixed	≈ 30%

Table 8.1: Nielsen [1997c] found that most users are search-dominant.

- Amazon CloudSearch; https://aws.amazon.com/cloudsearch/
- Azure Cognitive Search; https://azure.microsoft.com/en-us/services/search/
- Google Site Search (GSS) was discontinued on 01 Apr 2017.
- and many others...

8.9 Navigation Systems

- Browsable categories.
- Site-wide search.
- Site map.
- Site index.

Users Like to Search

In Nielsen's studies [Nielsen 1997c], most users are *task-focused* and rely primarily on searching rather than link-following to find information, as shown in Table 8.1. To facilitate searching:

- Put a search box or button on every page (by convention at the top right).
- Use global search by default (i.e. search the whole site by default, rather than only in the current scope).
- Relegate boolean queries to an "Advanced Search" page.

On-Site Searching Reduces Success

In Spool's studies [Spool 1997], users who used the on-site search facility, were actually *less* likely to find the information they were looking for, as shown in Table 8.2:

- The search engine may be poorly implemented.
- Search syntax is different from site to site.
- Users do not know how to formulate queries.
- Users rarely change the default search options.
- Users mistype search terms (an analysis of one week's log files from Netscape's DevEdge Online showed 3% of searches contained misspelled words).

	% of successful tasks
Without search	53%
With search	30%

Table 8.2: Spool [1997] found that users who searched were *less* successful than those who browsed.

Actually, Users are Not Search-Dominant

Whether people browse or search actually depends largely on how well each is supported on a particular site:

- Spool [2007] and Spool [2001] could not find any search-dominant users. Instead, he found users adapted their behaviour from site to site.
- Similar results were reported by Katz and Byrne [2003, page 217]:

  > "Given broad, high-scent menus, participants searched less than 10% of the time, but they searched almost 40% of the time when faced with narrow, low-scent menus."

See Koh [2016] for further discussion.

Provide Both Browse and Search

Provide *both* browse and search:

- Some users will prefer one or other.
- Many users will use both at some time, depending on the task at hand, and how well each is supported on a particular site.

Tognazzini [2011] and Johnson [2010] also make good arguments for providing both browse and search.

Even Better, Provide a Palette of Navigational Aids

In fact, if you can, provide all of these:

- *Multiple Taxonomies*: multiple category hierarchies to browse.
- *Search*: Attribute and full text search.
- *Site map*: either graphical or a topical table of contents.
- *Site index*: alphabetical index of common words and phrases.

The PeopleSoft web site `http://www.peoplesoft.com/` used to be a good example of this (PeopleSoft was acquired by Oracle on07 Jan 2005). See Figures 8.24, 8.25, and 8.26 and Fox [2002] and Fox [2003].

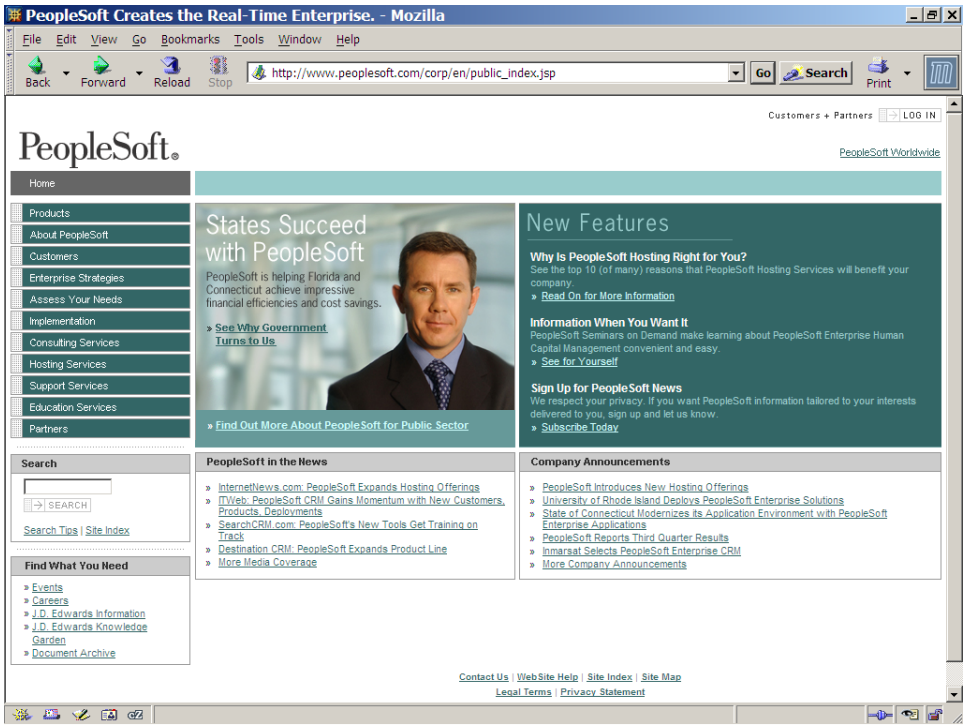

Figure 8.24: The former PeopleSoft web site home page, showing a topical navigational hierarchy and the local web site search box.

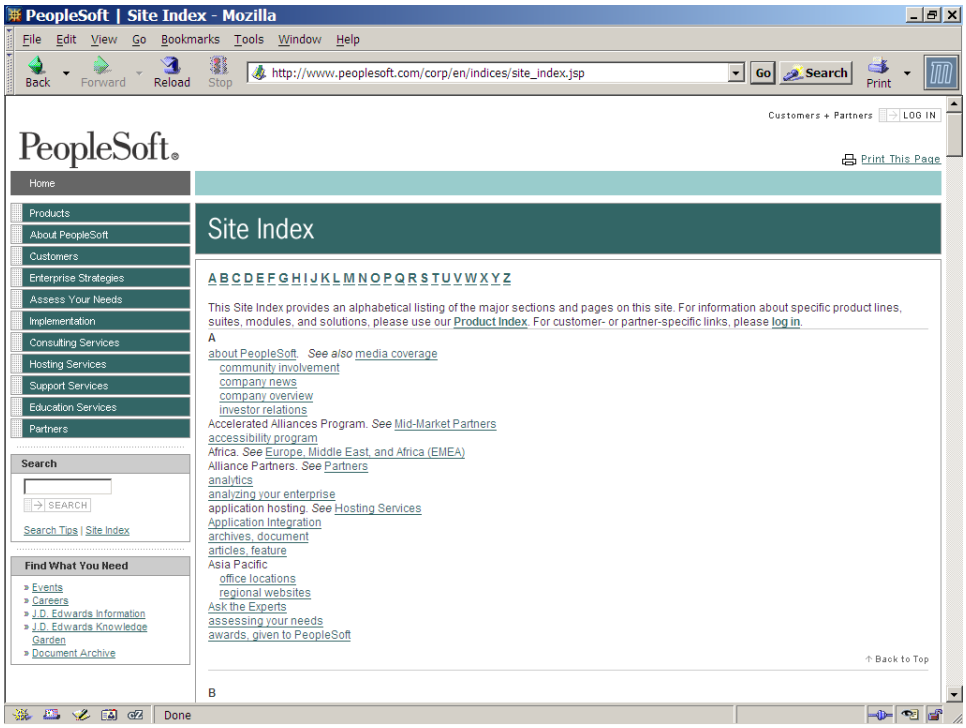

Figure 8.25: The former PeopleSoft web site's A-Z site index, like the alphabetical index at the back of a book.

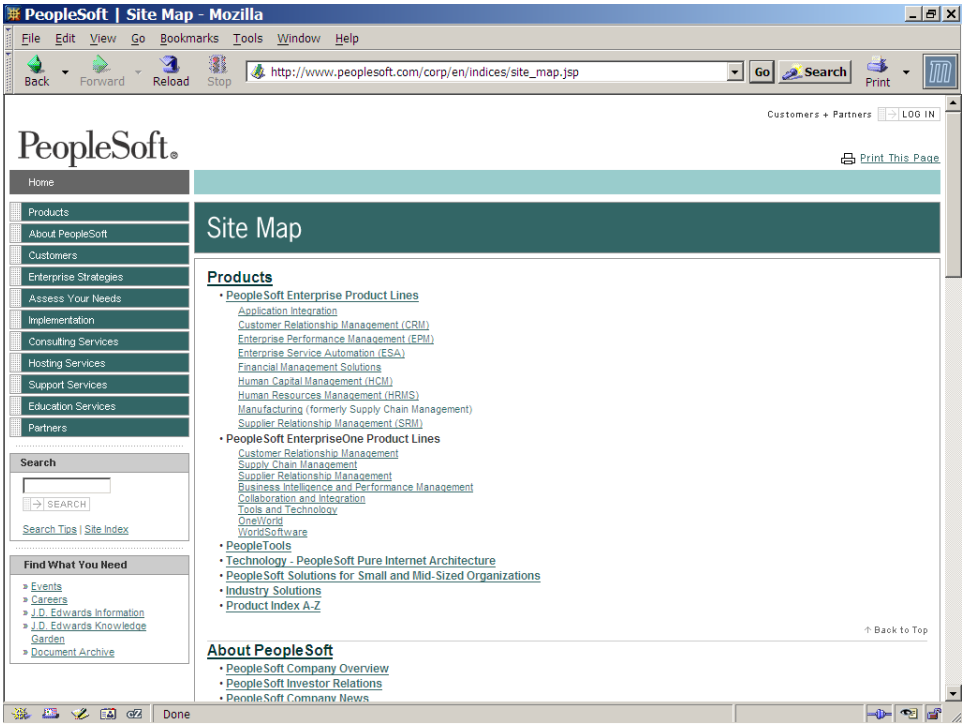

Figure 8.26: The former PeopleSoft web site's Site Map: like a table of contents for the web site.

8.10 Domain-Driven Design (Designing Connected Content)

Design based on first modelling the space of the domain:

- Identify and name objects and concepts in the domain of interest.
- Identify and name relationships between objects and concepts.
- Configure the content store.
- Design UI templates to integrate and pull content from the store.

This approach is sometimes also known as *domain modelling*, *content modelling*, or *designing connected content*.

Resources

++ Mike Atherton and Carrie Hane; *Designing Connected Content*; New Riders, 15 Dec 2017. ISBN 0134763386 (com, uk) [Atherton and Hane 2017]

++ Deane Barker; *Real World Content Modeling: A Field Guide to CMS Features and Architecture*; Self-published, 2019. ISBN 1692295608 (com, uk) . Free online version at `https://deanebarker.net/books/real-world-content-modeling/`

+ Michael Smethurst; *How We Make Websites*; BBC Radio Labs. 29 Jan 2009. `https://bbc.co.uk/blogs/radiolabs/2009/01/how_we_make_websites.shtml` [Smethurst 2009]

+ Mike Atherton; *5 Lessons from Beyond the Polar Bear*; blog post, 26 May 2011. [Atherton 2011]

+ UKGovLD; *Case Studies*; UK Government Linked Data Working Group; http://ukgovld.github.io/ukgovldwg/case-studies/

+ Stuart Williams; UKGovLD; *URI Patterns*; 2010. http://ukgovld.github.io/ukgovldwg/recommendations/uri-patterns.html

8.10.1 Using Linked Open Data (LOD)

- Store concepts and relationships in a triple store (queried with SPARQL).
- Each concept is assigned its own URL (ID) and is represented by both in HTML (human-readable web page) and XML (machine-readable data).
- Draw in external data from linked open data sources.
- Design UI templates to integrate and pull in content.

Video: Mike Atherton on Domain Modelling at the BBC

- Mike Atherton; *Domain Modelling at the BBC*; Talk at LightningUX, London, 06 Mar 2012 [Atherton 2012]. [Video: https://youtu.be/eb-_OoXP4Wo]

Video: Silver Oliver on Modelling Olympic Games at BBC

- Silver Oliver; *Domain Modelling at the BBC*; Talk at London Semantic Web Meetup, 28 Mar 2012 [Oliver 2012, 01:05-05:02]. [Video: https://youtu.be/sCnpSsxsb5U?t=01m05s]

Example: legislation.gov.uk

UK legislation from 1267 onwards:

- Managing legislation as data.
- URI naming scheme for documents and parts of documents.
- Versioning, changes, as in force at a particular time.
- Copyright, Designs and Patents Act 1988, Section 35, latest version: https://legislation.gov.uk/ukpga/1988/48/section/35
- as it stood on 30 Jan 2001: https://legislation.gov.uk/ukpga/1988/48/section/35/2001-01-30
- Metadata in various formats:
  https://legislation.gov.uk/ukpga/1988/48/section/35/data.pdf
  https://legislation.gov.uk/ukpga/1988/48/section/35/data.xml
  https://legislation.gov.uk/ukpga/1988/48/section/35/data.html
  https://legislation.gov.uk/ukpga/1988/48/section/35/data.rdf

See the talk by John Sheridan [Sheridan 2013].

8.10.2 Using a Headless CMS and APIs (Jamstack)

Jamstack = JavaScript, APIs, and Markup:

- Store concepts and relationships in a modern headless CMS (CMS with no UI).
- Each concept is composed of chunks.
- Access content via APIs such as REST, JSON:API, or GraphQL.
- Design frontend UI templates to integrate and pull in content.

References

+ Jamstack; `jamstack.org`
+ Deane Barker; *Web Content Management: Systems, Features, and Best Practices*; O'Reilly, 02 Apr 2016. ISBN 1491908122 (com, uk) [D. Barker 2016]
+ Dries Buytaert; *Headless CMS: REST vs JSON:API vs GraphQL*; Blog post, 11 Feb 2019. `https://dri.es/headless-cms-rest-vs-jsonapi-vs-graphql` [Buytaert 2019]
+ Jamstack; *Community Survey 2022. How are we building?*; `https://jamstack.org/survey/2022/#how-are-we-building`
+ Netlify; *The State of Web Development 2023*; 01 Dec 2023 . `https://netlify.com/resources/ebooks/the-state-of-web-development-2023/`

Video: Mike Atherton on Designing Connected Content

- Mike Atherton; *Designing Connected Content*; Talk at Digital Summit, Seattle, 12 Mar 2019 [Atherton 2019, 11:46-29:25]. [Video: `https://player.vimeo.com/video/322914806#t=11m46s`]

Video: Matt Biilmann on Jamstack 2024

- Matt Biilmann; *Jamstack 2024*; Talk at Shift Conference, 23 Apr 2024 [Biilmann 2024]. [Video: `https://youtu.be/yNGejB2qGVg`]

Open-Source Headless CMS

- Strapi; `strapi.io`; Open-source (self-hosted).
- Ghost; `ghost.org`; Open-source (self-hosted and hosted).
- Directus; `directus.io`; Open-source (self-hosted).
- WordPress REST API; `https://developer.wordpress.org/rest-api/`; Open-source (self-hosted).
- Netlify CMS; `netlifycms.org`; Open-source (Git-based, for static site generators).
- Drupal; `drupal.org`; Open-source (headless since Drupal 8).
- Craft CMS; `https://github.com/craftcms`; Open-source (self-hosted and hosted).

- ...

Commercial Headless CMS

- Contentful; `contentful.com`; Hosted, free, and commercial plans.
- Sanity; `sanity.io`; Hosted, free, and commercial plans.
- ...

Chapter 9

Information and Navigation Design

> *" Users rarely look at a web site and exclaim, "Wow, check out this brilliant classification scheme!" "*
>
> [Peter Morville, Information Architecture for the World Wide Web, 3rd Edition, Nov 2006 [Morville and Rosenfeld 2006, page 12].]

Navigation Design: design of navigation elements, placement of navigation blocks.

Information Design: "content design", placement of content blocks, wording and presentation of information to facilitate understanding.

Wireframes

- Build wireframe models (low-fi prototypes).
- Test the wireframe model with test users.
- Figure 9.1 shows a web site storyboard in DENIM, composed of individual page wireframes. Figure 9.2 shows a test run through the linked page wireframes.
- Figure 9.3 shows a wireframe of a facebook Group page, modeled using Balsamiq Mockups.

Wireframing Tools

- DENIM; James Lin, tablet-based research prototype [Lin et al. 2002a; Lin et al. 2000a] See Figures 9.1 and 9.2. Videos at CHI 2002 [Lin et al. 2002b] and CHI 2000 [Lin et al. 2000b]. [Video: `https://youtu.be/0ZA0TgmCMgI`]
- Balsamiq Mockups; `balsamiq.com`. Can switch between hand-drawn and clean look. See Figure 9.3. [Video: `https://youtu.be/70hfU7_95Gw`]
- Pidoco; `pidoco.com`. Can switch between hand-drawn and clean look.
- Figma; `figma.com`.
- Adobe XD; `https://adobe.com/products/xd.html`.
- MockFlow; `mockflow.com`.

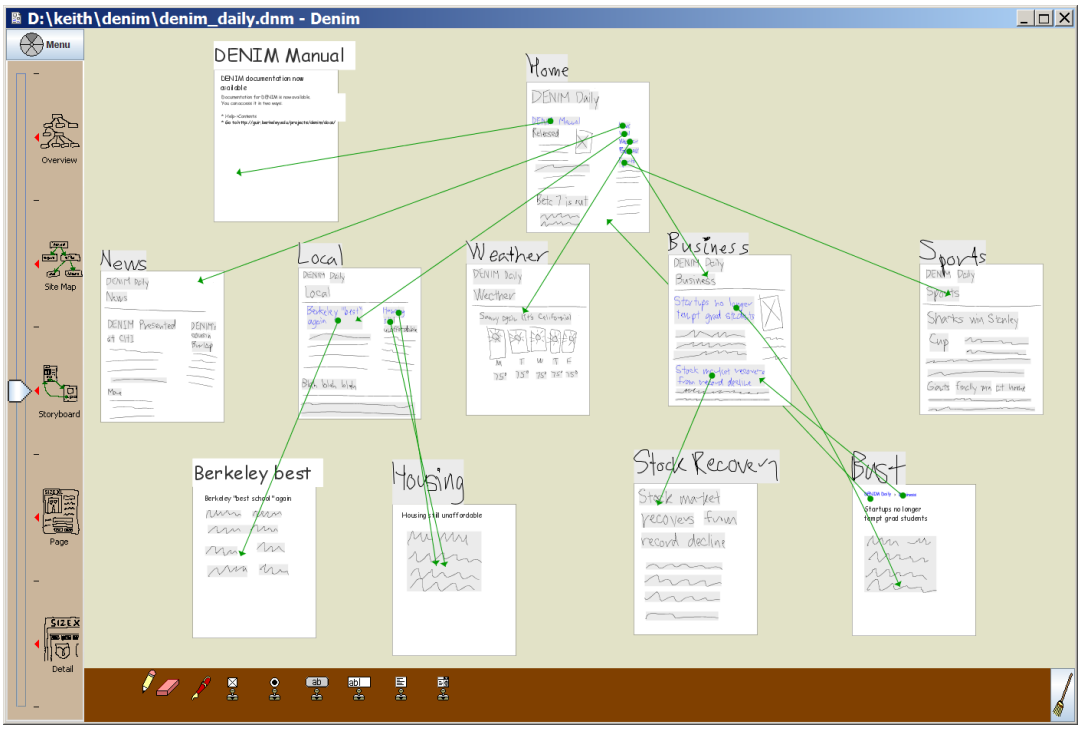

Figure 9.1: A storyboard of individual page wireframes modeled using DENIM.

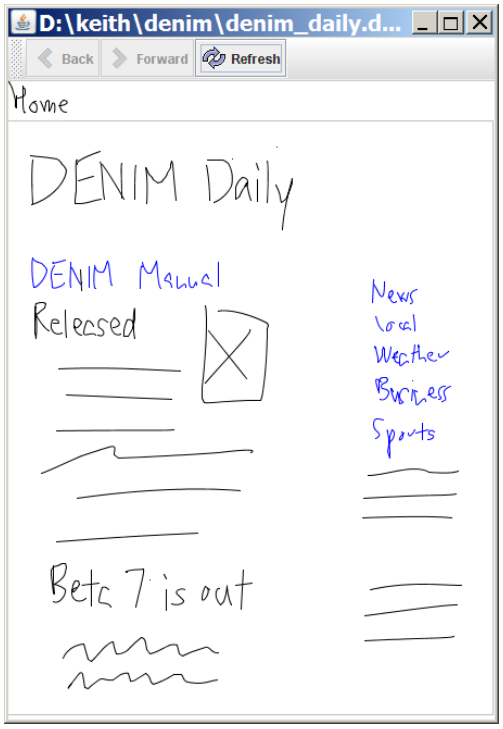

Figure 9.2: Running through a DENIM prototype.

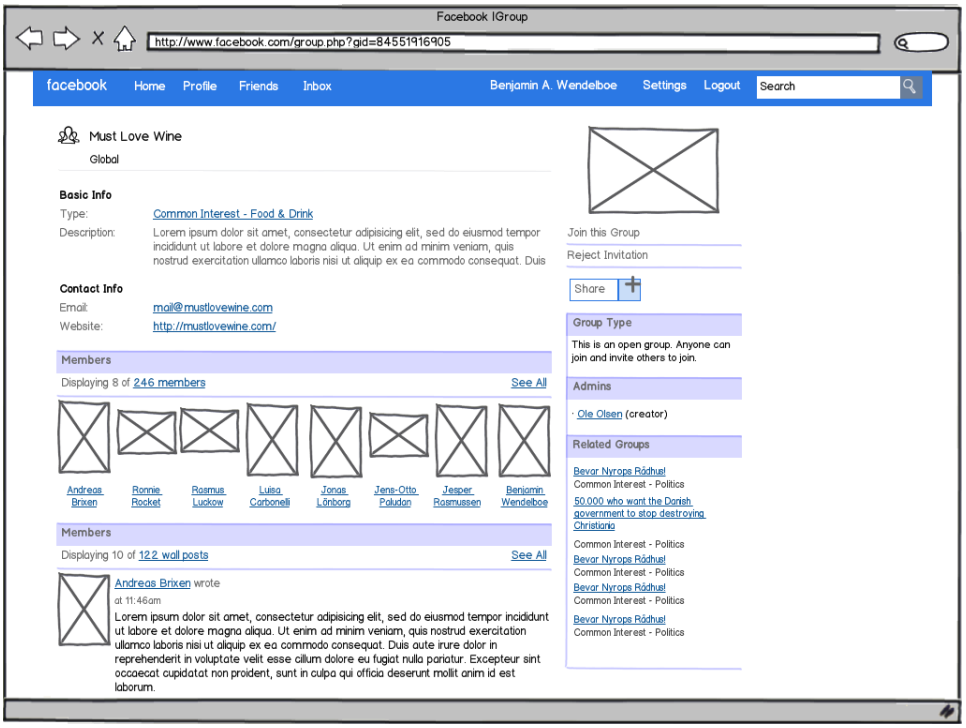

Figure 9.3: A wireframe of a Facebook Group page, modeled using Balsamiq Mockups. [Mockup contributed to `mockupstogo.net` by Benjamin A. Wendelboe. Image created by Keith Andrews.]

Figure 9.4: Jakob Nielsen's site UseIT (`useit.com`) used to have a clickable hierarchy bar at the top of each page reflecting the full path from the home page.

- Framer; `framer.com`.
- Axure; `axure.com`.
- UXPin; `uxpin.com`.
- HotGloo; `hotgloo.com`.

9.1 Navigation Design

Users form a mental model of the structure (information architecture) of a site:

- Convey the site structure clearly and consistently.
- Reflect the structure in the choice of URLs.
- Put a logo or banner on every page to reinforce the sense of place.
- Use colour-coding or other distinctions to indicate sub-sites or sub-areas within a site.

The URL is Part of the User Interface

For lack of better orientational feedback, users analyse URLs to form a conceptual model of a site:

```
http://useit.com/papers/heuristic/heuristic_list.html
```

- Keep URLs short.
- Use a domain name that is easy to remember and spell.
- Use meaningful names as part of the URL.
- Use easy-to-type URLs, avoiding punctuation and special characters.
- URL should reflect logical structure of site.
- URL should be "hackable", allowing users to move up the site structure by hacking off the end of the URL.
- Use hyphen ("-") rather than underscore ("_") to separate word parts in URLs:
  - Many URLs are displayed as links, appearing blue and underlined, which means underscores in the URL are obscured and look like spaces to users.
  - The Google indexer treats a hyphen as a word separator, whereas underscore is silently deleted and the word parts are merged [Schwartz 2022], for example:

    "`2011-2012`" is indexed as "`2011`" and "`2012`" (two words)
    "`2011_2012`" is indexed as "`20112012`" (one word)

Provide Information Scent

Give users clues in advance as to what is contained in each category or sub-category ("information scent"):

- Phrase and test category labels, to make sure they are as representative as possible.
- Provide hints or examples of items contained within each category [I. Barker 2005], as shown in Figure 9.5.
- The concept of information scent comes from the theory of information foraging [Pirolli 2007].

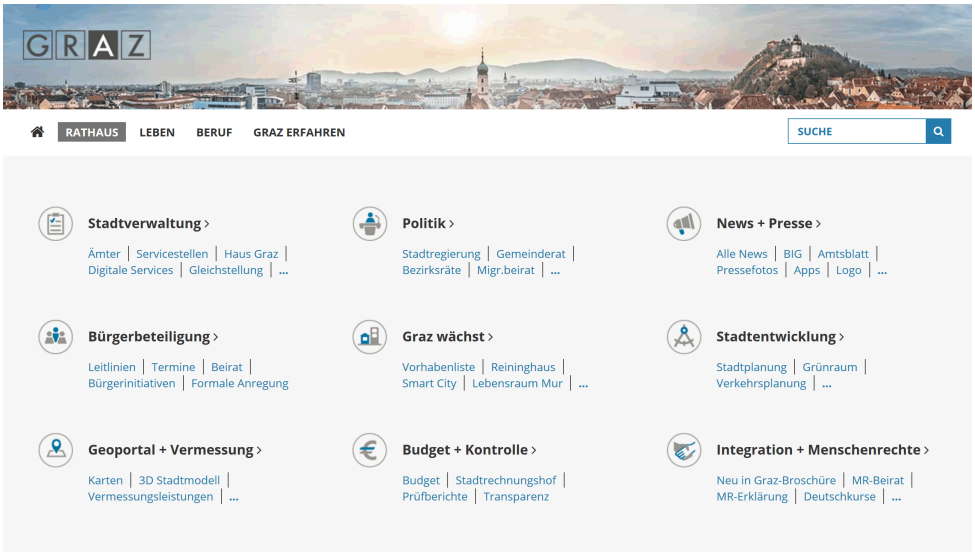

Figure 9.5: The web site of the city of Graz (`graz.at`) provides examples of what is contained within each category to assist users is making the right choice.

9.2 Text Design

References

+ Kinneret Yifrah; *Microcopy: The Complete Guide*; 2nd Edition, self-published. ISBN 9655727947 (com, uk) [Yifrah 2017] `microcopybook.com`

Users Scan Rather than Read

- Attention is attracted to text first. [Of the first three eye fixations on a page, 78% were on text [The Poynter Institute 2000; Nielsen 2000]]
- Users scan for highlighted (bold or blue) terms such as headings, links, and captions [Morkes and Nielsen 1997]. If everything is highlighted, nothing has prominence.
- For paragraphs of text, users often scan only the first few words or sentence of each paragraph, resulting in an F-shaped reading pattern [Pernice 2017]. [Only 16% read word-by-word [Nielsen 1997b].]
- Users expect one topic per paragraph. Users will skip over additional ideas, if they are not caught by the first few words in the paragraph.
- Users do not like reading on screen. Use less than 50% of the word count of an equivalent hardcopy version. [Reading from screen is more than 25% slower than from paper.]

Short or Long Pages (Scrolling)

In a 1994 study [Nielsen 1994], only about 10% of users scrolled beyond the first screenful of each page.

In more recent studies, users might *say* they don't like scrolling, but are in fact perfectly willing to scroll [UIE 1998; Nielsen 1997a].

- Longer pages work better, according to UIE study [UIE 1998].

- Place navigation elements and the most important content in the first screenful ("above the fold", in traditional newspaper jargon).
- Avoid using horizontal rules. Some users think the page is finished and do not scroll down.

Use an Inverted Pyramid Style of Writing

Traditional scholarly writing starts with a foundation and gradually builds to the conclusion, in pyramid style:

- Problem statement.
- Related work.
- Methodology.
- Results.
- Conclusions.

Journalists use an *inverted* pyramid, starting with the main conclusion and becoming progressively more detailed.

- Conclusion.
- Supporting information.
- Background.

Since web users typically do not scroll, it is important to make the main point first, then go into more detail.

Support Deep-Link Users

In hypertext, you never know where your readers are jumping in from:

- Do not assume that users have read "preceding" pages or have followed a particular path.
- For example they may have followed a link from a list of search results.
- Or been sent a URL deep in your site by email.
- Nielsen and Loranger [2006, page 27] found that on web-wide tasks, 60% of initial page views were of interior pages rather than site home pages.
- Each page must stand on its own and be linked to its context:
  - Page content should be self-contained.
  - Breadcrumb trail to locate page in the web site's hierarchy.
  - Logo with link to home page in top left corner.
  - Search box in top right corner.

Make Page Titles Distinctive

- Page titles (the text contained inside the HTML TITLE tag) are encountered by users in a variety of places:
  - In the browser window title bar.
  - When they save a bookmark to the page.
  - In search engine result lists.
  - When the browser window is iconified.
- Titles must be distinguishable from one another in a long list:
  - "Match Result" is a very bad page title.
  - "BBC | Sport | Football | World Cup | Germany 1 - 5 England" is a good page title.
- As an example of what not to do: the site `http://penny.at/` uses the same page title "Penny - Kampf dem Preis!" on every page on the site!
- Search engines sometimes give added weight to the words contained in page titles, get your keywords in there!

Banner Blindness

Users have learned to ignore what they think might be ads:

- Benway and Lane [1998] attribute the term "banner blindness" to Linda Johansen.
- Pernice [2018] provides more recent examples from eye-tracking studies.

Do not place important stuff in frames or locations that make them look like ads!

Video: Jakob Nielsen on Banner Blindness

- Jakob Nielsen; *Mobile Usability Futures*; Talks at Google, 28 May 2013 [Nielsen 2013, 15:33-16:27]. [Video: `https://youtu.be/sELOUAmFHjA?t=15m33s`]

Use the meta Element

Add meta-information to your pages (at least the main entry pages) using the meta element:

- Search engines pick up "keywords" and "description" attributes.

See the example in Listing 9.1.

Linkrot

A huge problem on the web is links which stop working over time ("linkrot") [Wikipedia 2019; Kille 2015]:

- Attrition rate of around 30% per year, according to van der Graaf [2017] (and incidentally Koehler [2004] came to the same value).

```
<meta name="keywords" content="vineyard,vineyards,wine,food,
gifts,shopping,mail order,Granoff,Gaiser,Regina,wineries,
vintners,food shop,wine shop,gift shop,order,
gift certificates"/>

<meta name="description" content="Virtual Vineyards: Your
Personal Food &amp;amp; Wine Shop. Buy food, wine and gifts all
at one convenient stop on the WWW."/>
```

Listing 9.1: Use of the meta element to convey description and keywords at the old Virtual Vineyards site.

- Attrition rate of around 5% per year of links posted on bookmarking site Pinboard [Ceglowski 2014a] and [Ceglowski 2014b, 00:30:07]. [These are links to pages people specifically want to bookmark.]

Check Regularly for Broken Links

Regularly check the links on your site for broken links:

- For a small site (few dozen pages and links), check links manually.
- For a larger site, use an online link checker service such as:
  - Dr. Link Check `drlinkcheck.com`
  - W3C Link Checker `https://validator.w3.org/checklink`
  - Online Broken Link Checker `brokenlinkcheck.com`
- Or use a locally installable tool, such as:
  - LinkChecker (Python2) `https://wummel.github.io/linkchecker/`.
  - Xenu's Link Sleuth (Windows) `http://home.snafu.de/tilman/xenulink.html`.

Avoid Link Overload

If everything is a link, text becomes hard to scan and read.

- Within flowing text, keep link source regions to the minimum words or phrase necessary.

See for example, the passage intended for media consumption on the PICS (Platform for Internet Content Selection) pages at W3C, shown in Figure 9.6.

Within-Page Links Can Confuse Users

Some pages contain links which move users up or down the page when clicked, effectively jump scrolling within the same page (called *within-page links*, or sometimes in-page links, jump links, or anchor links).

Studies have shown that this can confuse users:

- Users generally expect links to take them to new pages.

You can find a list of product announcements and other PICS-related press releases. These may be a good source of further press contacts.

An overview of the PICS system is available from the paper "PICS: Internet Access Controls Without Censorship," which will appear in Communications of the ACM, in October 1996. A shorter piece appeared in the August issue of Wired Magazine, p. 109-110.

Figure 9.6: A passage from the PICS pages at W3C showing "link overload". The text is overloaded with links making it difficult to read. The first links covers 20 words and spans two sentences, when in fact the simple phrase "press releases" would be an ideal source region!

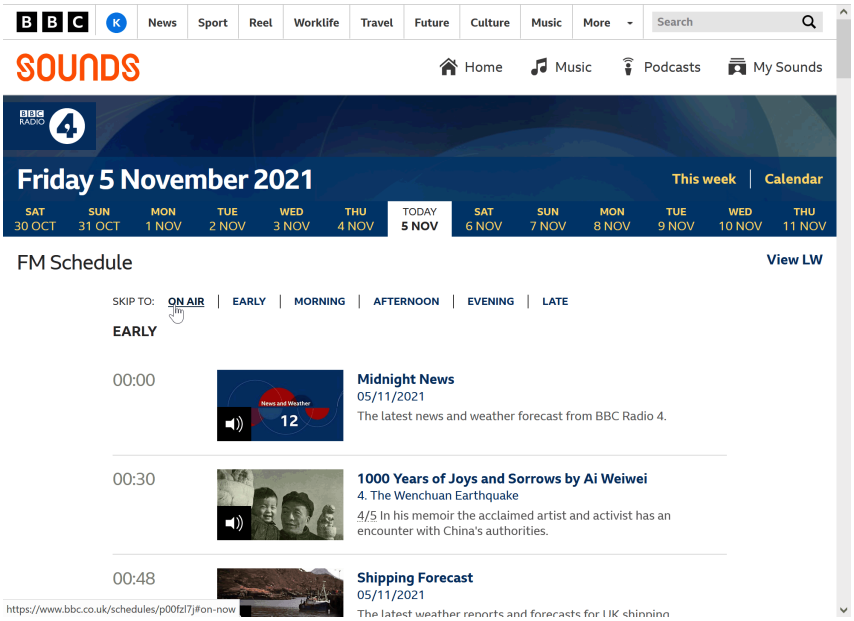

Figure 9.7: The Schedule for BBC Radio 4 [BBC 2021] has a row of within-page links: On Air, Early, Morning, Afternoon, Evening, Late. The introductory phrase "Skip To:" helps indicate that these link jump the user further down the same page.

- When such links have been followed, they do not always change colour as visited.

See Scanlon [1996], Nielsen [2006] and Schade [2017].

Examples:

- `https://cs.umd.edu/hcil/excentric/`
- `https://wikipedia.org/wiki/Dolphin`
- `https://wiki.creativecommons.org/FAQ`
- `https://bbc.co.uk/schedules/p00fzl7j` (see Figure 9.7).

Use the Link Title Attribute

The title attribute for links helps users predict where they might go, should they click the link:

```
<a href="https://projects.isds.tugraz.at/enigusab/"
title="EnigUsab: Improving the Usability of Enigmail.">EnigUsab</a>
```

Video: Kristina Halvorson on Use Your Words

- Kristina Halvorson; *Use Your Words*; An Event Apart Orlando 2018, 10 Oct 2018 [Video: https://youtu.be/PGy_eQTUvO0?t=11m32s]

9.3 Image Design

Use the right image format, depending on the kind of image.

Resources

++ Addy Osmani; *Image Optimization*; Smashing, 01 Apr 2021 . ISBN 3945749948 (com, uk) [Osmani 2021]

+ Jon Sneyers; *Time for Next-Gen Codecs to Dethrone JPEG*; Cloudinary, 22 Feb 2022. https://cloudinary.com/blog/time_for_next_gen_codecs_to_dethrone_jpeg

9.3.1 Vector Graphics

For vector graphics (diagrams, drawings, etc. composed of graphic objects):

- Use SVG. All modern web browsers support SVG 1.1.

SVG

- SVG is an editable text file containing tagged elements (similar to HTML).
- The elements describe graphical objects such as lines, polygons, circles, and text (vector graphics).
- SVG graphics can be freely scaled up or down without loss of quality.
- SVG elements can be used alongside HTML elements, and objects can be styled with CSS.

9.3.2 Raster Images

For raster images (composed of pixels):

- Online, use PNG for small images, line drawings, icons, diagrams, i.e. almost everything except photographs.
- Online, use JPEG for full-size, continuous tone images (photographs).

- For archiving and editing, use PNG, since it is lossless and has excellent compression.
- Make selective use of more modern image formats like WebP, AVIF, JPEG 2000, and JPEG XL (with a fallback, since not supported by every browser).

See Osmani [2021] and Google [2020] for more details.

GIF (1987)

- GIF looks row by row for patterns and assigns short codes to represent them (LZW compression).
- It compresses repeating patterns and large block of (exactly) the same colour value very well.
- Lossless (but max. 256 colours).
- Maximum of 256 colours, since GIF uses upto an 8-bit palette! For more colours dithering is necessary, which does not compress well (switch to JPEG rather than dithering a GIF).
- One colour index can be specified as the transparent colour.
- Sequence of images in one file for animations (animated GIF).
- The LZW patent expired in 2003.
- The original image format for the web.

GIF is OK for small (less than say 100 by 100 pixel) thumbnail versions of a photographic image upto 256 colours.

JPEG (1992)

- JPEG transforms the image into a frequency space, and selectively throws away bits of resolution.
- Lossy, quality degrades with successive editing and saving.
- User can control how much is thrown away – i.e. can trade image quality for space.
- Compresses continuously changing shades very well (photographs).
- Smudges hard edges, lines, and text.
- No provision for transparency.
- One image per file.
- Widely support in browsers and applications.
- JPEG 2000 supports lossless compression.
- The new JPEG XL will offer much better compression and faster decoding.

PNG (1996)

- Lossless.
- Indexed-colour images of up to 256 colours.

- True colour images up to 48 bits per pixel.
- Greyscale images up to 16 bits per pixel.
- Progressive decoding.
- Transparency.
- Full alpha channel (general transparency masks).
- One image per file (use APNG for animated images).
- Supported in all modern browsers and applications.

WebP (2010)

- Both lossless and lossy compression, savings over PNG and JPEG respectively.
- No progressive decoding.
- Transparency.
- Animation (sequence of images).
- Widely supported by browsers `https://caniuse.com/webp`.

AVIF (2019)

- Both lossless and lossy compression, highly efficient.
- HDR and wide colour gamut.
- Transparency.
- Animation (sequence of images).
- Widely supported by browsers `https://caniuse.com/avif`.

JPEG XL (2020)

- Both lossless and lossy compression, highly efficient.
- HDR and wide colour gamut.
- Progressive decoding.
- Transparency.
- Responsive imagery (multiple subresolutions).
- Still being implemented by browsers `https://caniuse.com/jpegxl`.

Video: Addy Osmani on Optimising Images

- Addy Osmani; *Optimizing Images for the Core Web Vitals*; Smashing Meets, 16 Mar 2022 [Video: `https://youtu.be/3NNL1LeMSe0`]

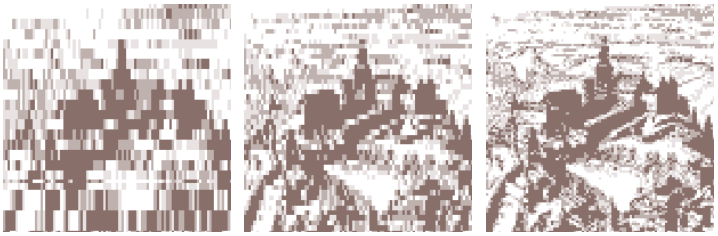

Figure 9.8: GIF interlacing. The image is transmitted in 8 passes. First, rows 1, 9, 17, . . . are sent, then lines 4, 12, 20, . . . , etc. During the first pass, the browser diplays each row of the image 8 times, i.e. row 1 is repeated in rows 2 to 8 on the screen. During the second pass row 4 of the image is recieved and displayed in rows 4 to 8, and so on.

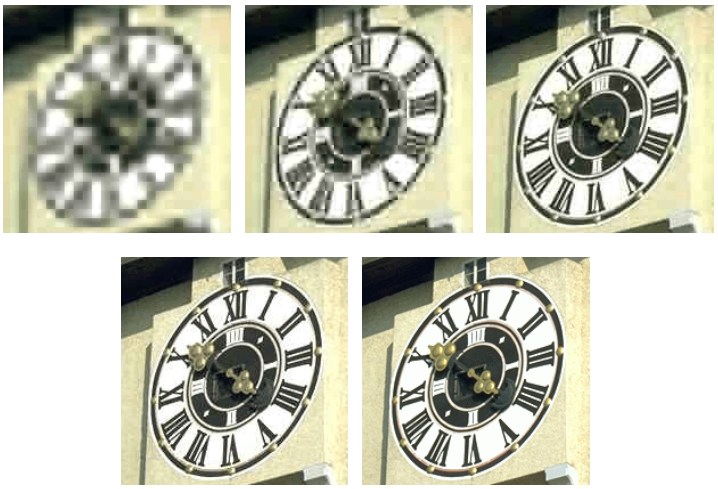

Figure 9.9: Progressive JPEG. First the most important (high order) bits of each frequency component are transmitted, then successively lower order bits. The overall effect is first a rough image, where the details are then filled in.

Progressive Decoding (Interlacing)

Progressive images are displayed initially as an entire but course, low-quality image.

- As more image data is received, the image is refined.
- Users perceive less delay.
- Use interlaced GIF (see Figure 9.8) and progressive JPEG (see Figure 9.9) for images larger than a few kb.

Transparency

Transparency does away with the blocky, rectangular outlines of images.

- In GIF images, a single colour index can be designated as the transparent colour.
- In other image formats, an alpha channel is supported.

See Figure 9.10.

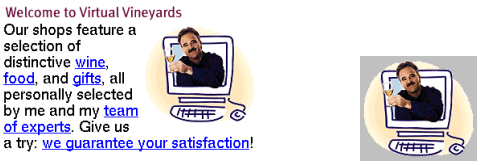

Figure 9.10: A GIF image with a transparent background no longer looks rectangular. From the old Virtual Vineyards home page.

Figure 9.11: The lines on the left illustrate aliasing, they have jaggy steps along the edges. On the right, the black lines are antialiased against a white background by adding intermediate (grey shade) pixels to fade gently from foreground to background.

Anti-Aliasing

Antialiasing removes "jaggies" by fading gently from a foreground to a background.

- Antialiasing must be done again for a each new background, otherwise a "halo" results.
- For this reason, beware of antialiased shapes on a transparent image background – their appearance is highly dependent on the actual background.

  See Figures 9.11, 9.12, and 9.13.

Always Specify Alt Text for Images

Always specify alternative text for images using the `alt` attribute.

```
<img src="kandrews.jpg" width="300" height="225"
alt="Photo: Keith Andrews." />
```

- If an image has moved or for some reason cannot be fetched, the text indicates what would have been there.
- `alt` text is indexed by search engines.
- Specifying `alt` text is considerate to text-only browser users and sight-impaired users who depend on text-reading software.

Figure 9.12: On the left a red circle without antialiasing. The right circle is antialiased against the white background.

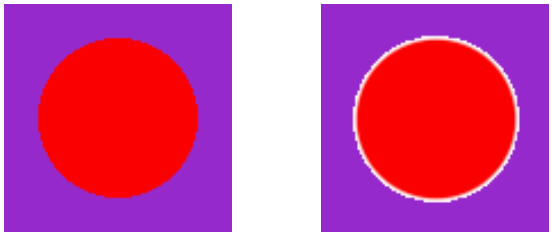

Figure 9.13: The aliased (jaggy) red circle can be displayed against any background. The antialiased circle is only suitable for display on the white background for which it was antialiased. Displaying it against a purple background makes its pink-white halo visible.

Specify Width and Height Attributes for Images in HTML

It now makes sense again to specify the *native* width and height (in pixels) of every inline image using the HTML `width` and `height` attributes:

```
<img src="kandrews.jpg" width="300" height="225"
alt="Photo: Keith Andrews." />
```

- The HTML `width` and `height` attributes are known as *presentational attributes* [Coyier 2020]. They are overridden by any CSS attributes.
- If final image sizes are known up front, browsers can display the textual content of a page and leave space for the graphics to load. [This avoids annoying layout shifts (janks) and users perceive the site to be faster, since they can begin reading the text as images are loading.]
- Browsers now infer the aspect ratio of images from the HTML `width` and `height` attributes, even if only one of them is overriden in CSS (a common practice in responsive design) final image sizes can be calculated up front [Pollard 2020].

Chapter 10

Visual Design

Visual treatment of text, graphics, and navigational components.

10.1 Greeking Test

Greeking Test of Page Templates

Tests the layout and visual design of navigational and content elements on a page.

- Technique first proposed by Tom Tullis [Tullis 1998].
- Mock up several page templates, including navigational and content areas (Photoshop).
- Replace all text with meaningless gibberish ("greek"). [In German "Kauderwelsch"]
- Ask test users to identify standard page elements, by drawing blocks around them on a colour printout:
  - main content
  - page title
  - person responsible for page
  - intranet-wide navigation (home, search)
  - site navigation (sections of a site)
  - last updated
  - intranet identifier
  - confidentiality/security info
  - site news items

  The percentage of correctly identified page elements is a measure of their performance.
- Ask users their subjective preference.

Greeking Case Study

- Five templates for Fidelity Investments intranet mocked up by web design companies.

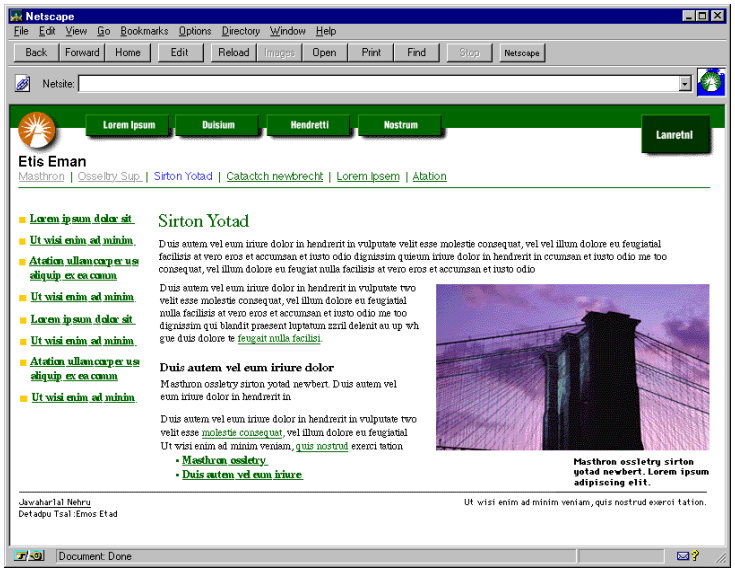

Figure 10.1: Fidelity Investments intranet greeking test, Template 1. [With kind permission of Tom Tullis, Fidelity Investments.]

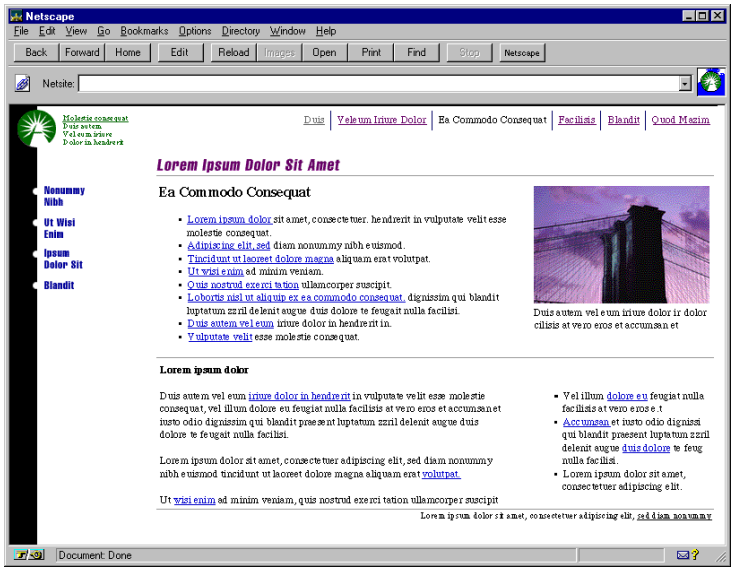

Figure 10.2: Fidelity Investments intranet greeking test, Template 2. [With kind permission of Tom Tullis, Fidelity Investments.]

- Greeking test with 23 Fidelity employees.

  Thanks to Tom Tullis from Fidelity for providing the templates in original size.

Greeking Case Study Results

- Users performed best with Template 3, correctly labeling 67% of the page elements. See Figure 10.6.
- Users liked Template 1 best, but only correctly identified 52% of the page elements. See Figure 10.7.
- A final design combining parts of Templates 1 and 3 was made and tested. Users both preferred it and

Figure 10.3: Fidelity Investments intranet greeking test, Template 3. [With kind permission of Tom Tullis, Fidelity Investments.]

Figure 10.4: Fidelity Investments intranet greeking test, Template 4. [With kind permission of Tom Tullis, Fidelity Investments.]

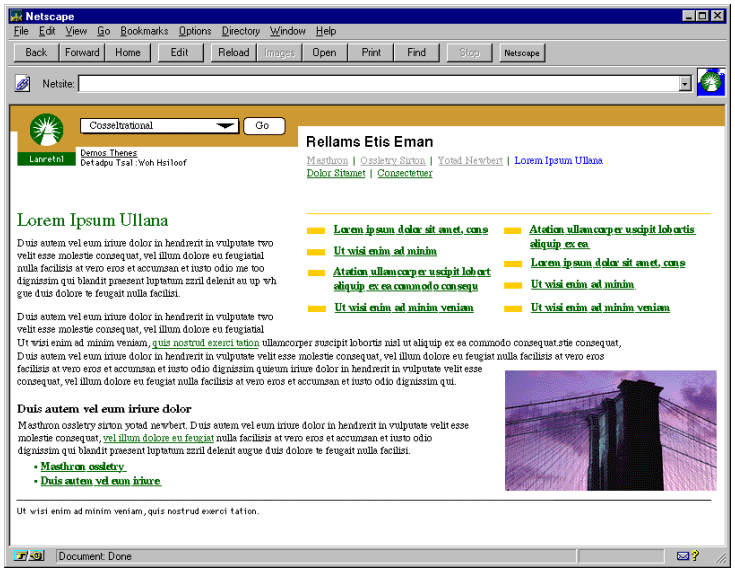

Figure 10.5: Fidelity Investments intranet greeking test, Template 5. [With kind permission of Tom Tullis, Fidelity Investments.]

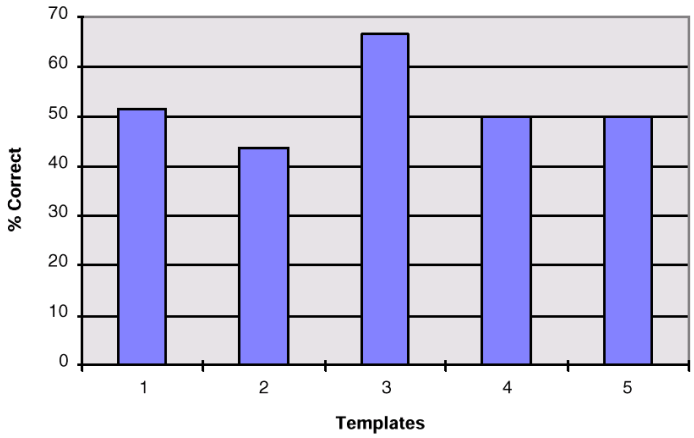

Figure 10.6: Average percentage of correctly identified page elements. [With kind permission of Tom Tullis, Fidelity Investments.]

performed best with it, correctly labeling 72% of the page elements.

Video: Steve Schoger on Visual Design Improvements

- Steve Schoger; *Practical Solutions to Common UI Design Problems*; Talk at CSS Day 2019, Amsterdam, 14 Jun 2019 [Schoger 2019]. [Video: `https://youtu.be/7Z9rrryIOC4`]
- Steve incrementally improves the visual design of a fictional flight booking site, showing many practical tips and tricks.
- Book PDF $99, at `refactoringui.com`.

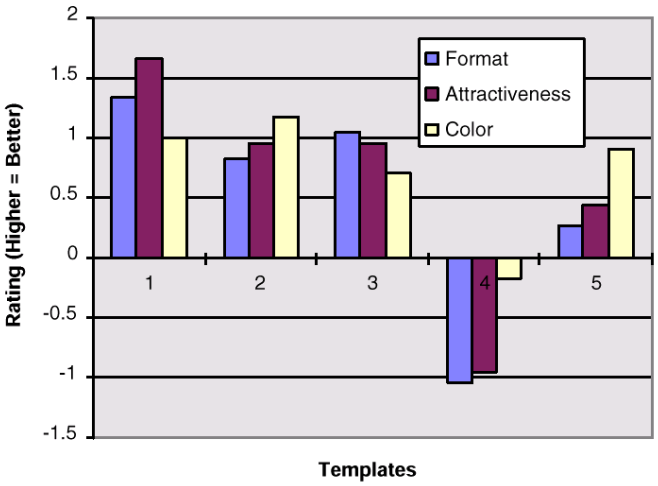

Figure 10.7: Average ratings for the five templates on three subjective scales. [With kind permission of Tom Tullis, Fidelity Investments.]

Chapter 11

Implementation and Optimisation

Resources

++ Angel Gabarino; *How to Become A Web Developer: A Field Guide*; Fullstack.io, 03 Feb 2020. ISBN 167482341X (com, uk) `https://newline.co/web-developers-field-guide` [Gabarino 2020]

Online Resources

++ Smashing Magazine; `smashingmagazine.com`

++ Google; web.dev; `web.dev`

++ Mozilla; MDN Web Docs; `developer.mozilla.org`

++ Frontend Focus; Weekly newsletter. `frontendfoc.us`

+ Kamran Ahmed; Developer Roadmaps; `roadmap.sh`

+ A List Apart; `alistapart.com`

+ *Zen Garden: The Beauty of CSS Design*; `csszengarden.com`

11.1 Tabular Page Layout ("The Old Way")

The "old" way is with nested invisible tables and transparent single-pixel (spacer) GIFs [Siegel 1996; Siegel 1997].

The "new" way is with (X)HTML5, CSS3, and JavaScript.

Controlling Page Layout with Nested Invisible Tables

Use nested invisible tables to divide up screen space:

- Turn on table borders when debugging, off for final layout.
- Use absolute table widths (in pixels), so that tables do not resize automatically.
- Use cellspacing (cellpadding) to guarantee white space.

Page Layout at Virtual Vineyards

Like many sites, Virtual Vineyards uses nested invisible tables to lay out its content on a grid.

See Figures 11.1 and 11.2.

Note: Virtual Vineyards was acquired by wine.com `www.wine.com` and no longer exists in its own right.

Virtual Vineyards with Table Borders On

Controlling Spacing with Single-Pixel Invisible GIFs

A 1 by 1 pixel, transparent GIF, say `dot-clear.gif`, can be used as a strut for precise control of spacing:

- Make it opaque during debugging, transparent for final layout.
- The vspace and hspace (or height and width) attributes can be used to specify how much space to leave.
- Use it for line indentation (e.g. the first lines of paragraphs)
- Create a margin with it in a table cell.
- Add leading (interline spacing) between lines with it.

Use a Clean Tiling Background Image

- In Photoshop, make a 1200 by 25 pixel GIF, which tiles vertically.
- At least 1200 pixels wide, so that it doesn't repeat horizontally (most people have screens less than 1200 pixels wide).
- Often a coloured left margin and white space to the right.

Problems Aligning Images

- Browsers have (different and unchangable) top and left margins, so aligining foreground images cleanly atop background images is impossible.
- Browsers leave (different amounts of) space between inline images, so image tiling and exact spacing can only be done by putting images inside borderless table cells.

Keith's New Home Page

My original home page has my photograph, wall-to-wall text describing my achievements, and my address, as shown in Figure 11.3.

A redesign with exact spacings is shown in Figures 11.4 and 11.5.

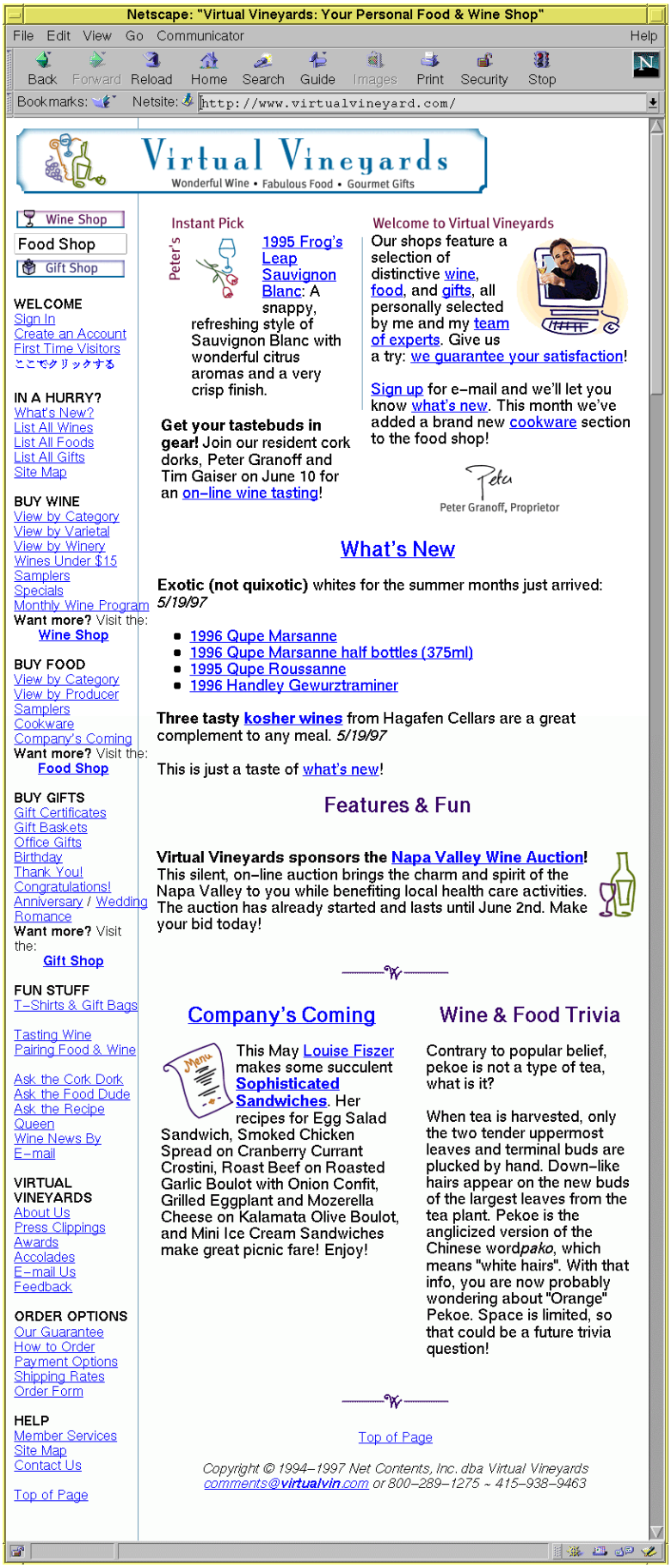

Figure 11.1: The Virtual Vineyards site.

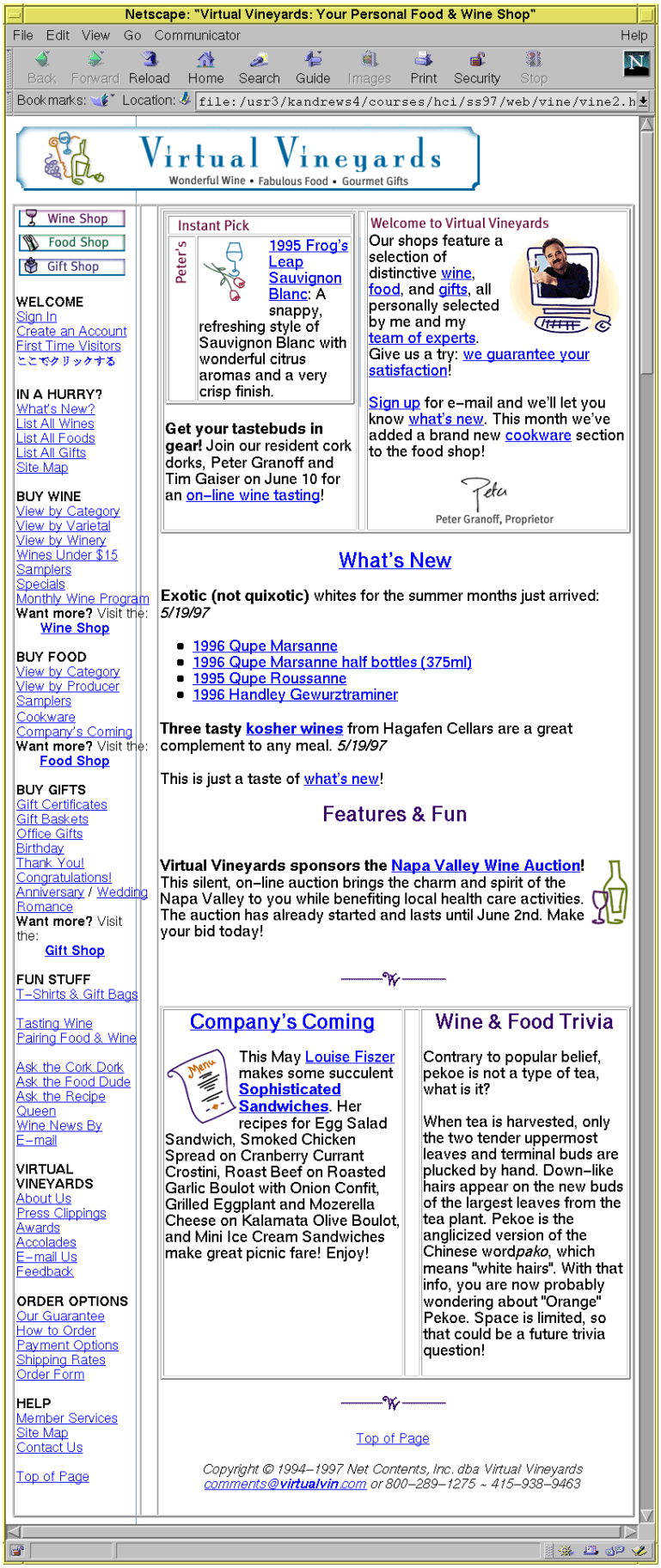

Figure 11.2: The Virtual Vineyards site, with table borders turned on so that nested invisible tables are displayed.

Figure 11.3: The original look of Keith's home page.

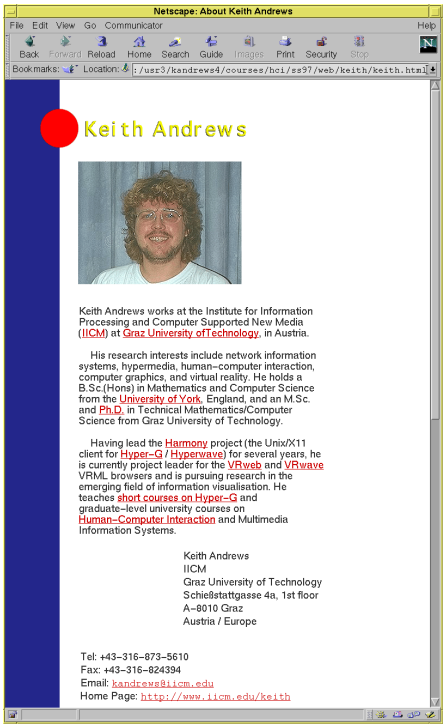

Figure 11.4: Keith's redesigned home page, using invisible tables for layout and transparent GIFs for spacing.

```
<HTML>
<HEAD>
<title>About Keith Andrews</title>
</HEAD>

<BODY
leftmargin=0 topmargin=0 bgcolor="#ffffff" text="#333333"
link="#cc0000" alink="#ff3300" vlink="#330099" background="spine.gif"
>

<br><IMG vspace=10 src="dot-clear.gif"><br>
<IMG hspace=23 src="dot-clear.gif">
<IMG src="circ-al2.gif" align=center width=80 height=80 alt="Image: Red circle.">
<IMG src="text2.gif" align=center width=300 height=40 alt="Text: Keith Andrews.">

<br><IMG vspace=10 src="dot-clear.gif"><br>
<IMG hspace=60 src="dot-clear.gif">
<IMG src="kandrews.jpg" align=center width=300 height=225
alt="Photo: Keith Andrews.">

<br><IMG vspace=20 src="dot-clear.gif"><br>

<!-- begin main table -->
<table border=0 cellpadding=0 cellspacing=0 width=577>
<tr>
<td width=127> <br> </td>  <!-- blank cell -->

<td width=450>
Keith Andrews works at the Institute for Information Processing and
Computer Supported New Media (<A href="http://www.iicm.edu">IICM</A>)
at <A href="http://www.tu-graz.ac.at/">Graz University of Technology</A>,
in Austria.

<br><IMG vspace=10 src="dot-clear.gif"><br>

<IMG hspace=8 src="dot-clear.gif">
His research interests include ... ...of Technology.

<br><IMG vspace=10 src="dot-clear.gif"><br>

<IMG hspace=8 src="dot-clear.gif">
Having lead the ...
...and Multimedia Information Systems.

<br><IMG vspace=10 src="dot-clear.gif"><br>

<table align=right border=0>
<tr>
<td>Keith Andrews</td>
</tr>
<tr>
<td>IICM</td>
</tr>
... <!-- other rows of address --> ...
<tr>
<td>Austria / Europe</td>
</tr>
</table>

<br clear=all>
<br><IMG vspace=10 src="dot-clear.gif"><br>

<table border=0>
<!-- Phone number, email, etc.  -->
</table>

</td>
</tr>
</table>   <!-- end of main table -->

</BODY>
</HTML>
```

Table 11.1: The HTML source code for Keith's new home page design. Some of the content has been omitted for the sake of brevity.

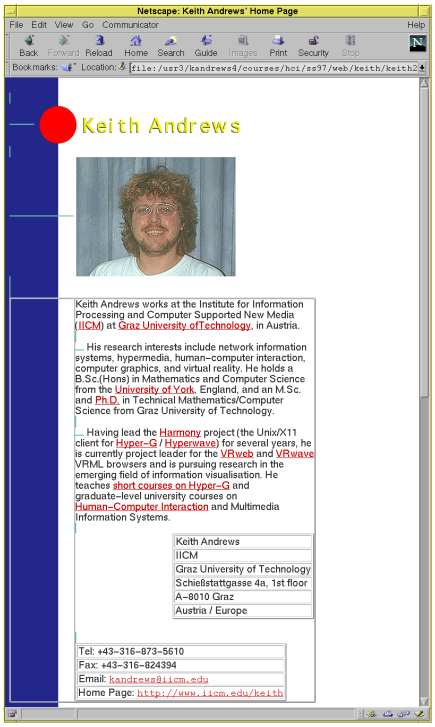

Figure 11.5: Behind the scenes at Keith's redesigned home page. Table borders have been turned on, so that their extent can be seen. Transparent GIFs have been made green and two pixels wide, so their use as struts for spacing is apparent. The red circle was interlaced explicitly against the split blue and white background used as background image.

11.2 Living HTML

HTML is now a living standard, maintained by the Web Hypertext Application Technology Working Group (WHATWG) [WHATWG 2024b].

The last versioned HTML standard was HTML 5.2, which was released on 14 Dec 2017 [W3C 2017].

References

++ Jennifer Robbins; *Learning Web Design*; O'Reilly, 5th Edition, 21 May 2018. ISBN 1491960205 (com, uk) [Robbins 2018]

++ Jeremy Keith and Rachel Andrew; *HTML5 for Web Designers*; A Book Apart, 2nd Edition, 17 Feb 2016. ISBN 1937557243 (com, uk) [Keith and Andrew 2016]

++ Dan Cederholm; *CSS3 for Web Designers*; A Book Apart, 2nd Edition, 24 Feb 2015. ISBN 0984442529 (com, uk) [Cederholm 2015]

++ Dan Cederholm; *Sass for Web Designers*; A Book Apart, 13 Nov 2013. ISBN 193755712X (com, uk) [Cederholm 2013]

++ Mat Marquis; *JavaScript for Web Designers*; A Book Apart, 28 Sep 2016. ISBN 1937557464 (com, uk) [Marquis 2016]

++ Marijn Haverbeke; *Eloquent JavaScript*; No Starch Press, 14 Dec 2014. ISBN 1593275846 (com, uk) [Haverbeke 2014] Free PDF at `eloquentjavascript.net`.

++ Amelia Bellamy-Royds et al; *Using SVG with CSS3 and HTML5: Vector Graphics for Web Design*; O'Reilly, 03 Nov 2017. ISBN 1491921978 (com, uk) [Bellamy-Royds et al. 2017]

++ Chris Coyier; *Practical SVG*; A Book Apart, 27 Jul 2016. ISBN 1937557421 (com, uk) [Coyier 2016]

++ David Demaree; *Git for Humans*; A Book Apart, 28 Jan 2016. ISBN 1937557383 (com, uk) [Demaree 2016]

Online Resources

++ Patrick Griffiths; *HTML Dog*; `htmldog.com` [Griffiths 2016]

+ Marcin Wichary; *HTML5 Presentation*; `https://keithandrews.com/courses/html5rocks/html5.html` [Wichary 2016] [Originally at `slides.html5rocks.com`]

+ Mozilla Developer Network; *Learn web development*; `https://developer.mozilla.org/docs/Learn`

+ Google; *Web Fundamentals*; `https://developers.google.com/web`

∘ WHATWG; *HTML Living Standard*; `https://html.spec.whatwg.org/` [WHATWG 2024a]

∘ W3C; *CSS Current Work* 04 Oct 2024. `https://w3.org/Style/CSS/current-work.html` [W3C 2024]

HTML5

HTML5 = (X)HTML5 + CSS3 + JS

- Semantic tags: section, article, figure, header, footer.
- Audio and video tags.
- Inline SVG.

CSS3

- New selectors.
- Web fonts.
- Text wrapping.
- Text columns.
- Opacity.
- Rounded corners.
- Colour gradients.
- Shadows.
- Transforms.

JavaScript

- WebSocket: bi-directional transfer of data.
- Native drag + drop.
- Filesystem API.
- Geolocation: ask current location.
- Device orientation: ask current orientation.
- Canvas 2D.
- Canvas 3D (WebGL).

11.3 Polyglot XHTML5

Online Resources

+ W3C; *Polyglot Markup: HTML-Compatible XHTML Documents*; W3C Working Group Note, 29 Sep 2015. http://w3.org/TR/html-polyglot/ [W3C 2015]
+ Jesper Tverskov; *Benefits of Polyglot XHTML5*; 27 Sep 2012. http://xmlplease.com/xhtml/xhtml5polyglot/ [Tverskov 2012]
  - Total Validator; *Total Validator* totalvalidator.com
  - W3C; *Nu Markup Validation Service* http://validator.w3.org/nu/ [W3C 2016]
  - W3C; *CSS Validation Service* http://jigsaw.w3.org/css-validator/

XHTML

- XHTML: The Extensible HyperText Markup Language.
- A stricter version of HTML, complient with XML syntax.
- XHTML tags (mark-up) are enclosed between less than ('<') and greater than ('>') characters.
- XHTML encodes the structure and content of a web page, CSS then specifies the presentation.
- General information and attributes go between the `head` tags.
- The actual content goes between the `body` tags.

Main Differences Between HTML and XHTML

In XHTML (compared to HTML):

- All tags must be in lower case.
- All documents must have a doctype.
- All documents must be properly formed .
- All tags must be closed.
- All attributes must be in quotation marks.
- All tags must be properly nested.

Serving HTML or XML to the Browser

The way a browser parses a (X)HTML file depends on the *content type* sent with it by the web server:

- `text/html`: the browser assumes HTML and parses loosely with liberal error handling.
- `application/xhtml+xml`: the browser assumes XHTML and parses strictly with an XML parser.

  Usually, if your (X)HTML file has the extension:

- `.html`: the server will send it as `text/html`.
- `.xhtml`: the server will send it as `application/xhtml+xml`.

XHTML5

- HTML5 has an XML serialisation (stricter subset) called XHTML5, which complies with the stricter rules for XML.
- For example, in XHTML5, all tags and attributes must be written entirely in lower case. In HTML5 upper case, lower case, or a mixture can be used.
- UTF-8 is the default character encoding for XML. Use UTF-8 for XHTML5 web pages.
- There are only five named character entity references in XML: `&`, `<`, `>`, `&apos;`, and `&quot;`. Do not use any others.
- Although hex character references (such as `&#xE4;` for ä) are allowed in XML, only use them for non-printing characters such as non-breaking space (` `). Do not use hex character references.
- For all other characters, for reasons of readability, use the UTF-8 character itself: use `Männer` instead of `M&#xE4;nner`.
- Every XHTML5 file is also an HTML5 file.

Polyglot XHTML5

- Polyglot XHTML5 [W3C 2015; Tverskov 2012] takes this a step further: the same file can be served as either HTML5 (`text/html`) or XHTML5 (`application/xhtml+xml`) *and works exactly the same in the browser*.
- For this to work, a few extra rules (conventions) are necessary, so that the DOM created inside the browser will be the same in both cases (and thus JavaScript scripts will work the same).

  Best practice is to write platform-independent, resolution-independent, polyglot XHTML5.

Extra Rules for Polyglot XHTML5

The following sum up most of the extra rules necessary for Polyglot XHTML5 [W3C 2015]:

- Use both the `lang` and `xml:lang` attribute.
- Use `<meta charset="UTF-8"/>`.
- Use `tbody`, `thead`, or `tfoot` in tables (at least one of these must be present).
- When `col` is used in a table, also use `colgroup`.
- Do not use the `noscript` element.
- Do not start `pre` and `textarea` elements with newline.
- Use `innerHTML` instead of `document.write()`.
- In a `script` element, wrap JavaScript in a commented-out `CDATA` section.

- Many names in SVG and one name in MathML use lowerCamelCase.

Separating Content from Form

Separation of content and form (presentation):

- The XHTML specifies the *content*, a Cascading Style Sheet (CSS) specifies the *form*.
- The same content (an XHTML file) can be *repurposed* using different CSS style sheets:
  - Extra-large, high-contrast display for sight-impaired users.
  - Audio rendering for blind users, or people driving their car.
  - etc.
- Since XHTML is also valid XML [Wikipedia 2012a], the content can be transformed automatically into different formats using XSLT (Extensible Stylesheet Language Transformations) [Wikipedia 2012b]:
  - PDF
  - HTML
  - plain text
  - etc.

Validation

It is good practice to *validate* your (X)HTML5 (and CSS) code, so as to catch unintended mistakes (analogous to linting program source code):

- In standard HTML5 parsing, some web browsers may be more tolerant than others when it comes to handling errors such as missing `</p>` or `</li>` tags.
- This can lead to differences in the internal DOM tree and sometimes subtle differences in behaviour and the way CSS is applied, which can be hard to debug.
- When validating HTML5 source code, a single error in the code (such as a missing closing paragraph tag) often produces a cascade of follow-up error messages in the validator.
- Fix the errors one at a time, starting at the top. Fixing one error often eliminates several error messages. Then validate again.

The goal is to write clean valid XHTML5 source code, but then to serve it to the browser as HTML5.

Online Validation Services

- Validator.nu (X)HTML5 Validator (Living Validator): `html5.validator.nu`.
  To validate as XHTML5:
  - Temporarily rename your file with the extension `.xhtml`, so that the stricter XML parser is used.
  - Use File Upload and validate the file.
  - When all validation errors are eliminated, rename your file back to the extension `.html`.

  [The Nu validator does not check for Polyglot rules, such as the use of at least one of `tbody`, `thead`, or `tfoot` in tables.]

- W3C CSS Validation Service: `https://jigsaw.w3.org/css-validator/` [W3C 2008].

Installable Validators

- Total Validator comprises an installable program and an extension for Firefox and Chrome, supporting within-browser validation `totalvalidator.com` [Total Validator 2016].
- Total Validator can also check the rules for valid Polyglot XHTML5, CSS, and accessibility.
- Unfortunately, the free Test version of Total Validator no longer tells you where the errors are (only how many errors were found), you have to buy at least the Basic version.

11.4 Building Fault-Tolerant Web Sites

Progressive Enhancement

- At the end of the 1990s, it took about 2 years for a newly released browser version to become widespread [Nielsen 1998; Nielsen 1999].
- Nowadays, browsers typically auto-update themselves, however a significant minority of users still use old browser versions.
- Use *progressive enhancement*: Build with HTML, style with CSS, and enhance with JavaScript [Keith 2016; Keith 2015b].
- HTML and CSS are fault-tolerant: Newer enhancements are simply ignored by older browsers.
- JavaScript is not fault-tolerant: Use *feature-sniffing* to detect support for newer features before use [Ateş et al. 2016]. [Not the same as *device-sniffing*!]

Browser Support for Features

Can check in advance:

- *Can I Use*; `caniuse.com` [Deveria 2024]

or in CSS:

- *CSS Feature Queries*; `@supports` `https://developer.mozilla.org/docs/Web/CSS/CSS_conditional_rules/Using_feature_queries`

or in JavaScript.

Test on Multiple Browsers and Platforms

Remember to try out your site with a variety of browsers, versions, and platforms:

- Test using different (real) browsers, versions, and platforms (set up a device lab). `buildingadevicelab.com`
- Use Browsersync to push design changes automatically to multiple devices. `browsersync.io`
- Test using different browsers and browser versions on real devices over the web:
  - BrowserStack; `browserstack.com` Debug on remote device using Chrome DevTools, as shown in Figure 11.6. Free for open source projects.
  - SmartBear BitBar; `https://smartbear.com/product/bitbar/`. Free for open source projects.
  - Browser Sandbox; `browserling.com`

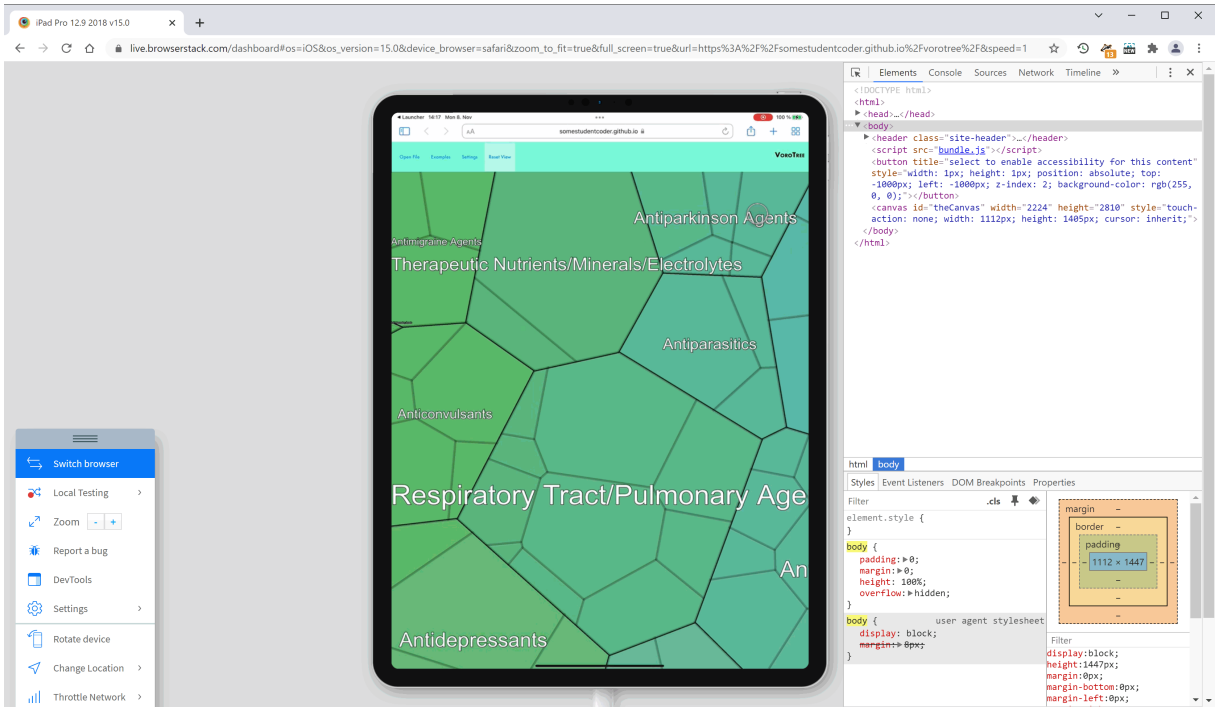

Figure 11.6: Using BrowserStack to debug on a remote device (here Safari on an iPad Pro 2018 running iPadOS 15) with local Chrome DevTools. The experimental interface being tested is at `https://somestudentcoder.github.io/vorotree/`.

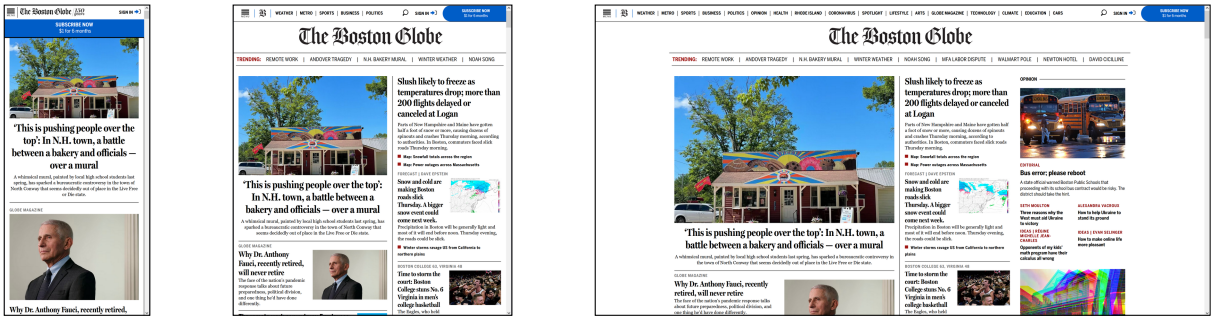

Figure 11.7: The Boston Globe (`bostonglobe.com`) was the first ever responsive web site. The content adapts to the width and other characteristics of the display device. [Screenshots taken by Keith Andrews on 23 Feb 2023.]

11.5 Responsive Web Design

A single web site design which dynamically responds (adapts) to the characteristics (screen width, resolution, capabilities, . . .) of the user's device.

The *same* web site at the *same* URL works and provides an appropriate experience across all devices:

- smartphone
- tablet
- laptop
- desktop
- large-screen tv
- car dashboard

The Boston Globe, shown in Figure 11.7, was the first web site to be made responsive (in 2011).

Web design *is* now responsive web design.

Being Responsive

Responsive web design is a combination of:

- Responsive layout: dynamically adjusting the layout to best suit the available window size (reflow at breakpoints, rescale in between).
- Responsive content: dynamically adjusting embedded content (tables, images, videos, charts, adverts, etc.) to best suit the device characteristics (space, resolution, etc.).
- Responsive interaction: dynamically adjusting interaction and navigation elements (menus, buttons, search boxes, etc.) to best suit the device characteristics (size, touch, voice, etc.).
- Progressive enhancement: selectively adding support for additional features such as location, orientation, tilt, and gestures. [Detect *features* not devices!]

References

++ Ethan Marcotte; *Responsive Web Design*; 2nd Edition, A Book Apart, 02 Dec 2014. ISBN 1937557189 (com, uk) [Marcotte 2014]

++ Ethan Marcotte; *Responsive Design: Patterns and Principles*; A Book Apart, 18 Nov 2015. ISBN 1937557332 (com, uk) [Marcotte 2015]

++ Scott Jehl; *Responsible Responsive Design*; A Book Apart; 19 Nov 2014. [Jehl 2014]

++ Stephen Hay; *Responsive Design Workflow*; New Riders, 05 Apr 2013. ISBN 0321887867 (com, uk) [Hay 2013]

+ Vitaly Friedman (Ed); *New Frontiers in Web Design*; Smashing Book 6, 2018. ISBN 3945749697 (com, uk) [Friedman 2018]

+ Vitaly Friedman (Ed); *Real-Life Responsive Web Design*; Smashing Book 5, 2015. ISBN 3945749212 (com, uk) [Friedman 2015]

Online Resources

+ Brad Frost; *This Is Responsive.*; `https://bradfrost.github.io/this-is-responsive/`

++ Matt Andrews; *Responsive Design at the Guardian or How I learned to Stop Worrying and Love the Mobile Web*; `https://mattandrews.info/talks/2013/05/10/responsive-design-at-the-guardian-port-80.html`

+ BBC News; *Cutting the Mustard*; Responsive News, 08 Mar 2012. `https://responsivenews.co.uk/post/18948466399/cutting-the-mustard`

++ Karen McGrane and Ethan Marcotte; *A Responsive Web Design Podcast*; `https://responsivewebdesign.com/podcast/` [Until 01 Mar 2018 .]

+ Responsively App; `responsively.app`.

Separate Desktop and Mobile Web (m.) Sites

- Two separate sites under two separate URLs.
- Two separate sites to maintain.
- Redirection is based on UserAgent or device-sniffing (too course).
- Examples include:
  - `southwest.com` vs. `m.southwest.com` See Figure 11.8.
  - `graz.at` vs. `m.graz.at` See Figure 11.9.

Curated Lists of Responsive Web Sites

- Eivind Uggedal; `mediaqueri.es`
- Awwwards; `https://awwwards.com/websites/responsive-design/`

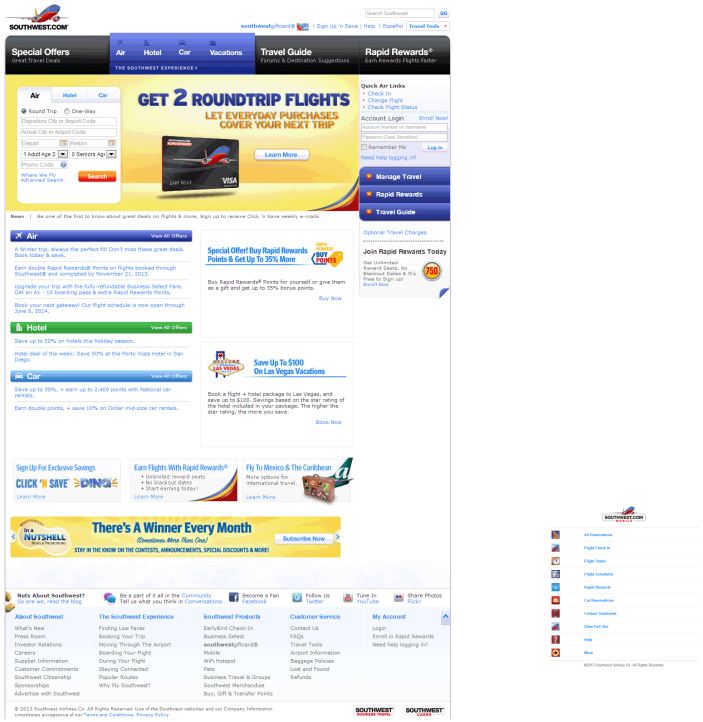

Figure 11.8: Separate desktop and mobile (m.) versions of the Southwest Airlines web site `southwest.com`.

Figure 11.9: Separate desktop and mobile (m.) versions of the Graz web site `graz.at`.

- DesignModo; `https://designmodo.com/responsive-design-examples/`

Individual Examples of Responsive Web Sites

- *The Boston Globe*; `bostonglobe.com` The first responsive web site.
- *Smashing Magazine*; `smashingmagazine.com`
- *Starbucks*; `starbucks.com`
- *TED*; `ted.com`
- *engadget*; `engadget.com`
- *BBC One*; `https://bbc.com/sport/`
- *The Guardian*; `theguardian.com`
- *Gov.UK*; `gov.uk`
- *City of Surrey*; `surrey.ca`
- *Texas State University*; `txstate.edu`
- *Andy Clarke*; `stuffandnonsense.co.uk`
- *SparkBox*; `sparkbox.com`
- *New Adventures conference*; `newadventuresconf.com`

Prevalence of Responsive Sites

- In 2013, around 11% of web sites (in the top 100,000) were responsive [Podjarny 2014].
- "Responsive design is Google's recommended design pattern" [Google 2016].

  Nowadays, almost all modern web sites are responsive.

Responsive Layout with CSS3 Media Queries

- First, appropriate breakpoints for the content are determined and specified in a breakpoint diagram as shown in Figure 11.10.
- It is good practice to specify the breakpoints in em or rem rather than in px, so they also respond when users set larger fonts (or text zooming). [Anyhow, at the root element, 1 em = 1 rem.]
- Most of the CSS code can be shared between all window widths.
- CSS3 media queries are used to distinguish between the different screen widths.

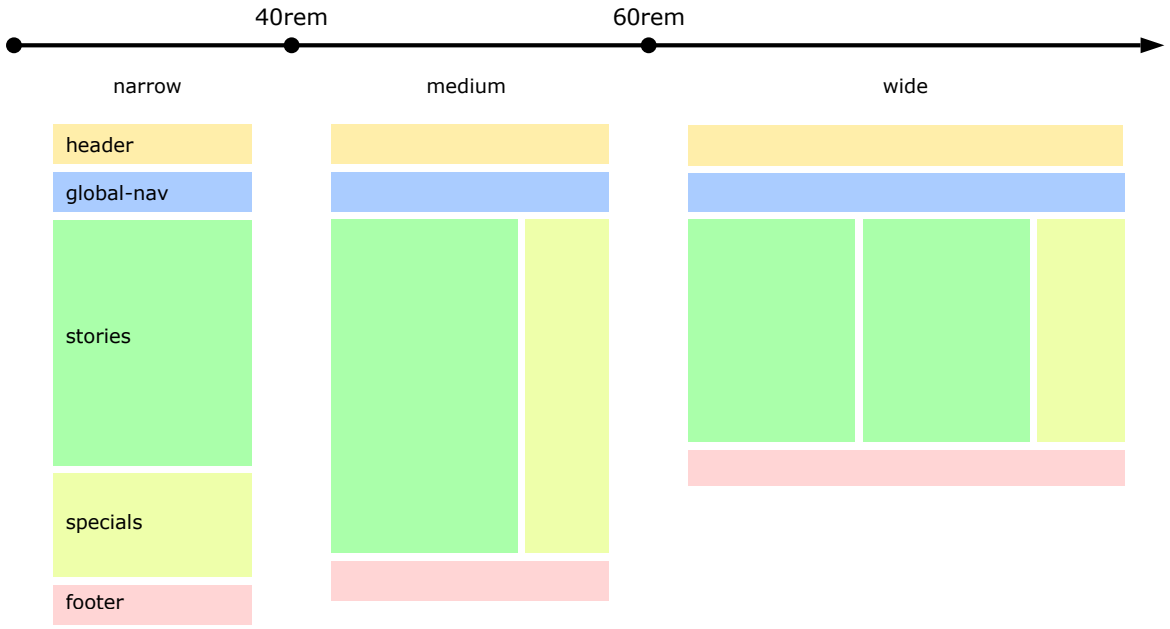

Figure 11.10: A breakpoint diagram.

Specifying Breakpoints with CSS3 Media Queries

```
/* settings for window-width: narrow */
@media only all and (max-width: 40rem) {
...
}


/* settings for window-width: medium */
@media only all and (min-width: 40rem) and (max-width: 60rem) {
...
}


/* settings for window-width: wide */
@media only all and (min-width: 60rem) {
...
}
```

Modern CSS

- Container queries for fine-grained responsive layout.
- ...

11.6 Progressive Web Apps (PWAs)

Progressive Web Apps (PWAs) try to combine the reach of a web app with the capabilities of a native app:

- launchable from home screen (A2HS).
- run in standalone browser window.
- offline functionality and caching through service workers.
- push notifications.
- distribute by URL, no need for app stores.

Resources

++ Google; *Progressive Web Apps*; https://web.dev/progressive-web-apps/

++ Gert Svaiko; *How To Optimize Progressive Web Apps: Going Beyond The Basics*; Smashing Magazine, 23 Dec 2020 https://smashingmagazine.com/2020/12/progressive-web-apps/

++ PWA Summit; pwasummit.org

Video: Aaron Gustafson on PWAs

- Aaron Gustafson; *Progressive Web Apps: Where Do I Begin?*; Talk at An Event Apart DC 2019, Wahington DC, 13 Jun 2019 [Video: https://vimeo.com/382335406]

11.7 Design Systems

design system = interconnected design patterns + shared practices

- design pattern = functional pattern or perceptual pattern
- functional pattern = components of an interface (buttons, menus, choosers, etc.) [nouns, typically in HTML]
- perceptual pattern = styling of an interface (typography, colours, spacing, etc.) [adjectives, typically in CSS]
- pattern library = tool to capture, share, and maintain design patterns (now often also referred to as a design system).

Think Components not Pages

- Build a system of components which (re-)arrange themselves according page constraints.
- Build a pattern library (living style guide) to capture, share, and maintain the components.

References

++ Marco Suarez, Jina Anne, Katie Sylor-Miller, Diana Mounter, and Roy Stanfield; *Design Systems Handbook*; InVision, 2021. Free download. https://designbetter.co/design-systems-handbook

+ Andrew Couldwell; *Laying the Foundations: A Book about Design Systems*; Owl, 2020. [Couldwell 2020]

+ Alla Kholmatova; *Design Systems*; Smashing Media, 2017. ISBN 3945749581 (com, uk) [Kholmatova 2017]

+ Anna Debenham; *Front-End Style Guides*; http://www.maban.co.uk/projects/front-end-style-guides/

+ Christopher Alexander et al; *A Pattern Language*; Oxford University Press, 1977. ISBN 0195019199 (com, uk) [Alexander et al. 1977]

+ Christopher Alexander; *The Timeless Way of Building*; Oxford University Press, 1979. ISBN 0195024028 (com, uk) [Alexander 1979]

+ Donella Meadows; *Thinking in Systems*; Chelsea Green Publishing, 03 Dec 2008. ISBN 1603580557 (com, uk) [Meadows 2008]

++ Jenifer Tidwell; *Designing Interfaces: Patterns for Effective Interaction Design*; 3rd Edition, O'Reilly, 30 Jan 2020. ISBN 1492051969 (com, uk) [Tidwell et al. 2020]

∘ Bill Scott and Theresa Neil; *Designing Web Interfaces: Principles and Patterns for Rich Interactions*; O'Reilly, 26 Jan 2009. ISBN 0596516258 (com, uk) [Scott and Neil 2009]

Online Resources

++ Brad Frost; *The Design System Ecosystem*; 21 Sep 2023 https://bradfrost.com/blog/post/the-design-system-ecosystem/

+ Jad Limcaco; *Design Systems Repo*; `designsystemsrepo.com`
+ Jina Anne; *design.systems*; `design.systems`
◦ *UI Patterns*; `ui-patterns.com`
◦ Anna Debenham; *Website Style Guide Resources*; `styleguides.io`

Conferences

++ Clarity; `clarityconf.com`
+ Schema; `schema.figma.com`
◦ Design Systems Community, Toronto; `https://designsystems.community/resources/`

Design Patterns in Architecture

Design patterns: sample design solutions based on good practice (Musterlösungen).

A hierarchy of design patterns:

- Knobs
- Doors
- Walls
- Rooms
- Buildings
- Communities
- Regions

Different patterns are available at each level of abstraction.

Design Patterns in Web Design

A hierarchy of design patterns:

- Radio Buttons
- Forms
- Search Interface
- Page Layout
- Navigation System
- Site Architecture
- Site Genre

Different patterns available at each level of abstraction.

A heuristically-derived system of pluggable interface components.

Curated Lists of Example Design Systems (Pattern Libraries)

+ Design Systems Gallery; https://designsystemsrepo.com/design-systems/
+ Naveen Prasath Pitchai; *Top 10 Design Systems in 2023*; 19 May 2023. https://linkedin.com/pulse/top-10-design-systems-2023-naveen-prasath

Example Design Systems (Pattern Libraries)

+ GOV.UK Design System; design-system.service.gov.uk
+ Shopify Polaris; polaris.shopify.com
  - Elisa Style Book; stylebook.elisa.fi
  - Intuit QuickBooks Design System; designsystem.quickbooks.com
  - Starbucks; https://starbucks.com/developer/pattern-library
  - Yelp; https://yelp.com/styleguide
  - Yahoo! Design Pattern Library; http://boxesandarrows.com/implementing-a-pattern-library-in-the-real-world-a-yahoo-case-study/ https://web.archive.org/web/20150905182317/https://developer.yahoo.com/ypatterns/everything.html

Tools to Maintain Design Systems

+ Design Systems Repo; *Tools and Resources*; https://designsystemsrepo.com/tools/.
+ *Storybook*; storybook.js.org.
  - *SC5 Style Guide Generator*; styleguide.sc5.io.
  - *Fractal*; fractal.build.
  - Lonely Planet; *Rizzo*; https://github.com/lonelyplanet/rizzo.
+ Figma; figma.com.
+ UXpin; uxpin.com.

Video: Brad Frost on Design Systems

- Brad Frost; *The Technical Side of Design Systems*; Talk at CSS Day 2019, Amsterdam, 13 Jun 2019 [Frost 2019]. [Video: https://youtu.be/TgWyyoofKIA]

11.8 Web Performance Optimisation

Web Performance Optimisation (WPO).

References

++ Glen Elkins; *The Web Performance Handbook*; 16 Mar 2021. ISBN: 979-8723030718.

+ Maximiliano Firtman; *High Performance Mobile Web*; O'Reilly, 26 Sep 2016. ISBN 1491912553 (com, uk) [Firtman 2016]

+ Steve Souders; *High Performance Web Sites*; O'Reilly, 2007. ISBN 0596529309 (com, uk) [Souders 2007a]

+ Steve Souders; *Even Faster Web Sites*; O'Reilly, 2009. ISBN 0596522304 (com, uk) [Souders 2009]

Online Resources

++ Google; *Core Web Vitals*; `https://web.dev/explore/learn-core-web-vitals`

++ Chrome User Experience Report (CrUX); `https://developer.chrome.com/docs/crux/`

++ HTTP Archive; `httparchive.org`.

++ Catchpoint; *WebPageTest*; `webpagetest.org`.

++ Google; *Lighthouse*; `https://developers.google.com/web/tools/lighthouse/`.

++ MDN; *Web Performance*; `https://developer.mozilla.org/en-US/docs/Learn/Performance`.

+ webhint; `webhint.io`.

+ Katie Deighton; *Google Search Ramps up Penalties*; 10 Aug 2021 `https://wsj.com/articles/google-search-ramps-up-penalties-for-slow-annoying-websites-11628614350`

++ Ivan Akulov; *Web Performance 101*; 16 Jul 2022 `https://3perf.com/talks/web-perf-101/`

++ Vitaly Friedman; *How We Improved SmashingMag Performance*; 21 Jan 2021 `https://smashingmagazine.com/2021/01/smashingmag-performance-case-study/`

++ Jake Archibald; *Performance-testing the Google I/O site*; 30 Apr 2021 `https://jakearchibald.com/2021/io-site-perf/`

++ Calibre; *Performance Newsletter*; Every two weeks. `https://calibreapp.com/newsletter`

Curated Lists of WPO Examples

++ Tammy Everts and Tim Kadlec; *WPO Stats*; `wpostats.com`

++ SpeedCurve; *Page Speed Benchmarks*; `https://speedcurve.com/benchmarks`

+ Tammy Everts; *Time Is Money*; O'Reilly, 2016. ISBN 1491928786 (com, uk)

Individual WPO Examples

- Google: +500 ms →-20% traffic [Mayer 2006].
- Amazon: +100 ms →-1% sales [Linden 2006].
- Bing: +500 ms →-1.2% revenue [Schurman and Brutlag 2009].
- Mobify: -100 ms → +1.11% conversion
  http://bizreport.com/2016/08/mobify-report-reveals-impact-of-mobile-website-speed.html

Response Time Limits

Three limits for response times from classic HCI research:

- *0.1 s*: Immediate response.
- *1 s*: Uninterrupted flow of thought.
- *10 s*: Keeping to the task.

  See Nielsen [1993a].

Total Loading Time

The total loading time is the time a user has to wait from clicking on a link or typing a URL until the whole new page is loaded and ready to use:

- Latency before the server starts transmitting the response.
- Download time of the page and its assets.
- Parsing and execution time in the browser.

The HTTP Archive reports (one year to 01 Sep 2023) median loading speeds (Time to Interactive) of around 7.0 seconds (desktop) and around 13.5 seconds (mobile)[HA 2023a].

Latency

Latency is the time it takes for the server to receive the request and begin responding. There are several potential delays:

- DNS lookup to convert the domain name in the URL to an IP address.
- Routing the request to the appropriate server.
- Waiting in a wait loop until the server services the request.
- Waiting for any dynamic content to be assembled into a HTML page on the server.

Download Time

Once the server starts transmitting the page back to the browser, bandwidth and page size become relevant:

- The speed of the connection.

	Response Time	
Connection	*1 Sec.*	*10 Secs.*
Analog Dialup (56 kbps)	4 kb	67 kb
ADSL (1 mbps)	70 kb	1.3 mb
LTE (30 mbps)	1.9 mb	35 mb

Table 11.2: Maximum acceptable page sizes for a response time of 1 and 10 seconds, assuming 0.5 seconds latency.

- The total size of files and assets needed for the initial view:
  - Caching means some files do not need to be downloaded.
  - Loading of some files can be deferred until later (lazy loading).
  - Compression can be used to make some files smaller.

Table 11.2 shows maximum acceptable page sizes (including inline images, css, scripts, etc.) for response times of 1 and 10 seconds, assuming 0.5 seconds of latency.

The HTTP Archive reports (one year upto 01 Sep 2023) median page weights of around 2.5 mb (desktop) and around 2.2 mb (mobile) [HA 2023b].

Parse and Execution Time

As assets arrive in the browser:

- HTML and CSS files have to be parsed and the DOM and CSSOM constructed.
- Images and other assets need to be decoded.
- JavaScript need to be interpreted and executed.

Souders' 14 Rules (2007)

Souders [2007a] explains 14 rules for improving the performance of a web site (based on research at Yahoo):

1. Make Fewer HTTP Requests.
   [Update: turn on HTTP/2 and use SVG for icons.]
2. Use a Content Delivery Network.
3. Add an Expires Header (to take advantage of browser cache). [Update: use Service Worker to take control of caching.]
4. Gzip Components.
5. Put Stylesheets at the Top.
6. Put Scripts at the Bottom.
   [Update: use async and defer.]
7. Avoid CSS Expressions.

8. Make JavaScript and CSS External.
9. Reduce DNS Lookups.
10. Minify JavaScript.
    [Update: use bundling and tree shaking.]
11. Avoid Redirects.
12. Remove Duplicate Scripts.
13. Configure ETags (cache expiry over multiple servers).
14. Make Ajax Cacheable.

[YSlow [Yahoo! 2010] was built by the Exceptional Performance team at Yahoo[Yahoo! 2008], but has now been superceded by the Dev Tools built into Chrome and Firefox.]

Video: Steve Souders on High Performance Web Sites

- Steve Souders; *High Performance Web Sites and YSlow*; Talk at Google, 13 Nov 2007 [Souders 2007b, 07:50-29:30]. [Video: `https://youtu.be/BTHvs3V8DBA?t=07m50s`]

Video: Steve Souders on the Illusion of Speed

- Steve Souders; *The Illusion of Speed*; Ignite talk, Velocity 2013 18 Jun 2013 [Souders 2013, 00:35-]. [Video: `https://youtu.be/bGYgFYG2Ccw?t=0m35s`]

Core Web Vitals

Three core performance metrics, as defined by Google:

- *Largest Contentful Paint (LCP)*: The time to render the largest image or text block visible within the viewport [loading time].
- *Cumulative Layout Shift (CLS)*: A measure of the disruption caused by layout shifts [visual stability].
- *First Input Delay (FID)*: [interactivity]. The time from a user's first interaction to when the browser begins to respond.
  [FID will be replaced by INP (Interaction to Next Paint) in 01 Mar 2024 .]

  See `https://web.dev/explore/learn-core-web-vitals`.

Checking Performance Metrics

- Use the Developer Tools in Chrome or Firefox.
- Run Lighthouse from the command line `https://developers.google.com/web/tools/lighthouse/`
- Use a web-based service such as `webpagetest.org` or PageSpeed Insights `https://developers.google.com/speed/pagespeed/insights/`.
- Can download a page and its assets with wget 1.9.1 (`https://gnu.org/software/wget/`):

```
wget --proxy=off --page-requisites --convert-links \
http://tugraz.at/
```

Video: Barry Pollard on Core Web Vitals 2023

- Barry Pollard; *The 9 Most Effective Core Web Vitals Opportunities of 2023*; Google I/O 10 May 2023. [Video: https://youtu.be/mdB-J6BRReo]

Web Runtime Performance

++ Kayce Basques; *Get Started With Analyzing Runtime Performance*; https://developer.chrome.com/docs/devtools/performance/

+ Luis Vieira; *Web Runtime Performance*; 01 Nov 2016 https://medium.com/the-ui-files/web-runtime-performance-462b1328df54

∘ Jake Archibald; *Rendering Without the Lumpy Bits*; Google Developers, 2013. https://youtu.be/oGLkBpIHj4Y

∘ Ilya Grigorik *Optimizing the Critical Rendering Path*; Velocity Santa Clara, 2013. https://youtu.be/YV1nKLWoARQ

Chapter 12

Conducting a Formal Experiment

> *" Would you fly in an airplane that hasn't been flight tested? Of course not. So you shouldn't be using software that hasn't been usability tested. "*
>
> [Ben Shneiderman, The Front Desk, BBC Video, 1995.]

Formal Experiment: Controlled experiment, usually in a lab setting, involving quantitative measurement of performance of test users and statistical analysis.

References

++ Andy Field; *Discovering Statistics Using R*; Sage Publications, 31 Mar 2012. ISBN 1446200469 (com, uk) [Field et al. 2012]

++ Andy Field; *Discovering Statistics Using SPSS*; Sage Publications, 3rd Edition, 2009. ISBN 1847879071 (com, uk) [Field 2009]

+ Andy Field and Graham Hole; *How to Design and Report Experiments*; Sage Publications, 2002. ISBN 0761973834 (com, uk) [Field and Hole 2003]

++ Jeff Sauro and James R. Lewis; *Quantifying the User Experience*; Morgan Kaufmann, 13 May 2012 ISBN 0123849683 (com, uk) [Sauro and Lewis 2012]

+ James R. Lewis and Jeff Sauro; *Excel and R Companion to Quantifying the User Experience*; CreateSpace, 01 Mar 2012 ISBN 1470025574 (com, uk) [Lewis and Sauro 2012]

+ Neil Salkind; *Statistics for People Who (Think They) Hate Statistics*; Sage Publications, Third Edition, Aug 2007. ISBN 141295150X (com, uk) [Salkind 2007]

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+ David Martin; *Doing Psychology Experiments*; Sixth Edition, Wadsworth, July 2003. ISBN 053460255X (com, uk) [D. Martin 2003]

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∘ Shaughnessy, Zechmeister, and Zechmeister; *Research Methods in Psychology* Sixth Edition, McGraw-Hill Education, May 2003. ISBN 0071113231 (com, uk) [Shaughnessy et al. 2003]

◦ Zechmeister, Zechmeister, and Shaughnessy; *Essential Research Methods in Psychology* McGraw-Hill Education, May 2003. ISBN 0072932341 (com, uk) [Zechmeister et al. 2003]

Online Resources

++ Usabilty News; http://psychology.wichita.edu/surl/usability_news.html

\+ Wichita State University, Software Usability Research Lab (SURL); http://psychology.wichita.edu/surl/

\+ *The R Project for Statistical Computing*; http://www.r-project.org/ [TRF 2016]

◦ Philippe Grosjean; *Tinn-R*; http://www.sciviews.org/Tinn-R/ [Grosjean 2009]

◦ Andy Field; *Welcome to Statistics Hell*; http://www.sussex.ac.uk/Users/andyf/teaching/statistics.htm

◦ I. Scott MacKenzie; *Research Note: Within-subjects vs. Between-subjects Designs: Which to Use?*; http://www.yorku.ca/mack/RN-Counterbalancing.html

◦ James Brown; *EDGAR: Experimental Design Generator And Randomiser*; http://www.jic.bbsrc.ac.uk/services/statistics/edgar.htm

◦ Alexander Bogomolny; *Latin Squares*; http://www.cut-the-knot.org/arithmetic/latin_intro.shtml

◦ Wikipedia; *Latin Square*; http://en.wikipedia.org/wiki/Latin_square

Formal Experiments

- *Summative* evaluations which provide bottom-line data (performance measurements).
- Two main uses:
  - Objective measurement of performance of a single design.
  - Objective comparison of the performance of two or more alternative designs.
- Require a large number of test users (sample size) for statistical accuracy: usually at least 20, often 50 or more.

Performance Measurement

Collect objective, quantitative data, e.g.:

- Time to complete specific task(s).
- Number of tasks completed within given time.
- Number of errors.
- Ratio successful interactions : errors.
- Time spent recovering from errors.
- Number of commands/features used.

- Number of features user can remember after test.
- How often help system used.
- Time spent using help.
- Ratio positive : negative user comments.
- Number of times user sidetracked from real task.

Validity

Validity: is measured data relevant to the usability of the real system in real world conditions?

Typical validity problems include:

- **Testing with the wrong kind of user**
  For example, testing business students instead of managers for a management information system. However, testing business students will generally lead to better results than testing, say, mathematics students.
- **Testing the wrong tasks**
  The results from testing a toy task in a prototype of a few dozen hypermedia documents may not be relevant to a planned system for managing tens of thousands of documents.
- **Not including time constraints and social influences**
  Queues of people waiting in line, noise levels in the working environment, etc.

Running a Formal Experiment

- Record each test on video, to be able to clarify any issues which emerge at a later time.
- Do not take timings with a stopwatch next to the user:
  - have the computer automatically log start and end times
  - or extract timings afterwards from the video
- *Never* mix thinking aloud with a formal experiment:
  - having to think aloud slows a user down
  - having to think aloud loud can change a user's behaviour
- The facilitator must take care not to influence a user.

12.1 Experimental Design

Null Hypothesis

- The null hypothesis is an assertion about a population parameter.
- The null hypothesis is often the reverse of what the experimenter actually believes. It is put forward to allow the data to contradict it.

- A typical null hypothesis is that no difference exists between the control and experimental groups (for the variable being compared).

Independent and Dependent Variables

- *Independent variable* (or *factor*): variable manipulated by the experimenter. For example, type of browser, or font size.
- *Dependent variable*: variable measured by the experimenter. For example, task completion time, or reading speed.

Testing Absolute Performance of One Interface

- One interface.
- Run an experiment to objectively determine whether the interface satisfies specific requirements.
- For example: measure how long it takes 20 expert users to perform task X.
- Result: an expert user can on average perform task X in 2 minutes 10 seconds ± 6 seconds.

Comparing Two Alternatives

- Two interfaces, A and B.
- Run an experiment to objectively determine which interface is better, according to some criterion (efficiency, error rate, etc.).
- There is one independent variable (interface) and it has two *levels* (A and B).
- Two different ways of designing an experiment:
  - *independent measures*: also called *between-groups* or *between-subjects*.
  - *repeated measures*: also called *within-groups* or *within-subjects*.

Independent Measures (Between-Groups) Experiment

- Two equally-sized groups of test users.
- *Randomly* assign users to two groups.
- Identical tasks for both groups.
- Group 1 uses only system A, group 2 only system B.

Pros and Cons:

\+ no problems with learning effect

\- large individual variation in user skills (std. dev. $\approx 50\%$)

Repeated Measures (Within-Groups) Experiment

- One group of test users.
- *Randomly* assign users to two equally-sized pools.
- Users perform *equivalent* tasks on *both* systems.
- Pool 1 uses system A first, pool 2 uses system B first.

Pros and Cons:

+ automatically controls for individual variability
- transfer of skill between systems (learning effect)

Example Designs

Independent Measures (Between-Groups)	
System A	*System B*
John	Dave
James	Mariel
Mary	Ann
Stuart	Phil
Keith	Tony
Gary	Gordon
Jeff	Ted
Bill	Edward
...	...
Charles	Thomas
Celine	Doug

Repeated Measures (Within-Groups)	
Participant	*Sequence*
Elisabeth	A, B
Sven	A, B
Amanda	A, B
Claudia	A, B
Terry	A, B
Nigel	A, B
Barry	A, B
...	...
Ben	B, A
Michael	B, A
Richard	B, A

Comparing Multiple Alternative Interfaces

A repeated measures design is usually preferred because:

- Variability between test users is removed, which provides greater statistical power to detect differences.
- Fewer test users are required in total, since each users tries each test condition.
- In the example in Table 12.1, the differences between the two interfaces are very small relative to the differences among subjects, but repeated measures is still able to detect such differences.

Counterbalancing Presentation Order

One problem with repeated measures designs is the *learning effect* (or *practice effect*):

- Users tend to do better later in the test, having accumulated a certain amount of practice and familiarity with the tasks and interfaces being tested.
- If all test conditions (interfaces) are presented in the same order, later test conditions (interfaces) will gain an unfair advantage.
- The solution is to *counterbalance* the presentation order of the test conditions.

Test Person	*Interface A*	*Interface B*
TP1	14.00	17.00
TP2	22.00	24.00
TP3	29.00	31.00
TP4	48.00	53.00
Av	**28.25**	**31.25**
StdDev	**14.52**	**15.59**

Table 12.1: Data from a simple repeated measures experiment to compare two interfaces for a particular task. The independent variable is interface, with two levels, A and B. The dependent variable is task completion time in seconds. Every test user was faster with A than with B. Even though the differences are small, they are very likely to be real, since they are consistent across all four test users.

1	2	3		1	2	3	4		1	2	3	4	5
3	1	2		4	1	2	3		5	1	2	3	4
2	3	1		3	4	1	2		4	5	1	2	3
				2	3	4	1		3	4	5	1	2
									2	3	4	5	1

Figure 12.1: Three simple (unbalanced) latin squares: 3 × 3, 4 × 4, and 5 × 5. Looking at the rows, each element appears once in each position. Each row corresponds to one test case, or presentation sequence of the test conditions (interfaces).

Latin Squares

- A mathematical construct where, looking at the rows, each element appears once in each position.
- For example, in a 3 × 3 latin square, the element '1' appears once in first place, once in second place, and once in third place.
- Each row of the latin square represents one sequence of test conditions and is called a *test case*.

Constructing a Latin Square

- In the simplest construction algorithm, each row is shifted once to the right (or left) to form the next row.
- However, the order of the elements within rows remains (more or less) the same.
- For example, in Figure 12.1, element '2' comes immediately after element '1' in every row except the last.
- Figure 12.1 shows three simple latin squares.

Balanced Latin Squares

- In a *balanced* latin square, each element additionally follows every other element exactly once.
- Balanced latin squares only exist for experiments with an even number of conditions (2 × 2, 4 × 4, 6 × 6, etc.).

1	2	4	3
2	3	1	4
3	4	2	1
4	1	3	2

1	2	6	3	5	4
2	3	1	4	6	5
3	4	2	5	1	6
4	5	3	6	2	1
5	6	4	1	3	2
6	1	5	2	4	3

Figure 12.2: Two balanced latin squares: 4 × 4 and 6 × 6. Each element appears once in each position. Additionally, each element follows every other element exactly once.

- See Figure 12.2.

Constructing a Balanced Latin Square

Shaughnessy et al. [2003, page 250] gives the following procedure to construct a balanced latin square with an even number of conditions:

1. Number the conditions 1 to N.

2. The first row is:

   $1,\ 2,\ N,\ 3,\ N-1,\ 4,\ N-2,\ 5,\ \ldots$

3. To generate the second row, add one to each number in the first row ($N + 1$ wraps around to 1).

   The second row is:

   $2,\ 3,\ 1,\ 4,\ N,\ 5,\ N-1,\ 6,\ \ldots$

4. To generate the third row, add one to each number in the second row (again wrapping $N + 1$ around to 1).

5. and so on.

If there is an odd number of conditions, two squares must be constructed. The first according to the procedure above, the second by reversing the rows of the first. The second is then appended on to the bottom of the first to make an N × 2N square.

Test users must be assigned *randomly* to each condition.

This procedure derives originally from Williams [1949]. More details and example squares for up to 26 conditions are given by Pezzullo [2012].

$n = 2$	1	2					
	2	1					
$n = 3$	1	2	3				
	2	3	1				
	3	1	2				
	3	2	1				
	1	3	2				
	2	1	3				
$n = 4$	1	2	4	3			
	2	3	1	4			
	3	4	2	1			
	4	1	3	2			
$n = 5$	1	2	5	3	4		
	2	3	1	4	5		
	3	4	2	5	1		
	4	5	3	1	2		
	5	1	4	2	3		
	4	3	5	2	1		
	5	4	1	3	2		
	1	5	2	4	3		
	2	1	3	5	4		
	3	2	4	1	5		
$n = 6$	1	2	6	3	5	4	
	2	3	1	4	6	5	
	3	4	2	5	1	6	
	4	5	3	6	2	1	
	5	6	4	1	3	2	
	6	1	5	2	4	3	
$n = 7$	1	2	7	3	6	4	5
	2	3	1	4	7	5	6
	3	4	2	5	1	6	7
	4	5	3	6	2	7	1
	5	6	4	7	3	1	2
	6	7	5	1	4	2	3
	7	1	6	2	5	3	4
	5	4	6	3	7	2	1
	6	5	7	4	1	3	2
	7	6	1	5	2	4	3
	1	7	2	6	3	5	4
	2	1	3	7	4	6	5
	3	2	4	1	5	7	6
	4	3	5	2	6	1	7

Figure 12.3: Balanced "Williams designs" (latin squares) for 2 to 7 conditions. If the number of conditions n is even, the Williams design is an $n \times n$ balanced latin square. If the number of conditions n is odd, the Williams design is a $2n \times n$ rectangle, composed of two $n \times n$ latin squares.

12.2 Statistical Analysis

The appropriate statistical test depends upon the answers to the following questions:

- *What type of data is involved?*
  Frequency or score (interval/ratio).
- *How many independent variables are involved?*

- *What kind of study is involved?*
  Experimental or correlational.
- *What kind of experimental design is involved?*
  Independent measures or repeated measures design.
- *How many conditions does the independent variable have?*

- *Are the data parametric or non-parametric?*

Figure 12.4 contains a flow diagram to help choose the appropriate statistical test for a given situation.

Sample Size (How Many Test Users?)

- Depends on desired confidence level and confidence interval.
- Confidence level of 95% often used for research, 80% is acceptable for practical development.
- Nielsen: survey of 36 published usability studies came up with a rule of thumb of 16–20 test users [Nielsen 1993b, pages 166–169].

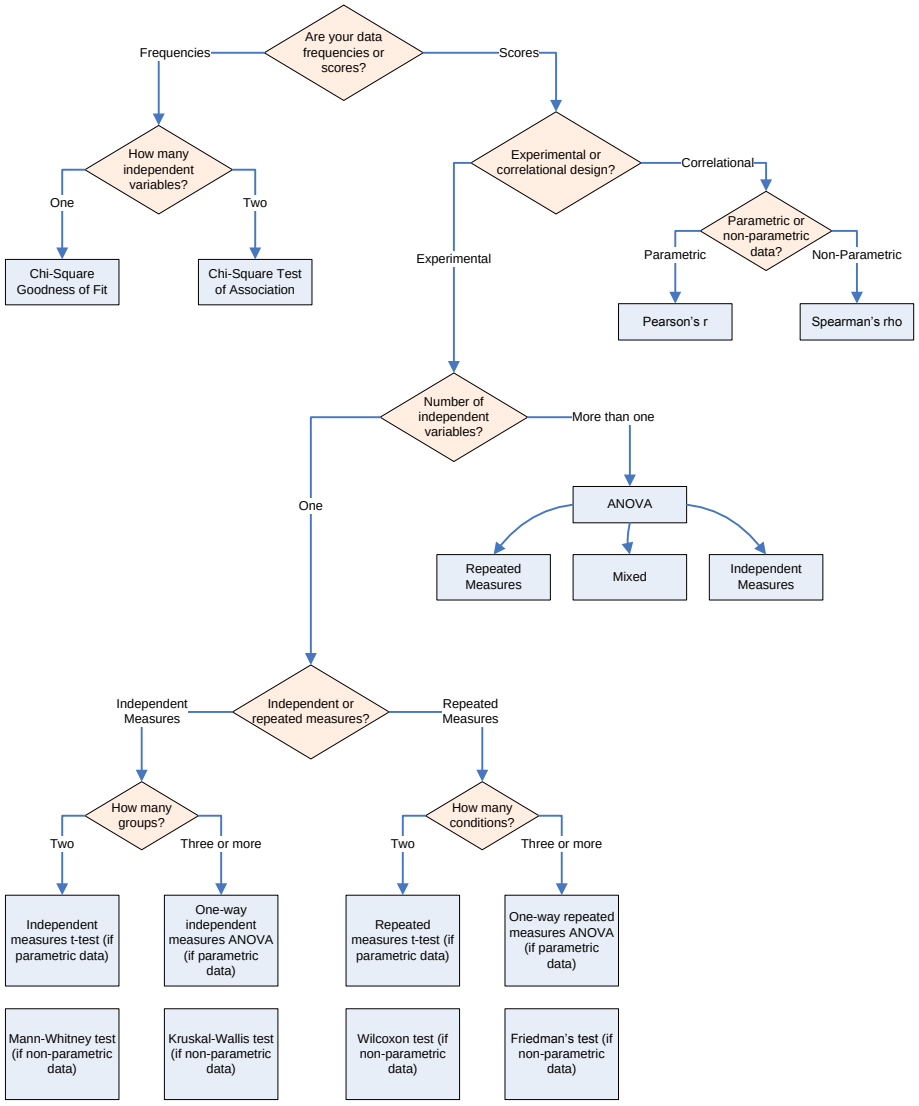


Figure 12.4: A flow chart to help choose the appropriate statistical test. Adapted from Field and Hole [2003, page 274].

12.3 Examples for Common Situations

These examples are taken from a study of four different branching factors in a product hierarchy conducted for IAweb in WS 2005/2006.

[For a comparative evaluation of four hierarchy browsers conducted in 2006 by my Master's student Janka Kasanicka, see Andrews [2006] and Kasanicka [2006].]

12.3.1 Performance Data (Not Normally Distributed)

Completion times are recorded for each user for each of a set of (equivalent) tasks. The analysis depends on whether the observed data are (near enough) normally distributed.

- In a counterbalanced repeated measures design, the time taken by each of 48 test users to complete equivalent tasks in each of the 4 conditions (branching factors) was recorded.

- The times recorded for the task "Find Product X" are shown in Table 12.2.

12.3.2 Effectiveness Data

Binary or partial measure of success.

12.3.3 Rating Data

Rating data are recorded on a seven-point Likert scale. The data are transformed to a score for each condition (branching factor) from 0 points (worst) to 6 points (best) from each user on a variety of scales.

- Users were asked to rate each of the four conditions (branching factors B4, B7, B16, B24) on a seven-point Likert scale.
- The rating data are shown in Table 12.3.

12.3.4 Preference Data

Each user votes for their overall most preferred condition (branching factor) for a variety of factors (best overview, perceived speed, best overall), resulting in a tally of votes for each condition.

- Users were which of the four conditions (branching factors B4, B7, B16, B24) they preferred overall.
- The preference data are shown in Table 12.4.

Pros and Cons of Formal Experiment

++ collects objective, quantitative data (bottom-line data)

++ allows comparison of alternative designs

– needs significant number of test users (20, 50, or more)

- usable only later in development process

- requires facilitator expertise

- cannot provide why-information (process data)

User	*Case*	*B4*	*B7*	*B16*	*B24*
1	3	32	26	13	19
2	15	27	24	28	18
3	4	30	14	14	9
4	6	11	14	11	15
5	11	12	29	18	27
6	7	13	17	9	34
7	2	26	19	18	28
8	14	16	12	28	17
9	16	15	37	20	13
10	8	18	20	8	46
11	1	30	15	41	16
12	13	14	12	10	13
13	12	38	19	25	29
14	5	17	22	19	29
15	10	13	12	16	29
16	9	23	31	8	35
17	5	63	16	19	25
18	15	15	17	23	8
19	14	12	18	11	11
20	10	13	13	17	23
21	3	13	15	36	16
22	12	15	16	13	35
23	7	40	33	17	26
24	4	15	9	16	9
25	16	11	18	12	13
26	8	13	9	9	24
27	9	13	18	29	23
28	1	21	26	16	16
29	11	55	23	20	28
30	2	38	25	33	61
31	6	11	13	10	17
32	13	15	13	11	72
33	7	18	43	14	35
34	8	24	24	28	34
35	13	18	14	82	16
36	10	17	11	14	12
37	6	13	30	16	20
38	11	25	34	10	19
39	9	15	22	19	35
40	14	22	11	17	11
41	2	28	13	14	77
42	3	47	10	6	10
43	1	44	20	21	40
44	4	49	22	16	10
45	16	14	12	14	13
46	5	15	17	8	8
47	15	17	17	21	28
48	12	11	15	11	33
Av		**22.4**	**19.2**	**18.5**	**24.7**
SD		12.7	7.7	12.1	15.3

Table 12.2: Task completion times in seconds to find a product in each of four product hierarchies with different branching factors B4, B7, B16, and B24.

User	*B4*	*B7*	*B16*	*B24*
1	5	5	4	3
2	3	2	3	2
3	6	2	3	0
4	6	6	5	5
5	5	1	4	3
6	6	6	6	5
7	6	5	2	1
8	5	4	2	4
9	6	2	6	6
10	2	6	1	4
11	5	2	4	6
12	1	5	3	3
13	0	2	3	4
14	5	5	4	4
15	3	3	2	1
16	5	4	3	5
17	5	6	5	5
18	6	5	1	1
19	5	4	4	4
20	5	6	3	2
21	6	5	1	0
22	4	6	1	0
23	1	4	3	4
24	4	4	4	5
25	6	2	5	0
26	1	5	2	1
27	2	5	5	4
28	6	5	1	0
29	3	5	5	4
30	5	5	1	0
31	6	6	3	1
32	4	1	6	4
33	3	1	3	2
34	2		3	4
35	3	4	6	6
36	3	4	2	1
37	5	1	3	5
38	3	1	4	4
39	2	5	4	4
40	2	5	5	4
41	5	1	5	2
42	1	6	6	6
43	3	5	4	5
44	2	6	6	2
45	6	2	5	4
46	6	5	6	4
47	5	3	4	1
48	4	5	5	5
Av	**4.0**	**4.0**	**3.7**	**3.1**
SD	1.8	1.7	1.6	1.9

Table 12.3: User ratings for each of four product hierarchies with different branching factors B4, B7, B16, and B24. The data from a seven-point Likert scale was transformed to a score of 0 (worst) to 6 (best). User 34 did not give a rating to condition B7.

User	*B4*	*B7*	*B16*	*B24*
1	1			
2			1	
3	1			
4	1			
5	1			
6		1		
7		1		
8		1		
9	1			
10		1		
11				1
12		1		
13			1	
14		1		
15		1		
16				1
17		1		
18	1			
19	1			
20				1
21	1			
22		1		
23		1		
24	1			
25	1			
26		1		
27		1		
28	1			
29	1			
30		1		
31	1			
32			1	
33	1			
34				1
35				1
36		1		
37	0.5		0.5	
38		1		
39		1		
40			1	
41	1			
42				1
43				1
44	1			
45			1	
46	1			
47	1			
48		1		
Total	**18**	**17**	**5**	**7**

Table 12.4: User overall preference for one of four product hierarchies with different branching factors B4, B7, B16, and B24. User 37 could not decide between B4 and B16, so the vote was not counted.

Chapter 13

Evidence-Based Guidelines

> *" Nielsen has had a bad habit of presenting personal opinions as research fact. "*
>
> [George Olsen, Usability News, 31 July 2002 [Olsen 2002].]

Web usability guidelines which are based on evidence from formal experiments.

Online Resources

- U.S. Department of Health and Human Service (HHS); *Research-Based Web Design & Usability Guidelines*; `guidelines.usability.gov` [HHS 2006]
- Software Usability Research Laboratory (SURL); `surl.org`
- Usability News; `http://psychology.wichita.edu/surl/newsletter.htm`
- Mary Evans; *Web Design: An Empiricist's Guide*; Master's Thesis, University of Washington, 1998. [M. Evans 1998]

13.1 Screen Fonts

13.1.1 Bernard, Mills, Peterson, and Storrer, 2001

Bernard et al. [2001] conducted a study comparing 12 different fonts.

Experimental Design

Counterbalanced, repeated measures design.

The independent variable (that which is varied) is font family.

Twelve different fonts (in three categories):

- *Sans serif*: Agency FB, Arial, Comic Sans MS, Tahoma, Verdana.
- *Serif*: Courier New, Georgia, Goudy Old Style, Century Schoolbook, Times New Roman.
- *Ornate*: Bradley Hand ITC, Monotype Corsiva.

Participants

- N = 22 participants: 7 male, 15 female.
- Age ranged from 20 to 44 (mean 25, sd = 6) years.

Tasks

- All text set at 12 pt size (≈ 3 mm high). [Agency was set to 14 pt to reach 3 mm height]
- All text was black on a white background.
- 12 passages of text from Encarta of around 1032 words, horizontal margins set at 640 pixels.
- Each passage contained 15 randomly placed substitution words.
- Each user asked to read 12 passages, one for each font.
- Users asked to read "as quickly and as accurately as possible" and flag (read aloud) any word appearing out of context.

Measures

Objective measures:

- % substitution words detected.
- Reading time in seconds.
- Reading efficiency := % substitution words detected / reading time.

  Subjective measures:
- Rating for Perceived Font Legibility (6-point likert scale).
- Also ratings for:
  - Font Type Conveyed Personality
  - Font Type was Elegant
  - Font Type Appeared Youthful & Fun
  - Font Type Appeared Business-Like

  These are not considered further here.
- Preference ranking of the 12 fonts.

Results

Objective measures:

- Reading time (regardless of accuracy): Tahoma ‹ Corsiva. all other differences not significant.
- Reading efficiency: no significant differences.

  Subjective measures:

- Perceived legibility:
  Courier › Agency, Courier › Goudy, Courier › Bradley, Courier › Corsiva.
  Comic › Agency, Comic › Goudy, Comic › Bradley, Comic › Corsiva.
  Verdana › Agency, Verdana › Goudy, Verdana › Bradley, Verdana › Corsiva.
  Georgia › Agency, Georgia › Goudy, Georgia › Bradley, Georgia › Corsiva.
  Times › Agency, Times › Goudy, Times › Bradley, Times › Corsiva.
- Preference ranking: % chosen as first or second preference choice, Verdana, Arial, and Comic are most preferred.

Conclusions

- Almost no objective differences between fonts at 12 pt.
- Based on subjective measures, Verdana is a good choice for a default font.

13.1.2 Bernard, Lida, Riley, Hackler, and Janzen, 2002

Bernard et al. [2002] conducted a study comparing 8 different fonts at three different sizes.

Experimental Design

Counterbalanced, mixed measures design.

The independent variables were font family (within-subject) and font size (between-subject).

Eight different fonts:

- *Sans serif*: Arial, Comic Sans MS, Tahoma, Verdana.
- *Serif*: Century Schoolbook, Courier New, Georgia, Times New Roman.

Three different font sizes: 10 pt, 12 pt, and 14 pt.

Participants

- N = 60 participants: 16 male, 44 female.
- Age ranged from 18 to 55 (mean 24, sd = 7.8) years.

Tasks

- All text was black on a white background.
- 8 passages of text from Encarta of around 1032 words, horizontal margins set at 640 pixels.
- Each passage contained 15 randomly placed substitution words.
- Each user asked to read 8 passages, one for each font.
- 20 users read at 10 pt, 20 users at 12 pt, and 20 users at 14 pt.

- Users asked to read "as quickly and as accurately as possible" and flag (read aloud) any word appearing out of context.

Measures

Objective measures:

- % substitution words detected.
- Reading time in seconds.
- Reading efficiency := % substitution words detected / reading time.

  Subjective measures:
- Rating for Perceived Font Legibility (6-point likert scale).
- Also ratings for Perceived Attractiveness (not considered further here).
- Preference ranking of the 8 fonts.

Results

Objective measures:

- Reading time (regardless of accuracy):
  Times ‹ Courier, Times ‹ Schoolbook, Times ‹ Georgia.
  Arial ‹ Courier, Arial ‹ Schoolbook, Arial ‹ Georgia.
  12 pt ‹ 10 pt.
  All other differences not significant.
- Reading efficiency: no significant font family or font size effects.
  Fonts which were read faster were also generally read less accurately.

  Subjective measures:
- Perceived legibility:
  10 pt Tahoma › 12 pt Schoolbook. 10 pt Arial › 12 pt Tahoma.
  10 pt Georgia › 12 pt Tahoma, 10 pt Georgia › 12 pt Schoolbook.
  12 pt Verdana › 10 pt Comic, 12 pt Verdana › 10 pt Schoolbook, 12 pt Verdana › 10 pt Verdana.
  12 pt Courier › 10 pt Comic, 12 pt Courier › 10 pt Schoolbook, 12 pt Courier › 10 pt Verdana.
  12 pt Courier › 12 pt Schoolbook, 12 pt Courier › 12 Tahoma, 12 pt Courier › 14 pt Comic.
  14 pt Arial › 14 pt Comic.
  14 pt Arial › 10 pt Schoolbook, 14 pt Arial › 10 pt Comic.
- Preference ranking: % chosen as first or second preference choice.
  Over all three font sizes:
  Times ‹ Arial, Times ‹ Comic, Times ‹ Tahoma,
  Times ‹ Verdana, Times ‹ Courier, Times ‹ Georgia.
  Schoolbook ‹ Verdana.

Conclusions

- There were no significant differences in reading efficiency between font types at any size.
- In terms of pure reading time (regardless of accuracy), Times and Arial were read significantly faster than Courier, Schoolbook, and Georgia. Fonts at 12 pt were read significantly faster than fonts at 10 pt.
- Arial and Courier were perceived as the most legible fonts (not significantly). Verdana was the most preferred font (not significantly).
- Overall, Verdana is recommended as a good choice: it is the most preferred, whilst also being read fairly quickly and perceived as fairly legible.

13.1.3 Boyarski, Neuwirth, Forlizzi, and Regli, 1998

Boyarski et al. [1998] conducted a study comparing 3 pairs of fonts. We consider the first study described in Part 1 of the paper.

Experimental Design

Three comparison tests, each a counterbalanced, repeated measures design.

Three pairs of fonts compared:

- Georgia vs. Times Roman.
- Georgia vs. Verdana.
- Verdana vs. Verdana Italic.

The independent variable (that which is varied) in each case is font family.

Participants

- Three separate tests, each with N = 16 participants.
- Age (of the 48 users total) ranged from 20 to 53 (mean 30, sd = 7.8) years.

Tasks

- All text was black on a white background.
- Two comparable tests (called Form-E and Form-F) were taken from an established set of reading speed and comprehension tests, the Nelson-Denny Reading Test.
- Four passages from Form-E and four passages from Form-F were extracted, each consisting of three to seven paragraphs of text and having four associated comprehension questions.
- Each user was asked to read 4 passages of text for each font.
- All text was set at 10 pt size with 13 pt leading and an average line length of 10 words.
- Texts were presented in Micrsoft Word 6.0 (Windows 95) with the window set at 640 × 480 pixels.

- Users asked to "Work for both speed and accuracy; that is, work rapidly but try not to make mistakes."
- After each font, users were asked to rate the font on a 9-point likert scale for each of the dimensions: Hard/Easy to Read, Fuzzy/Sharp, and Illegible/Legible.
- At the end of the test, users were shown both fonts side by side (on two monitors) and asked to express a preference for one font on a 9-point likert scale (5 being the neutral point) for each of the dimensions: Easiest to Read, Most Pleasing to Read, and Most Sharp.

Measures

Objective measures:

- Reading time in seconds.
- Score := Number of comprehension questions answered correctly (out of 16).
- Effective reading speed := score / reading time.

  Subjective measures:

  Indirect ratings (9-point likert scale) for:
- Hard/Easy to Read.
- Fuzzy/Sharp.
- Illegible/Legible.

  Direct comparison (9-point likert scale, 5 being neutral point):
- Easiest to Read
- Most Pleasing to Read
- Most Sharp

Results

Objective measures:

- Reading time:

  No significant difference between Georgia and Times.
  No significant difference between Georgia and Verdana.
  No significant difference between Verdana and Verdana Italic.
- Score (comprehension):

  No significant difference between Georgia and Times.
  Georgia › Verdana
  No significant difference between Verdana and Verdana Italic.
- Effective reading speed:

  No significant difference between Georgia and Times.
  No significant difference between Georgia and Verdana.
  No significant difference between Verdana and Verdana Italic.

Subjective measures:

In the indirect comparison:

- Perceived as Easy to Read:
  Georgia › Times
  No significant difference between Georgia and Verdana.
  Verdana › Verdana Italic
- Perceived as Sharp:
  Georgia › Times
  No significant difference between Georgia and Verdana.
  Verdana » Verdana Italic
- Perceived as Legible:
  Georgia › Times
  No significant difference between Georgia and Verdana.
  Verdana » Verdana Italic

Conclusions

- There were no significant differences in (absolute) reading speed or effective reading speed between any of the font pairings at 10 pt.
- In the subjective ratings, Georgia is significantly preferred to Times.
- In the subjective ratings, Verdana is significantly preferred to Verdana Italic.

Chapter 14

Web Usability Case Studies

A series of case studies to illustrate how much can be learned from discount usability techniques.

14.1 SunWeb: User Interface Design for Sun Microsystem's Internal Web

- Summer of 1994, Sun has large amounts of distributed, internal information.
- 10,000% annual Web growth on Internet, even higher behind Sun's firewall.
- Tight timeframe in order to get consistent UI within Sun.
- Separate visual identities for internal and external pages.
- SunWeb design lead by Jakob Nielsen and Darrell Sano.
- Most of UI work done in few weeks.
- Note: 1994 design style – many icons and options.

The material in this section is adapted with kind permission from notes by Jakob Nielsen[Nielsen and Sano 1994].

Usability Plan

"Discount Usability Engineering" – four usability studies over a period of two weeks:

- Card sorting to discover categories (4 users).
- Icon intuitiveness testing (4 users).
- Card distribution to icons (4 users).
- Thinking aloud walkthrough of page mock-up (3 users).

Note:

- Participants in last two tests also asked for ratings of icon aesthetics.
- Different users used in each study to avoid learning effects.

Card Sorting

- UI group brainstormed about possible information services/concepts in system (51).
- One notecard for each concept.
- Scattered on desk in random order.
- User sorts cards into piles (not too small or too large) according to similarity.
- Group piles into larger groups.
- Name groups using Post-it notes.
- About 30-40 minutes per user.
- Analyse data by "eyeballing".
  [could also use statistical techniques]

Icon Intuitiveness

- Based on results of card sorting study, 15 first-level groupings of information defined for SunWeb.
- Designed icon for each of them.
- Show icons (without titles) to each user and ask what they mean. The results are shown in Table 14.1.
- Redesign of icons which tested poorly.

Card Distribution to Icons

- Test whether users associate correct concepts with icons.
- Mock up of home page design on desk.
- Icons printed in colour at 200% magnification, with labels.
- Post-it tape used to divide table into areas for each icon.
- Users place concept cards under most appropriate icon, as shown in Figure 14.1.
- Approx. 15 minutes per user.
- At end of test, users asked to comment on which icons they liked and disliked.

Thinking Aloud Page Walkthrough (Paper Prototype)

- Magnified color screendump of home page design.
- Test users asked to point to each button and think aloud what information they expected to find there.
- At end of test, users asked to comment on which icons they liked and disliked.

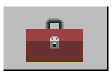
Icon	*Intended Meaning*	*User Interpretation*
	Geographic view of the company (branch offices in different locations).	World, global view, planet, the world, Earth.
	Benefits	Health field, money, health care is expensive, Clinton's health plan, hospital, don't know, benefits.
	Public relations (TV with commercial).	TV set, video, TV, TV, TV.
	Product catalog.	System oriented, disk, CD, Computer, CD-ROM, CD-ROM.
	Specialized tools (tool-box).	Briefcase, personal info, briefcase, toolbox, briefcase.
	What's new (bulletin board).	Bulletin board, bulletin board, bulletin board, laundry.
	World Wide Web.	Networking on a world scale, map, location, dimensions of the planet, networking around the world, geography, global.

Table 14.1: SunWeb: Results of icon intuitiveness study. [With kind permission of Jakob Nielsen.]

Figure 14.1: SunWeb: Card distribution to icons. [With kind permission of Jakob Nielsen.]

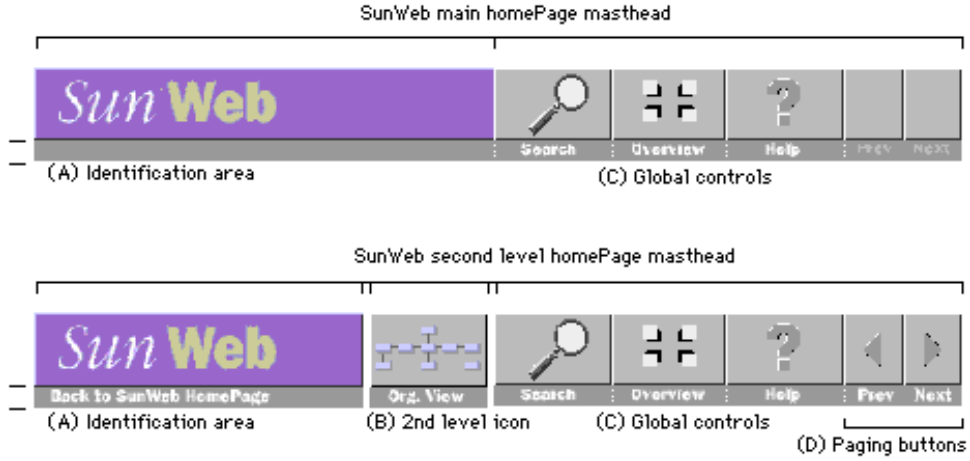


Figure 14.2: SunWeb main homepage masthead (top) and second level masthead (below). [With kind permission of Jakob Nielsen.]

Remarks

- For web page design, study the information structure.
  [since interaction techniques are determined by specific Web browser, over which you generally have no influence]
- Card sorting and icon intuitiveness studies were the most useful.

Iterative Design

- SunWeb design went through many revisions.
- For example, five main iterations of "Specialised Tools" icon.

Unified Design

- Consistent visual design applied to graphic elements.
- Textual labels in small font beneath each icon.
- Predictable location for information and controls on every page of SunWeb.
- Banner components placed in central repository with usage guidelines to encourage adoption.
- SunWeb banner colours from minimal, 64-colour palette.
  [reduce colour map problems, leave plenty free]

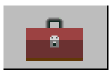
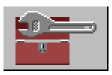
Icon	*Intended Meaning*	*User Interpretation*
	Toolbox.	Briefcase
	Open toolbox, with tool.	"Tool", but almost any concept was considered to be a tool.
	Storefront.	"Circuit board!"
	Storefront.	Confused with shopping and product catalog.
	Application chest.	Final design.

Table 14.2: SunWeb: Five iterations of Specialised Tools icon. [With kind permission of Jakob Nielsen.]

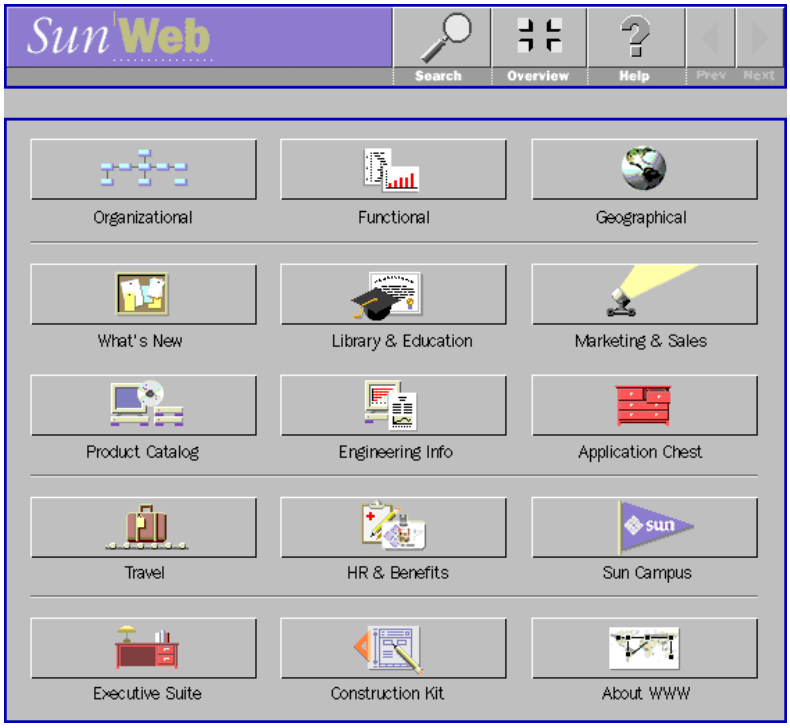


Figure 14.3: SunWeb final home page design. [With kind permission of Jakob Nielsen.]

14.2 SunWWW: User Interface Design for Sun's Web Site

Several rounds of usability testing for the 1995 redesign of Sun's external WWW site:

- Thinking aloud test of exisiting design.
- Competitive tests of other companies' sites.
- Card sorting.
- Icon intuitiveness.
- Paper prototyping.
- Thinking aloud test of running prototype.
- Usability testing both in usability lab in Sun HQ and at offices around world.

The material in this section is adapted with kind permission from notes by Jakob Nielsen [Nielsen 1995].

Thinking Aloud Test of Existing Design

- Inconsistent header bars.
- Strange image maps.
- Top button-bar did not look enough like buttons – immediately redesigned.
- Redesign resulted in 416% increased use over two-month period (Jan.–Mar. 1995).
  [overall use of server increased "only" 48% in same period]

Card Sorting for New Design

Card sorting with concepts from Sun's WWW site, to gain an insight into how users would organise concepts:

- Users were asked to sort the cards into piles, such that cards representing similar concepts were in the same pile.
- Users were also allowed to group piles to indicate looser levels of similarity
- Finally, they were asked to name their piles.

Testing Paper Mock-Up of Home Page

- Homepage designs printed on colour printer and magnified on colour copier.
- Users first asked to comment on their general impression.
- Then asked to point to elements they might want to click on and what they would expect to happen.
- Area of desk marked with masking tape, so user doesn't pick up the printout.

Figure 14.4: Usability lab setup at Sun. [With kind permission of Jakob Nielsen.]

Figure 14.5: The top button bar of Sun's WWW site before and after redesign. Changing the button bar resulted in 416% increase in use over a two-month period! [With kind permission of Jakob Nielsen.]

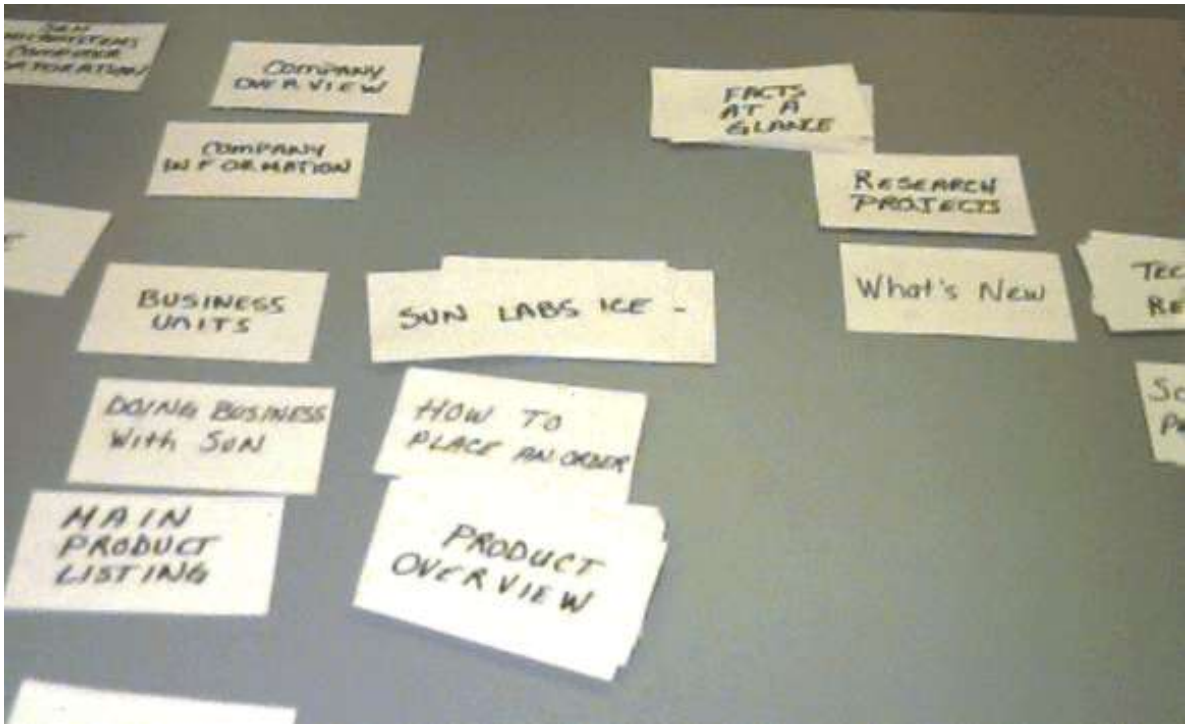


Figure 14.6: Card sorting for Sun's WWW site. Users group concepts into similar categories and name them. [With kind permission of Jakob Nielsen.]

Figure 14.7: Paper prototyping for Sun's WWW site. [With kind permission of Jakob Nielsen.]

Figure 14.8: Thinking aloud test of working prototype of Sun's WWW site. Note the small table clock to the left of the computer, so the facilitator does not continually look at their wristwatch. [With kind permission of Jakob Nielsen.]

Thinking Aloud Testing of Working Prototype

- Mostly in the Sun usability lab in Mountain View.
- Three tests at Sun offices in Europe and Asia.
- With a set series of tasks.

SunWWW Working Prototype

Nine Iterations of Sun's WWW Home Page

SunWWW Feedback 1

- Users mistook the page to be Adobe's home page rather than Sun's!
- Most users' initial impression was "very busy" or "complicated".
- Even though beautifully designed, users did not notice the month name (January), negating the regular update message of magazine-style.
- When the month was pointed, users liked it but worried how they would be able to access the cover story next month.
- Users liked the subtitle "Entertainment for Propellerheads", but it was removed anyway to enhance the site's credibility.

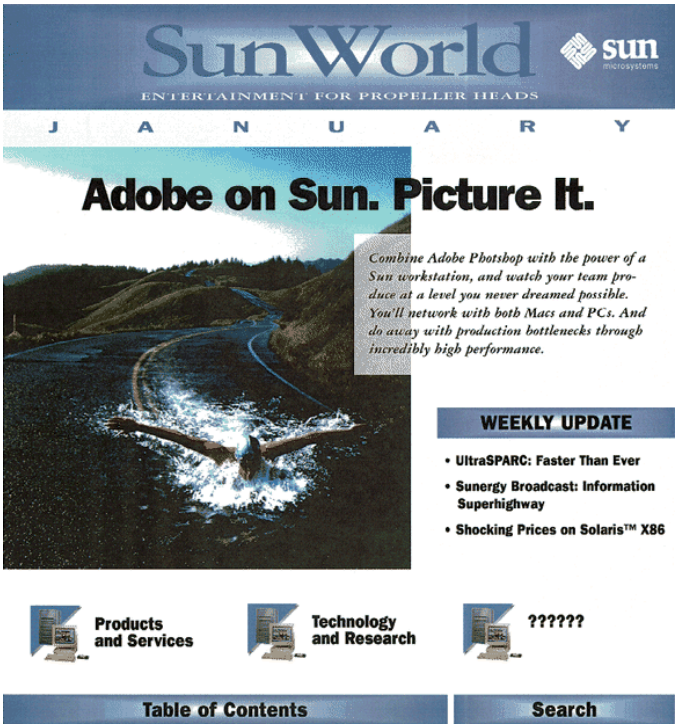


Figure 14.9: SunWWW Design 1, the first attempt at a magazine-style home page. [With kind permission of Jakob Nielsen.]

- Users did not understand they could click on the lead paragraph to get more information about the Adobe story (no affordance for clickability). Likewise for the Weekly Update bar and the three bullet items.
- The striking colours in the photo seemed to clash with the rest of the screen design.

SunWWW Feedback 2

- The month name was now more prominent and was seen by the users. They all liked the fact that the page was dated.
- The blue {MORE} button made it clear there was more information.
- They understood that "News and Commentary" was clickable.
- Users still believed it was a page about Adobe – the Sun logo was made much more prominent on subsequent designs.
- Users generally liked the design: "pretty," " nice looking," "looks professional".
- A few users thought that they could only click on the "News and Commentary" bar and that the individual stories were not clickable.

SunWWW Feedback 3

- Users were still having problems understanding the status of the page compared with other things called SunWorld (a Sun trade conference).

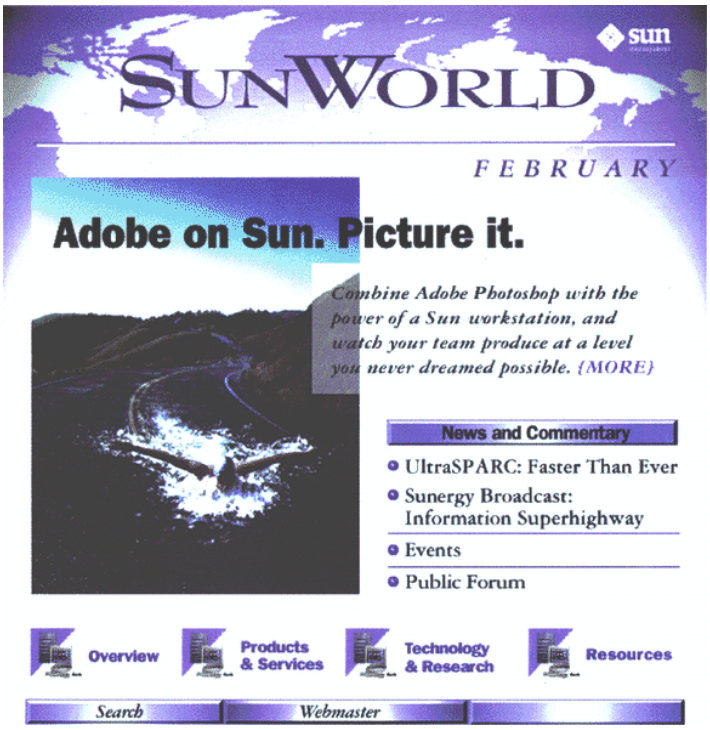


Figure 14.10: SunWWW Design 2. [With kind permission of Jakob Nielsen.]

Figure 14.11: SunWWW Design 3. [With kind permission of Jakob Nielsen.]

Figure 14.12: SunWWW Design 4. [With kind permission of Jakob Nielsen.]

- We decided to get rid of the name SunWorld for the home page. (and consequnetly also the world map as its graphic identity).

SunWWW Feedback 4

- This design succeeded in making the Sun logo prominent.
- However, it overwhelmed users with buttons, giving them too many options.
- All the buttons have equal priority, a "laundry list interface".

SunWWW Feedback 5

- New cover story about HotJava.
- The test users did not like the "Duke" illustration.
- First design with real icons for the various buttons. Some of the user comments are shown in Table 14.3.
- Some icons are larger and more colourful than others to indicate prioritisation.

SunWWW Feedback 6

- New coffee cup design for HotJava.
- No underlay under top three stories for simpler design.
- Blue text and bullets were perceived as clickable.

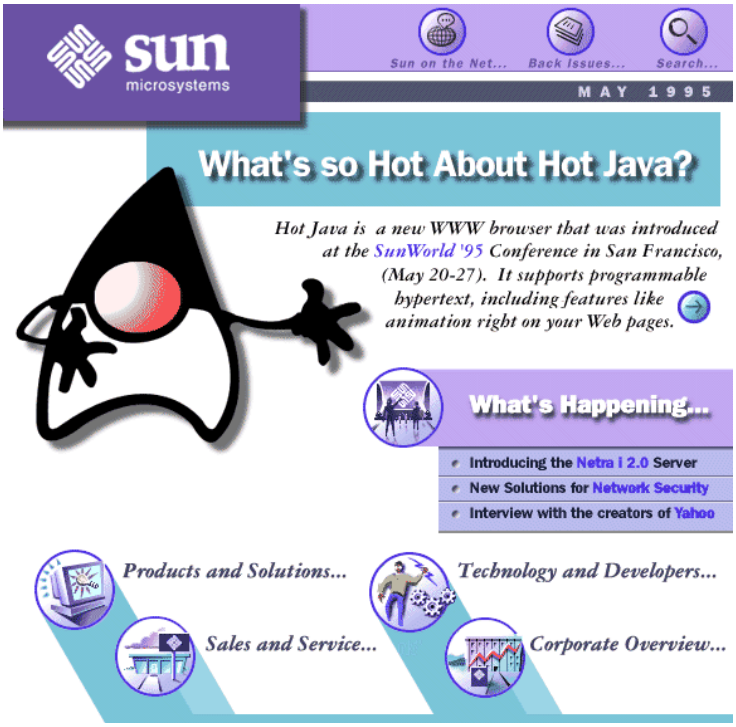


Figure 14.13: SunWWW Design 5. [With kind permission of Jakob Nielsen.]

Icon	*Intended Meaning*	*User Interpretation*
	Sun on the Net	"a punctured balloon", "a snowman", "a talking collapsing world", "an idea coming out of a globe".
	What's Happening	"a parade", "people at a Sun launch", "an intensely ugly logo with people in front of it".
	Sales and Service	"gas station", "diner", "public restroom", "store to buy Sun equipment", "fast food".
	Technology and Developers	"Thunder and lightning", "electric - looks painful", "person being killed by technology", "dance machine", "why do Sun developers look bug-eyed?".

Table 14.3: User comments on Design 5 icons. [With kind permission of Jakob Nielsen.]

Figure 14.14: SunWWW Design 6. [With kind permission of Jakob Nielsen.]

- However, What's Happening bar was no longer thought to be clickable!
- "Sun on the Net" icon still not working, decided globe had to be round!

SunWWW Feedback 7

- Adding trianlge to What's Happening bar made it clickable.
- "Technology and Developers" icon still looking too much like a thunderbolt.
- "Corporate Overview" icon perceived as "Sun's headquarters suffering earthquake damage" and "a fever chart".
- "Sun on Net" icon now round but still misinterpreted: "astronaut in space suit", "an olive", and "a golfer trying to hack his way out of the rough"!

SunWWW Feedback 8

- Triangle on What's Happening button a bit too dark to really look engraved.
- Also, our first professionally illustrated coffee cup looked too much like a nuclear explosion.

SunWWW Feedback 9

- At last: the perfect home page :-)

Figure 14.15: SunWWW Design 7. [With kind permission of Jakob Nielsen.]

Figure 14.16: SunWWW Design 8. [With kind permission of Jakob Nielsen.]

Figure 14.17: SunWWW Design 9. [With kind permission of Jakob Nielsen.]

Figure 14.18: All Nine Iterations. [With kind permission of Jakob Nielsen.]

14.3 MSWeb: Microsoft Intranet Site

Redesign on Microsoft Intranet site:

- Vivian Bliss; *Redesigning the Microsoft Corporate Intranet*; http://argus-acia.com/acia_event/bliss_session.html

14.4 Designing Web Applications

Web applications, typically implemented in Java or HTML and Javascript, help users get specific tasks done, such as accessing their bank account or signing up for health insurance benefits.

Here is the story of one such design effort:

- Bruce Tognazzini; *Trials and Tribulations of Web Application Design*; http://asktog.com/maxscrns.html

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