CHAPTER 1

Information Architecture: Definitions and Scopes

Information architecture is an exciting area of study that is growing in importance in academics, industry, as well as everyday life. As we all interact with technology everyday—websites, search engines, mobile apps, smart car apps, or smart home devices, why do we have a good experience with some of them but not others? Who creates and designs these things that make our life pleasant (or miserable)? How can we structure information in a usable way so that we can all find it when we need it? Clearly, it is valuable to study the "space" between technologies, human cognitive abilities, information content, and the context of use. Enter Information Architecture (IA), which now is becoming an emerging interdisciplinary field that is rooted in website design, information design, user experience design, information organization, information access, and information use.

1.1 DEFINITIONS OF INFORMATION ARCHITECTURE

Like many other emerging disciplines, there exist many definitions of information architecture. Let's start with a look at a few examples of the definitions first.

1.1.1 WURMAN'S DEFINITION OF INFORMATION ARCHITECT

One cannot talk about information architecture without mentioning Richard Saul Wurman, who coined the term "Information Architecture" or, at least, brought it to wide attention in the 1970s. Wurman was trained as an architect and skilled at graphical design, but "making information understandable" has been "the singular passion of his life." He sees the problems of gathering, organizing, and presenting information as closely analogous to the problems an architect faces in designing a building that will serve the needs of its occupants. His definition of information architects emphasizes the *organization* and *presentation* of information (Wurman, 1996).

> *"(1) The individual who organizes the patterns inherent in data, making the complex clear. (2) A person who creates the structure or map of information which allows others to find their personal paths to knowledge. (3) The emerging 21st century professional occupation addressing the needs of the age focused upon clarity, human understanding, and the science of the organization of information."*

Wurman explains, "I mean architect as used in the words architect of foreign policy. I mean architect as in the creating of systemic, structural, and orderly principles to make something work." The job of information architects is more focused on "making the complex clear" through better organization and presentation of information.

1.1.2 ROSENFIELD AND MORVILLE'S DEFINITION

While Wurman insightfully bridged *information* with *architecture*, it is Louis Rosenfield and Peter Morville who brought information architecture to the mainstream with their popular "polar bear" book on information architecture (2015). Now in the fourth edition (with Jorge Arango as an additional author), the authors took a multi-perspective approach to define information architecture.

- The structural design of shared information environments.
- The synthesis of organization, labeling, search, and navigation systems within digital, physical, and cross-channel ecosystems.
- The art and science of shaping information products and experience to support usability and findability, and understanding.
- An emerging discipline and community of practice focused on bringing principles of design and architecture to the digital landscape.

The first bullet is a very broad perspective on information environments with an emphasis on "structural design." The second bullet specifies the scope of information architecture in the digital and physical information space as well as the cross-channels. The third highlights the relationship between information architecture, usability, findability, and understanding of information. The spirit of IA as a discipline is well represented in the fourth bullet—bringing principles of *design* and *architecture* to the *digital landscape*. It also explains why information architecture became a discipline in the web environment, although the IA related work existed long before the World Wide Web era. And it continues to evolve.

1.1.3 PERVASIVE INFORMATION ARCHITECTURE

We live in a world of complex information environments. Besides websites, more information devices such as televisions, car dashboards, and mobile apps become more interactive and linked to each other, and social media becomes more prevalent—people are using, creating, and sharing more and more information in multiple channels or cross-channels. In their book, *Pervasive Information Architecture*, Resmini and Rosati (2011) emphasize that, as the information environment evolves, "information architecture was moving into uncharted territories, becoming a boundary practice whose contributions were crucial where complexity, unfamiliarity, and information overload stood

in the way of the user, regardless of the very nature of the environment being designed. Information architecture was moving beyond the confines of the web." Thus, their definition of information architecture underscores information architecture as a process and service design, involving designing multi-channel and cross-channel user experience.

1.1.4 ENTERPRISE INFORMATION ARCHITECTURE

Information architecture has a special meaning to organizations and institutions. In addition to organizing and using information, IA in organizations involves architecture and implementation and management of key information assets, thus a special term, Enterprise Information Architecture. Newman et al. (2008) define *Enterprise Information Architecture* as "part of the enterprise architecture process that describes—through a set of requirements, principles and models—the current state, future state, and guidance necessary to flexibly share and exchange information assets to achieve effective enterprise change." In their article, they further explain each component of this definition and outline challenges of information architecture in the enterprise environment. Essentially, the roles of information architects in enterprise include designing, integrating, and aggregating information spaces/systems and facilitating information sharing and collaboration in order to foster enterprise culture, improve productivity, ensure quality of custom service and competitive advantage, and support business profitable growth and innovation. Enterprise information architecture itself has become an important domain of study in the business world.

1.1.5 THE DEFINITION USED IN THIS BOOK

In the above, we provide snapshots of different definitions of information architecture, from pre-web, web-centric, to the post-web era, and to the enterprise environment. A common theme of the evolution is from information-centric to user-centric, thus the definition we use in this book:

> Information architecture is about organizing and simplifying information for its intended users; designing, integrating, and aggregating information spaces to create usable systems or interfaces; creating ways for people to find, understand, exchange and manage information; and, therefore, stay on top of information and make the right decisions.

Information architects not only design individual information spaces (e.g., websites, software, applications, intranets) but also tackle strategic aggregation and integration of multiple information spaces, including all channels, modalities, and platforms. They not only organize information but also simplify information for better understanding. Finally, the goal of IA design is not only to support people to find information but to manage and use information.

This definition serves as the common theme for all the chapters/topics in this book. At the end of the book, we will revisit this definition again.

1.2 FROM WEB DESIGN TO INFORMATION ARCHITECTURE

The rise and rapid evolution of the web has brought many opportunities and challenges for users and designers. The user population has grown exponentially from originally academic users to virtually everybody, from young children to elderly people. User needs have expanded from viewing information only to taking actions and contributing to the site's information content and architecture. At the same time, user expectations of the web, websites, and search engines have risen accordingly. For example, more people expect search engines to be answer engines—giving the answer right away instead of just showing pages that have the potential to provide answers; people assume that any answer should be available on the web. The web is no longer just made up of hyperlinks for people to browse; it is the place for people to hop on as a routine, conduct daily activities, connect with others, and experience and influence the world.

As the breadth and depth of people's interaction with the web evolves, the boundaries between the physical world and cyber space are blurring. The needed information architecture work organizing information—connecting information objects and intended users, identifying pathways for people to navigate, creating tools and rules for people to organize information on their own and collaborate with their others, and integrating and aggregating various information spaces, applications, platforms, and channels—becomes so critical and ubiquitous. At the same time, because cyber space is so intertwined with every aspect of people's lives, information architecture alone can no longer fulfill all the sophisticated user needs—the information needs to be relevant and understandable; the space needs to be organized and explorable; the interaction needs to be efficient and engaging; the overall experience needs to be pleasant, effective, engaging, and trustworthy.

To accomplish these goals, information architects work closely with many other disciplines to ensure all the issues are taken care of and all challenges are met. Only when all the related disciplines fully leverage their expertise and skillsets, can the overall user experience be made possible. This brings the convergence of multiple disciplines as User Experience (UX) Design (Garrett, 2002), including usability/human factors engineering, interaction design, graphical design, information architecture, and many more.

1.3 INFORMATION ARCHITECTURE AND RELATED DISCIPLINES

Although many of the above-mentioned disciplines originated in different contexts aiming to solve different problems, the evolvement and expansion of the web brings them together. *Usability engineering* is primarily concerned with human computer interaction, and its goal is to make sure the user interface allows the user to accomplish their tasks effectively, efficiently, and satisfactorily. Usability engineering started before the web era by focusing on the usability of software user interfaces. The web explosion made it applicable to all web applications and websites.

Information science is a very broad interdisciplinary field concerning theories, applications, and technologies related to creation, organization, retrieval, and use of information. It is also the field where Rosenfeld and Morville started developing information architecture methodologies for creating content organization, navigation, and labeling systems. Subdomains of information science that are most relevant to information architecture include users' information needs and information-seeking behaviors, information organization and retrieval, and understanding the content and context of information.

Human factors engineering is the discipline of applying what is known about human capabilities and limitations to the design of products, processes, systems, and work environments. Originating from designs of airplane pilot's dashboards and hardware or physical products, human factors professionals obviously now apply their expertise to digital platforms.

Interaction design is a broad concept that goes beyond computer interface design. Any design that involves people's input and the product's response can be categorized as interaction design, including home appliances, electronics, and even electronic car dashboards. However, the interactivity between the user and the system in software user interface and web applications is so rich and omnipresent that we cannot talk about web design and user experience without mentioning interaction design. In cyber space, it is getting very hard to separate *information architecture* from *interaction design* because they are both concerned with defining the system and user behavior, giving users controls to make sense of things, take actions, and to accomplish certain things. Some people try to differentiate the two by emphasizing that interaction designers can show the dynamic interactions between the user and the system. Information architects can do the same thing if needed. It all depends what can best demonstrate the user experience concepts. People in different organizations may get different titles, but the truth of the matter is certain people on the project teams need to worry about the functional behavior of the system and of the user. These people are doing information architecture and interaction design type of work.

Recently there is a school of thought that argues that IA is not a profession. "There are no information architects, and there are no interaction designers. There are only user experience designers" (Morville et al., 2015). In our perspective, this is not to deny the existence of the information architecture discipline but a desire to strengthen it. The important message in this statement is, though, to call for synergy augmentation between two sub-communities that really belong to the same big community. In practice, the terms "user experience architects" and "information architects" are sometimes used interchangeably. Rima Reda, an "experience architect" (2014). described the connections between experience and architecture, pointing out the many common grounds, including "visual problem solving," which spans several disciplines no matter the label.

Although interaction design and information architecture came from different contexts and backgrounds, they are both landing on the same web wonderland and beyond. They both have

been transformed because of today's technological and social contexts where neither group had previous experience.

Visual design does not only concern itself with the aesthetical aspect of the information space and the user interface. Good visual design clarifies communication and makes the information and interaction easier to understand. Visual designers make the best use of the visual language, such as colors, shapes, layouts, spacing, alignments, and styles, to help reinforce the communication between the system and the user, express emotions, trust, and personalities of the site or application and engage the user in a positive way. Visual designers bring great principles, theories, and best practices accumulated in the print world. By closely working with other disciplines, they help transform design concepts to pixel perfect screens.

Finally, *information design* is another area (Jacobson, 2000) that overlaps with information architecture. While it may not be an established field of study, information design has been used interchangeably with *visual design* or *graphical design* with an emphasis on designing displays for the content or structures of information, thus more closely related to the field of *information visualization*.

In this book, we argue that information architecture is one of the most important elements in user experience design, and information architecture work serves as the glue to stick all the related puzzle pieces together. From a user-centered design process perspective, information architects get involved in the process from the beginning to the end.

- They work with the business to help establish business vision and strategy about the website, the intranet, or the digital workspace.
- They work with user researchers/usability engineers to identify the right research methods and determine the research goals and objectives. Also, they digest research findings and transform them into specific design concepts.
- They work hand in hand with interaction designers to define the interaction model and system behavior. They determine the system functionality and connections between information objects and workflows.
- They work with visual designers to create user experience visioning screens upfront and later convert design concepts into final designs with all visual details in place.
- They also work with development and testing teams to make sure the design gets implemented and functions as intended.

That being said, we think information architecture has had and will continue to have a great role to play in user experience design practices. As information access, sharing, creation, organization, management, and consumption become ubiquitous, the collaboration among all disciplines will become even more critical and necessary.

1.4 SUMMARY

Information architecture is a field with growing importance across all walks of life, as boundaries between the physical world and information spaces blur. IA can be defined several ways, we define it for this book in terms of designing, organizing, and integrating information spaces so that people experience positive outcomes—being informed and making good decisions. Information architects work closely with other professionals, bringing together the pieces of the puzzle needed to create meaningful, functional, and beautiful information spaces.

CHAPTER 2

Information Architecture and Evolving Information Spaces

Online and other digital information spaces are increasingly integrated into everyday life. Today, over three billion people around the globe are connected to the internet, including a large majority in developed countries and an increasing number in developing countries (ICT Data and Statistics Division, 2015). It seems that more and more time is spent "online" as formerly offline activities (like depositing a check or hailing a cab) move to websites and mobile apps. Cellular networks, WiFi, and mobile devices keep connections alive 24 hours a day; while broadband connectivity lets the 1's and 0's that carry information fly around the globe at the speed of light. Mobile, wearables, sensors, artificial intelligence, and "the internet of things" are quickly becoming a bigger part of our lives.

Although it only has a short history, the content and look of the World Wide Web (the web, WWW) and internet, as well as information space design and digital technologies in general, have all gone through several generations of changes. In this chapter we will highlight major changes in this evolution—from a domain of the select few to the connected world many of us live in today, with ubiquitous connectivity and where freedom of internet access is considered a basic human right and a "driving force" in development (United Nations General Assembly, 2012).

Activities in information spaces today can be distributed across time and space, where previously they were bound to a time and location; "formerly clear lines are fading away—between online and offline, internal and external, owned and shared, customer and user, social and business" (Guenther, 2013, p. 10). Examples of this include the following:

- Patrons previously went to the library and retrieved physical books for a short borrowing period. Now, patrons can borrow eBooks online.
- Shoppers browsed the displays at a department store, what was called "window shopping." Now, shoppers can order almost anything online.
- Children used a modem to connect over the family telephone line and signed off so their parents could make a phone call. Now, many homes have dedicated broadband internet access.

In the previous edition of this book, we anticipated the "always on" world that includes the web, mobile apps, social media, medical sensors, home automation devices, and more. Today, inte-

grated information spaces highlight the need for information architects (IAs) to take into account multi-channel use (e.g. mobile apps and desktop), designing for the benefits and limitations each provides. For example, mobile phones include GPS location services that can enhance the usefulness of an app, "show me restaurants nearby," but are limited by the screen size. Desktop computers, on the other hand, have large screens that support word processing and graphic design, but are unlikely used by a hungry person while they are walking through a city.

Information spaces are pervasive and inter-connected (Resmini and Rosati, 2011), accessible anytime and anywhere. Therefore, IAs should work to maximize the benefits, while minimizing limitations, inherent in each channel or device—a task that can sometimes entail what seems like multiple IA for one project. Ideas like responsive design (Marcotte, 2011) help maintain a cohesive experience while maintaining learnability and findability across devices and channels. Although this chapter looks back at past developments, we also see new areas like voice and automated assistants becoming a part of IA in the future.

2.1 FROM THE WEB TO INTEGRATED INFORMATION SPACES

According to W3C World Wide Web Consortium, the first general release of WWW happened on May 17, 1991 (2000). Since then, the web has grown exponentially, with people and devices connecting to each other at an increasing rate while creating, sharing, and consuming information. The web experience was once mostly static content delivered to a user at a computer workstation. Now, interactive content delivered to the user on the device of their choosing is often the norm.

2.1.1 FROM FOUNDATION TO INTEGRATION

Early in its history the web was primarily meant for read-only access, where the majority of users consumed information created by relatively few. The overall arc has moved toward more interaction and creation, demonstrated by social media, blogs/wikis, online office applications, and more. These capabilities increased the utility of web-based technologies, and helped create our "information society" with a "profound impression on the way the world functions" (Executive Secretariat of the World Summit on the Information Society, 2005).

An information society is one where functions of business, education, healthcare, government, and other critical areas exist largely in information spaces. We feel this is a fair description of the state of affairs in many parts of the world. The information society developed over the years through many generations of the web, starting with the technological foundation and resulting in today's integrated era.

Generations

The web has undergone several transitions since its release: from a foundational era where many of the "core" internet technologies were invented and available to those in the know, to the more static but publicly available web1.0, the more dynamic web2.0, and highly interactive "integrated" eras. Below we provide a generalized timeline with selected technology examples that highlight each timeframe.

Table 2.1: Technology development highlights marking eras of internet/web, and related technologies

Internet- and Web-related Technologies	Generation
Modems, packet switching, wide area network, ARPAnet (precursor to the internet), data packets sent between computers, email, handheld mobile (cellular) phones, ethernet, TCP/IP specifications released, the term "Internet" coined, world wide web (WWW, the web) created at CERN	Foundation The domain of scientists and researchers 1958–1990
High Performance Computing and Communication Act of 1991 (origins of the joke that Al Gore invents the internet), WWW opens to public, America Online (AOL), MOSAIC web browser, Netscape web browser, Yahoo!, Amazon.com, MP3s, Internet Explorer web browser, Macromedia/Adobe Flash, Opera web browser, Apache open source web server, Javascript/CSS, Craigslist, GPS made available for civilian uses, WiFi, Netflix, Google, Paypal, Bluetooth	Web1.0 The web opens to the public 1990–1998
Blogs, Blackberry mobile device, RSS, Pandora music streaming, Wikipedia, Napster, Xbox and Playstation online gaming, Firefox web browser, MySpace, Wordpress blogging platform, Delicious social tagging, Skype, Yelp, Second Life, Flickr, Facebook, Youtube, Google Docs, Twitter	Web2.0 The social web, and mobile beginnings 1998–2006
Amazon Web Services (Cloud Computing), SaaS, iPhone released, Chrome web browser, Android mobile OS, Apple App Store, Android market, Roku streaming device, Instagram, iPad, Pinterest, Bitcoin, Nest home automation, Apple SIRI voice interface, Uber, WeChat, Apple Car Play, Android Auto, Amazon Echo voice interaction, Fitbit wearable device, Apple Watch, Oculus Rift virtual reality	Integrated Information Spaces Information society 2006–Present

Table 2.1 above represents the evolution from a generalist point of view. The pre-history of the web, including Vannevar Bush's Memex (Bush, 1945) and other early ideas around information

spaces and information architecture could fill a book of its own. Similarly, many internet developments along the way are left out, like ALOHAnet (Abramson, 1970), PHP/MySQL Server, and Blogspot. However, the trend is clear that we are on a trajectory from one of limited access by specialists to interaction and connections (almost) everywhere for (almost) everyone.

2.2 FOUNDATION

> *In 1971 a team of engineers drove around Philadelphia night after night in a trailer home stocked with sensitive radio equipment, trying to set up the first working cell phone system* (Gertner, 2012, p. 3).

The foundational generation of the web is when many of the technologies that power the information spaces we take for granted were developed at universities and industrial labs. For the most part these technologies were created by and for researchers and scientists who had a vision of a connected future. The book *Where Wizards Stay Up Late*, by Hafner and Lyon (1998), provides an excellent insight into this time, which has its spirit of invention characterized by their passage on Ray Tomlinson's inclusion of the @ symbol in email addresses:

> *"I got there first, so I got to choose any punctuation I wanted," Tomlinson said, "I chose the @ sign." The character also had the advantage of meaning "at" the designated institution. He had no idea he was creating an icon for the wired world.*

This was a time of experimentation and discovery, mostly out of sight of the general public. The internet grew out of ARPAnet, a network of connected computers initially developed for the military and later turned to the civilian uses of research and education. Access at this point was mostly limited to people at research centers and universities. Most people had little reason, or ability to connect. Developments like the World Wide Web by Tim Berners-Lee at CERN and opening of the internet to a wider audience (S.272 - High-Performance Computing Act of 1991) ushered in the Web1.0 generation.

2.3 WEB1.0

Web1.0 is characterized by public access to the web—when the internet really became a thing that many people could use. Graphical browsers like Netscape Navigator and Internet Explorer provided access to multimedia content, although limited by low-bandwidth modem connections. Dial-up providers like America Online and Compuserve, web search engines like Lycos, and portals like Yahoo! provided access to websites for school, work, and play over telephone lines that had long served homes and businesses. Email, chat rooms, and instant messenger apps handled interpersonal messages. Millions of people adopted the web as a place for learning, communicating, connecting, and entertainment.

Most web pages were static, consisting of text, links, and images (JPG or GIF formats) organized by tables or frames. Little more than hyperlinks connected information resources; users navigated around the web to find what they were looking for. Microsoft Windows remained the main platform for computer use, while the web was supplemental. Very little personalization or customization was possible, although database-backed dynamic content grew in importance.

Many of the technologies and companies we rely on today were first used in this generation, including Google, WiFi, and eCommerce. Demand for increasingly interactive websites, and the technology to support them, ushered in a fast-changing digital landscape. Improvements in bandwidth, user interfaces, and social media soon paved the way for increased interactivity in the web2.0 generation, where information architecture started to become more and more important.

2.4 WEB2.0

While the term "Web2.0" (coined by Tim O'Reilly) has fallen out of use, it marked a turning point in the evolution of the web, setting the stage for today's integrated information spaces. Although many existed beforehand, web2.0 popularized and made central to the online experience several technologies, including:

- mashups;
- personalization and aggregators;
- rich internet applications;
- tagging and hashtags;
- wikis, blogs, and social media; and
- web office applications.

So many of these technologies are ingrained in our experiences that we do not differentiate by name any longer, they are just part of "the web," a constant part of our information experience.

2.4.1 MASHUPS

Mashups allow developers to create apps that support users by combining separate technologies into something new (Merrill, 2006; Yu et al., 2008). A prime example is utilizing Google maps to show locations of restaurants and/or businesses, along with reviews (Figure 2.1). The result looks like a new standalone app, but behind the scenes two or more data sources are combined, or "mashed" together. Web application programming interfaces (APIs) enable sites to share their content for use in mashups.

Behind the scenes, APIs consist of "endpoints" that publish data in a format like JSON or XML for other systems to access and reuse (Rodriguez, 2008). Figure 2.2 shows an example of a result for a query sent to the U.S. National Library of Medicine's MedlinePlus endpoint that returned data in XML format. In the query, we asked the API to return results for the term "diabetes" from their Health Topics database. You can try it yourself by following instructions at https://medlineplus.gov/webservices.html.

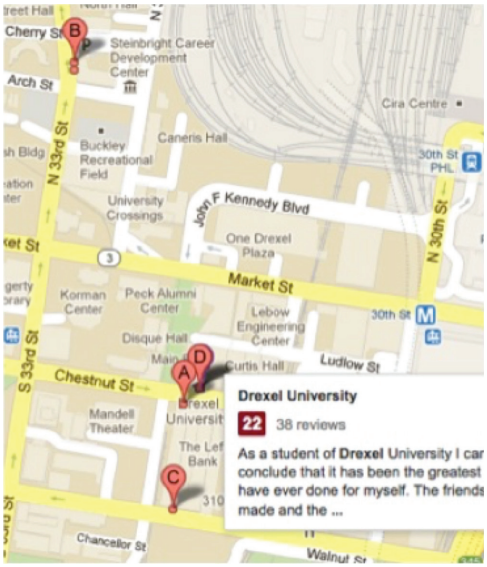

Figure 2.1: A maps mashup combining search, geographic, and reviews data sources.

Figure 2.2: Results in XML format for the API query, https://wsearch.nlm.nih.gov/ws/query?db=healthTopics&term=%22diabetes.

2.4.2 PERSONALIZATION AND AGGREGATION

Many sites in the web2.0 generation allowed users to remix and control data that appeared on websites they visited. Users could manually subscribe to news feeds and blogs, add tools or services, and link applications and arrange them in a meaningful way for personal use. On banking websites, for example, users could add their credit cards and billing information, or track investments from different resources. Example of aggregation websites from this generation include: Netvibes, Pageflakes, iGoogle, and Yahoo!

Corporate intranet sites, in particular, were places where customization and personalization became popular. For example, at a large university the intranet could include course registrations, course materials, financial aid, payroll, and many others. Depending on the user type (student, faculty, staff) different information was available to each user type. Individual users were able to customize and select components, and include news and events or other university content on their

homepage. In addition to the explicit customization described above, some sites also implemented implicit personalization—tailoring the website content based on a user's profile or activity. A good example of this was Amazon.com's ability to recommend new items based on past purchases at their eCommerce site.

2.4.3 RICH INTERNET APPS

Rich Internet Apps (RIA) provided methods for users to interact with information over the web (Fraternali et al., 2010). Although the term has fallen out of favor, RIA features are included in many websites and apps today. Imagine trying to use apps without these features:

- direct manipulation (e.g., drag and drop to move objects/components around on the page);
- immediate system feedback/messaging for error handling or contextual help;
- typeahead text predictions;
- mouseover objects to show additional information;
- automatic saving of user-entered information; and
- refreshing information on parts of a web page without having to reload the entire page.

2.4.4 TAGGING AND HASHTAGS

Tagging gives users the power to label and categorize resources using freely chosen keywords. Compare this to a traditional library, where a professional cataloger assigns a resource into a previously defined category, even when that resource does not fit neatly or addresses several topics. Tags are especially important for categorizing with user-centered, emerging, and event-based keywords, which may not yet (or ever) be in a controlled vocabulary—and in spaces like Twitter where there is no central cataloging authority. IAs can leverage this framework of unstructured tags contributed by users to provide additional access points. Golder and Huberman (2006) found that the application of tags follows predictable patterns; and other researchers found tags themselves can be categorized, such as personalized tags like "toread" (Marlow et al., 2006).

Tags have evolved in many systems to "hashtags," which are labels preceded by the hash or pound symbol "#." Much like the "@" symbol has been coopted by email, the hash symbol is now associated with tags. For example, the hashtag "#PhillyCHI" on Twitter provides access to any tweet a user chose to categorize as related to the Philadelphia chapter of the ACM SIGCHI. Many sites and apps allow users to assign hashtags to information resources. Examples of information spaces

that leverage tagging include Pinterest, Flickr, Twitter, and Instagram (see for example, the Instagram post in Figure 2.3).

Figure 2.3: An image posted by Drexel University to Instagram, with hashtags for related topics (libraryscience, etc).

2.4.5 WIKIS, BLOGS, AND SOCIAL MEDIA

Compared with other web2.0 applications, wikis and blogs (although they existed during the web1.0 era) were more user driven. Wikis and blogs are platforms for individuals to easily express themselves, share ideas with other people, get feedback, and contribute to the public knowledge base in a very dynamic manner. While wikis adopted a democratic model for people to freely collaborate on shared topics of interest (e.g. Wikipedia), blogs allowed authors (bloggers) to self-publish articles and other materials. Company blogs became a creative way for the business to engage and communicate with their customers in a more casual environment. Blog and wikis gave anyone with a connection the ability to contribute their thoughts, ideas, and creativity to the web. Table 2.2 shares some examples of public wikis and blogs. In the corporate enterprise, companies like IBM

also researched these tools (and other social media) for use in behind the firewall, available only to company employees (DiMicco et al., 2008).

Table 2.2: Examples of wikis and blogs

Wiki	Blogging
Wikipedia	Blogger
Wikitravel	Tumblr
Wikibooks	Wordpress

Social media helps people connect, share, and keep in touch with close friends and family and a wider range of acquaintances. Examples of social media sites include Facebook, Twitter, Flickr, and LinkedIn. Users can post updates and information including text, images, and video—while also reading and reacting to their network's activities. Social media sites are used for general networking like Facebook and Twitter, for topic-specific activities like Flickr (photography) or LinkedIn (business connections). There are even social networks for people with similar medical conditions, such as PatientsLikeMe, where users can share information on treatments and emotional support.

2.4.6 WEB OFFICE APPLICATIONS

Web office apps provided word processing, spreadsheets, and other productivity software through a web browser. This connected experience gave users the ability to work on a single document stored online with multiple devices. Office 365 and Google docs are popular examples of web office apps today. Collaboration emerged as a prime benefit, several authors could edit a single document instead of emailing copies back and forth. Web office apps helped to pave the way for cloud applications, and the growth of the Software as a Service (SaaS) industry.

2.5 INTEGRATED GENERATION

Building on the web2.0 era, technologies in the integrated era are generally liberated from a specific device or location. Where at the web's release a computer with a wired connection was required, Wifi and wireless (cellular) networks today provide a connection in most of the developed and much of the developing world. Mobile continues to grow; a 2016 report by the Pew Research Center finds 72% of people in the U.S. own a smartphones (including over 90% of those aged 18–34); while South Korea leads the surveyed countries, where a reported 88% of the population (and a remarkable 100% of 18–34 year olds) own a smartphone (Poushter, 2016).

Even automotive companies are in on the act; below is some copy from Chevrolet advertising the WiFi features of their cars:

> *Our stronger signal means you have a fast and reliable connection. Stream movies and TV on the go, or even play games. And so you know, the built-in WiFi hot spot is powered by your vehicle, so you don't have to worry about your mobile device battery. That way, you can keep the action going* (Chevrolet, n.d.).

In short, many people are almost always within arm's reach of a device with a web connection, ready to search or create new information, connect with friends and colleagues, or be entertained. Sensors and wearables connect and provide information even without explicit interaction. Given the demographic trends, expect that all types of connectivity will continue to grow in both developed and developing countries, for all sorts of technologies (Figure 2.4).

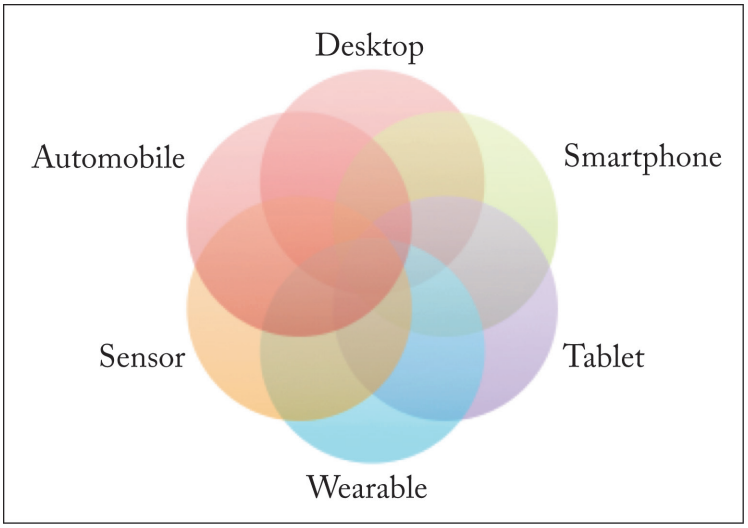

Figure 2.4: Integrated information spaces.

The integrated era is characterized by technologies and concepts, such as:

- artificial intelligence/automated assistants;
- cloud;
- mobile;
- sensors and the internet of things;
- wearables; and
- ubiquity and user-centered design.

2.5.1 ARTIFICIAL INTELLIGENCE, AUTOMATED ASSISTANTS

Now that we live in a world of information overload, technology is helping us sort through the noise to find what we want. The ever growing landscape of technologies leads to the need for ever "smarter" assistants or agents (Maes, 1994). Examples of popular assistants that utilize artificial intelligence (AI) include: Siri (Apple), Alexa (Amazon), Google Assistant, Cortana (Microsoft), and Watson (IBM).

Assistants are intended to appear "smart." They rely on machine learning and artificial intelligence to efficiently complete routine tasks, and provide answers the user may not be able to find on their own. In fields like medicine, IBM's Watson provides answers for doctors who input symptoms; while in the home assistants can help automate tasks, share reminders, and help other aspects of day-to-day life.

2.5.2 CLOUD

Cloud computing provides two major benefits. First, access to large amounts of storage and second, access to powerful computer-processing hardware over the internet. Web office apps, games, and others all take advantage of these capabilities. The entire SaaS industry, for example, is built to provide business services "in the cloud" to millions or billions of users. As software and storage is no longer limited to a user's device, new opportunities for collaboration open up. Additionally, startups can leverage "enterprise class" hardware, without great up-front costs, opening the door for entrepreneurs to launch innovative businesses at a large scale.

Big tech companies like SAP, IBM, and others have as a key part of their strategy moving their services from an installed base, requiring a client to purchase or lease many servers and copies of individual software, to "the cloud." Cloud also means updates can be "pushed" to clients without the need to install anything new. Google docs and Zoho paved the path toward the wide acceptance of online productivity apps, and now almost any task can be completed "online." Major cloud providers include: Amazon AWS, Microsoft Axure, and Google Cloud.

2.5.3 MOBILE

Mobile devices are almost everywhere today, making it hard to believe that they are a relatively new invention. Beginning with the release of the iPhone in 2007 (although devices like Blackberry preceded it), smartphones became mainstream devices. Supported by cellular data, mobile devices took off quickly and now account for a large percentage of user's "screen time." In fact, many people reach for a smartphone even when a more "capable" device like a laptop computer is nearby. Mobile opened up a whole new world of interactions for IAs to explore, including components like GPS and cameras, apps able to leverage those components in new ways, and as an always on device they

support push notifications and event-based interactions. Because mobile devices are not typically shared, they support personalization and customization based on the user's preference.

2.5.4 SENSORS AND THE INTERNET OF THINGS

Perhaps the best experience with information spaces is one in which the technology seems to "disappear" (Weiser, 1991). In addition to systems supporting information creation and consumption by human users, sensors and "the internet of things" opens a new world of "invisible information architecture" by connecting items like automobiles, home thermostats, and even refrigerators to the web. One day (soon?) a refrigerator will tell the user they need milk, or even automatically order it to be delivered by an Uber driver at a time the user is home to accept delivery, based on the user's calendar (accessed as a web service mashup). Of course, with drones even the Uber driver may one day be unnecessary.

2.5.5 WEARABLES

Wearables, like Fitbits and Apple watches, generally need to connect with another device like an iPhone to perform all their functions. Sometimes they are used to collect biometric data, like heart rate, and are now advanced to a point where text messages and alerts can appear. While the future appears bright for these devices, from an IA standpoint they tend to be extensions of other devices and apps for the time being. However, they are now part of the information landscape and should be considered in projects as an opportunity to expand IA. In the future they may be decoupled from other devices.

2.5.6 UBIQUITY AND USER-CENTERED DESIGN

In developed countries today there is an expectation that people are connected. Tax forms and other government documents are online. Banking and essential services are conducted through online apps. On a college campus, students search for resources on a library website and download them instantly. For most technology users it is probably more common for a device to be connected than not, providing opportunities for IAs to leverage the capabilities brought about by broadband, cloud, and other technologies. IAs help information spaces work for people by adopting a user-centered approach. This means the users' goals and needs are researched and balanced against the desires of a business or technology limitations. The aim is to make sure people can effectively use the system, and have a good experience. The next chapter covers IA and user-centered design in depth.

In the integrated era, information systems are everywhere—from the home to office and anywhere in-between. Televisions, kitchen appliances, and even Bluetooth-connected showerheads have gotten in on the act. By designing for the information behaviors, user interactions, and adopt-

ing the design patterns and principles which we discuss in later chapters, IAs can help mitigate information overload and produce readily learnable interfaces.

Table 2.3: Three generations of the web

	Web1.0	Web2.0	Integrated
Purpose and Motivation	Web presence and eCommerce	User participation (e.g., wikis, blogs); harness collective intelligence	Connect data contextually and semantically; access anytime, anywhere; connect, create, and share
Platform	Windows is the platform; web is supplemental	Web is the "platform"	Information society
Major Ways of Information Access	Web directories (e.g. the original Yahoo!) and earlier search engines (e.g. Lycos, InfoSeek, and AltaVista)	Search engine with popularity-based ranking (e.g., Google); aggregators	Context-sensitive and personalized; data decoupled from device, linked data over the semantic web
Personalization Customization	On individual sites	User-controlled customization across sites, e.g., site aggregators	Context-sensitive personalization and customization
Information Architecture	From less structured links to structure provided by the site owner	Emergent IA based on user activities/ participation	Integration of displays, devices, content structure, linked data, and usage data
Navigation	In-line links, frames pre-determined navigation	Dynamic navigation based on participation	Context-based browsing and links
Look and Feel	Text heavy with some graphics, frames, and tables	Consistent look and feel; branding design; user experience design	Responsive design and interactive interfaces; voice and automated assistants
Web and Apps	Page-based application	Server-driven web applications and pre-compiled web applications	Linked web and mobile apps perform many essential functions in society

Content and Interaction	From static content to database-backed dynamic content	RIAs without page refreshing	Distributed linked data; second screen, user journeys over time and across devices
Modalities and Media Types	From text only to multi-media	Multi-modalities and channels aggregated by the web	Video, mobile, information overload
User Activities	Multiple sites via directories, portals, or search engines; information seeking	User contributing content and tags; communities based on common interests	Participation in the information society

2.6 SUMMARY

Users can create, consume, and connect at ever increasing rates in our integrated era (Table 2.3). Underpinning these advances are previous generations of the web (see Table 2.1) that laid the groundwork for today's information society. Technology predictions are notoriously unreliable, but current trends point toward artificial intelligence and automated systems becoming more integrated into the digital landscape.

Information technology is an industry of constant change and disruption. We included a history of the generations of the web because we feel it is important to look back and understand that human beings invented all the technologies we take for granted, and today we build on what has come before. Information architects will have a large hand in "inventing the future," and should learn to adapt and leverage the right technologies in the right contexts, while also keeping an eye toward creating the new and unexpected.