CHAPTER 8

SCOUT THE LAY OF THE LAND

Understanding the Broader Context of a Design Project

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Learning Objectives

So that you can guide student design teams on real needs of clients, upon reading this chapter you should be able to

• Identify a broad range of factors to consider in understanding the context of the design solution, including geographical, economic, and cultural factors and human, material, and environmental resources
• Identify processes and sources for learning more about the context of the design task
• Synthesize the information that is collected into a form that is useful
• Use information about the context to develop clear and measurable criteria for the design task
INTRODUCTION

In the previous chapter the importance of gathering information from stakeholders was discussed. However, in order to clarify the task more fully, designers need to also take into account the contextual components of the artifact being designed, such as the geography, economy, cultural norms, material resources, human resources, and environmental resources. This information helps the team create a coherent and cogent description of purpose and a scope of the design need or opportunity for a particular problem in a specific location. After collecting this information, the design team establishes a set of criteria by which possible alternative solutions are evaluated and compared (Chapter 11), and the final outcome is judged by the client, user, and other stakeholders (Chapter 13).

This chapter will focus on working with students as beginning designers who are attempting to develop informed design practices, by guiding the students to explore, comprehend, and frame the problem thoroughly. Building on the techniques of gathering client information presented in Chapter 7, the exploration continues into areas where the users or stakeholders may or may not have information to share. These issues may not come to mind for the users during interviews either because they are so immersed in the environment on a daily basis that they do not see the details and possible design problems, or because they are located in a different area and are unaware of issues related to a particular location.

COMMON CHALLENGES FOR STUDENTS

Beginning students often take a narrow view of a design project, considering it a technical task rather than a human undertaking with social and environmental consequences and considerations. A common description of an engineer is, indeed, a problem solver. However, this is a limited vision of an engineer. Too often students focus on the solving part of design work, rather than deeply understanding the problem. As a result, they might end up solving the wrong problem, or develop solutions with critical errors because a particular constraint was not well understood. It may be that they don’t recognize the importance of understanding the broader context, or that they don’t have the necessary tools to do so. We do know that female engineering students seem to be more concerned about the broader context than their male counterparts as freshmen, but this gender difference disappears by the time they finish college (Kilgore, Atman, Yasuhara, Barker, & Morozov, 2007).

As an example to illustrate these challenges, imagine that you were asked to design a playground for your neighborhood. What are all of the different things you would consider? What types of information would you want to have? Now imagine that you were asked to design a retaining wall system to prevent flooding of a large river. What are all of the different factors you would consider in this case?

Kilgore et al. (2007) found that students tend to think about a relatively short and narrowly focused list of things they would consider in designing a playground, types of information needed for designing a playground, and factors for designing a retaining wall. For example, for the playground problem, students mostly considered the overall cost of the playground, the safety of different activities, and the amount of time it would take to create different pieces of equipment. In a related study, Atman and her colleagues found not only that students who made more information requests and gathered more types (cate-
categories) of information tended to have higher-quality solutions (Atman, Chimka, Bursic, & Nachtmann, 1999), but that the number and variety of information requests increased with experience as measured in populations of first-year students, seniors, and professional engineers (Atman et al., 2007). In contrast to the three main types of information requested by novices, advanced students and experts considered information related to all of the following: accessibility, safety, material costs, budget, material specification, information about the area, labor availability and costs, body dimensions, utilities, technical references, legal liability, maintenance concerns, neighborhood opinions, neighborhood demographics, availability of materials, and supervision concerns.

In another study, Wertz, Fosmire, Purzer, and Cardella (in press) analyzed reports students created for a design project for a first-year engineering course to investigate the types of sources students access while working on design projects, the students’ ability to cite the sources appropriately, and students’ ability to use information appropriately (i.e., to use information that is relevant and to use information to support their reasoning). The results from this study show that students mostly relied on Web resources and that their documentation skills were weak. However, when students did successfully document information, it was generally used appropriately. Thus, two other challenges for educators are (1) to prompt students to make use of many different types of resources, not only electronic ones; and (2) to reinforce documentation skills (such as using APA, MLA, or CBE format). This might be a matter of reminding students that these skills are not only relevant for their English or communication classes but also are important in their acculturation as ethical, professional engineers (see Chapter 5).

WHAT INFORMATION IS IMPORTANT? WHY?

Professionals (such as engineers, lawyers, doctors, and nurses) look for information based on specific needs (Leckie, Pettigrew, & Sylvain, 1996), and research shows that professionals consider many more needs related to a project than do novices. It is critical for novice engineering designers to understand and recognize which facets of the problem require additional information before they jump into generating solutions (Bursic & Atman, 1997; Crismond & Adams, 2012). Finding the right sources of information helps fill the knowledge gaps in any design project. It is also important for designers to realize that information gathering is a process that is likely to be revisited throughout a project as the team explores possible solutions and continues to interact with the clients and other stakeholders. Categories of information that influence design include geographical, economic, and local and cultural contexts of the problem. Design teams should also look at availability of resources, both human and material, in the location where any potential solution will be implemented.

REALITY CHECK 8.1

A team of engineering students was given a project to provide a play space in Ghana. They started to brainstorm solutions, figuring out what they could build out of mud, twigs, grass, and animal skins. They were quite surprised when introduced to the community to find it had modern tools and even (intermittent) electricity.

They students hadn’t bothered to figure out what materials were available, if the project had a budget, or the types of play activities that were common in Ghana. What should the students have done differently?
Revisiting the playground example, there are many types of resources that will help the student get a complete understanding of the problem and the context for the solution. Some examples of contextual information include city or county building and zoning ordinances, culture of the community near the proposed location, budget, existing site conditions (grass, asphalt, pitch, drainage), local climate, and accessibility of the site for workers and future users. Various questions or considerations around budget can produce additional constraints or opportunities in a design project, be it finding additional or different equipment, or using a contractor or local volunteers for construction and/or installation.

For the retaining wall example, historical information that could be helpful in making design decisions includes water levels and volume of the river in question, history of flood and high water mark, frequency of flooding, seasonal variations in water flow, type of land, and occupants of the floodplain (e.g., farmland, petroleum refining plant, other manufac-

![FIGURE 8.1 Relational diagram for information needs of the playground design project.](image-url)
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Additional potential concerns include type of soil along the river and how easily it erodes, any communities or landowners who would be affected by the retaining wall, any aesthetic issues or concerns about the wall, and landowners whose property may be impacted. Human resources include the level of education/training of people involved in the project. (The information to be gathered from and about the people/clients related to the problem is discussed in Chapter 7.)

One way to get a more sophisticated sense of the types of information that are necessary for a complete contextual understanding is to use a concept diagram. These diagrams look a bit like part of a data flow chart, helping map where information comes from and what sorts of information are needed in consideration of the design project. Figure 8.1 shows a context diagram for the playground example.

CONTEXTUAL INFORMATION

As discussed in Chapter 7, the client can explain why the design project is being carried out and potential users have the most direct understanding of the need and community expectations. It is likely that conversations with the client may generate context concerns unknown to the user. Designers need to make notes about these issues and make sure they gather as much context information as possible on those topics.

Every design project takes place in a specific cultural context. This includes the prevailing local socioeconomic conditions, which can be discovered by reference to national, regional, or local statistical data and studies. Aspects of the broader cultural conditions are implicit in the problem statement provided by the client, but this needs to be made explicit. It is important to determine what practices are considered normal or are forbidden by local custom of the primary user population. In the playground design, is the local neighborhood culture one where the children regularly gather and play together with only a few parents watching the group, or is the practice more about a small number of children gathering with all parents being present? The culture of an area becomes very important when the designer is working outside of a familiar situation or when the site is remote and cannot easily be observed. When this is the case, information sources include published information about a given culture and input from people who have been to the location. It also includes information that may come up in the cultural review, such as whether the community has a pattern of recycling that needs to be supported or restrictions on the number of people that can occupy an indoor space based on the limits of the current air handling system.

Historical information is a resource for possible solutions that have been proposed by others for a similar situation. Finding what has been done before and evaluations of what did or did not work are all important pieces of information to have before moving on to making a design decision. Techniques and locations for gathering this kind of supporting information are articulated in Chapter 10.

Environmental considerations include geographical and climatic information. It is imperative for designers to fully understand the location, so one should not depend solely on the stakeholders but observe the location while the people are using existing facilities. If something appears different than what the users stated, one should go back and ask for clarification and gather external information about the area. The geographical context includes the physical conditions of the site and the nearby areas. For
example, Is it an indoor or outdoor setting? Does the construction need to work with an existing structure or is it a new construction? Is the construction site easily accessible for people and any required machinery? Outdoor issues can include annual snowfall, rainfall, wind, or sunshine. These are all important considerations, particularly for outdoor constructions such as the playground. Part of understanding the location and developing design constraints includes determining any local building regulations and codes. For the playground example this could include setback from the road, materials and paints considered safe around children, or height restrictions.

Of course a core consideration is the economics of the project across its entire life cycle. Budgets for design projects need to contain much more than just the cost of materials for whatever solution is finally selected (see Chapter 12 for more on material selection). For the playground example, the designers need to know if the land is already available or whether a site still needs to be identified and land purchased. Beyond purchase of equipment or materials, there are construction and/or installation costs and landscaping to ensure proper drainage of the land, safety of the children, and aesthetics. Another cost frequently overlooked is a consideration of any ongoing maintenance fees for equipment, power fees for lights, or city water fees for restrooms.

Legal information includes any applicable building codes—state, national, or international—that need to be followed, along with any local ordinances. Local governments may have laws concerning road setbacks, building height restrictions, or zoning requirements about the type of use a particular space can support. Additional legal requirements may arise from the contract that was signed.

One additional context component that needs to be considered is infrastructure. This includes a variety of information that will provide both criteria for any design solution and opportunities or ideas unique to a particular location. Criteria will grow out of information about local utilities, availability of services, and costs to connect with an existing infrastructure as well as maintain an ongoing service. Opportunities are likely to arise from discovering local businesses and services that make the design solution easier to implement through locally sourced materials or more appealing to the community through safe walking access and nearby amenities.

Material data sheets and vendors of commercially available materials components are primary sources of materials cost, as outlined in Chapter 12. Additionally, local availability of materials may be a consideration, especially with the growing interest in sustainability. Using locally sourced materials or native species (in landscaping) can decrease the environmental impact of the artifact being designed. Local labor costs can vary by location and the range of specialized skills required. In a case like the playground, consideration can also be given to local volunteer labor that may be available for construction. The cost of transport to site and specialist equipment needed for construction (e.g., earth moving equipment or cranes) should be considered.

Locating Contextual Information

The design team will need to determine which of the categories discussed in the previous section—cultural, historical, environmental, economic, legal, infrastructural—are most relevant to their particular project as they develop a strategy for acquiring needed contextual information. Table 8.1 summarizes contextual aspects and types of information rather than specific items or sources. Later chapters in this handbook provide details about differ-
ent sources and what kind of information they contain.

It takes time to find relevant and trustworthy information. Just like the design process, gathering context is not linear. Any of these contextual information gathering steps could uncover information that causes the designer to review a previous set of information and add detail. The more information that can be gathered, and the more understanding the designer has of the overall problem, the more complete and satisfactory the final designed artifact will be.

**Assessment of Information Gathering/Context Setting**

One method of assessing the quality of information gathering is through peer evaluation of mini-presentations of the design setting and concerns. In a design class, teams working on other projects can provide external perspectives and help identify gaps in the contextual setting. Students can also create a problem statement document, referenced appropriately, that reflects their understanding of the contextual considerations. This document can be used formatively as the first step in an iterative process of problem refinement.

**USING CONTEXT IN FRAMING THE PROBLEM**

Once a student (or designer or engineer) has gathered information about the larger context, that information needs to be used to inform design decisions. Two tools that can help in the process of synthesizing the information are scenarios and storyboards. A third related tool is a persona. Designers create personas to synthesize the types of information collected about users and stakeholders into a fictional person (where the key to the practice is that the persona is not purely fictional, because the creation of this “person” is based in the evidence of the collected data about the stakeholders). Chapter 7 provides an overview of this design tool; in this section we describe how personas are used with scenarios and storyboards.

**Scenarios**

To complement the personas that the designer has created to embody the information collected about the stakeholders, the designer can create a scenario to synthesize information collected about the larger context of the design project. A scenario can be understood as a short story, where the persona is the starring character, and the crux of the storyline focuses on the persona’s interaction with the product or process being designed. However, it is essential that the short story is not based in pure fiction, but instead that the details come from contextual information. At times the designer might focus the scenario on the user’s life or experience prior to the introduction of the new artifact that has been designed (and so the story brings to light the user’s unmet needs), while at other times the designer might instead create the scenario of how the new artifact is experienced by the user. It is also common for the designer to create both types of scenarios, as a before-and-after set (Preece, Rogers, & Sharp, 2002; Rosson, & Carroll, 2001; Stone, Jarrett, Woodroffe, & Minocha, 2005).

A scenario can summarize and remind designers of the different factors they should take into account in their design process. Students can review the example scenario provided in Box 8.1 and list all of the factors they would take into account if they were designing a
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The appeal of the playground. Will children want to go there?

Location within the neighborhood. Will families walk or drive? How much parking is available?

Places for parents to sit.

Shade.

Ability to accommodate activities for children of different ages, activities that children of different ages can do together, and activities that keep 10 to 15 children occupied at the same time.

Storyboards

An alternative way to tell the story is through storyboards. Storyboards are a series of images and captions that provide a more visual summary of key features of the context in which the artifact being designed will be used, and

<table>
<thead>
<tr>
<th>Type</th>
<th>Example Design Information</th>
<th>Example Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural (including socioeconomic)</td>
<td>Demographic data&lt;br&gt; Average income; income distribution&lt;br&gt; Local employment statistics&lt;br&gt; Ethnic neighborhoods—cultural norms&lt;br&gt; Residential vs. commercial spaces ratio&lt;br&gt; Attitudes to public facilities</td>
<td>National Census Data&lt;br&gt; Reports of state or regional agencies&lt;br&gt; Bureau of Labor Statistics&lt;br&gt; User community observation&lt;br&gt; Observation (photographs, frequency counts)</td>
</tr>
<tr>
<td>Historical</td>
<td>Trends in use of public facilities&lt;br&gt; Success of past public facilities</td>
<td>Local histories including oral histories&lt;br&gt; Newspaper articles&lt;br&gt; Residents of longstanding</td>
</tr>
<tr>
<td>Environmental (geographical; climatic)</td>
<td>Annual weather patterns; snowfall, rain, sunshine, wind&lt;br&gt; Soil types</td>
<td>National Oceanic and Atmospheric Association&lt;br&gt; U.S. Geological Survey</td>
</tr>
<tr>
<td>Economic</td>
<td>Ongoing maintenance costs; electric, water, repair&lt;br&gt; Nature, properties and availability of local (indigenous) materials&lt;br&gt; Availability of general and specialized skills&lt;br&gt; Availability of other people to assist (e.g., volunteer labor)</td>
<td>Local energy company rate sheet&lt;br&gt; Better Business Bureau listing of local contractors or specialists</td>
</tr>
<tr>
<td>Legal</td>
<td>Safety requirements&lt;br&gt; Required setbacks from a road&lt;br&gt; Contracts</td>
<td>Local and state building codes&lt;br&gt; Local authority rules and regulations&lt;br&gt; Contracts/agreements with clients</td>
</tr>
<tr>
<td>Infrastructural</td>
<td>Community waste options (recycling, composting)&lt;br&gt; Local services—accessibility (walking, parking, construction equipment)</td>
<td>Local utility companies (water, electric, sewage, gas)&lt;br&gt; Directory of local business and services</td>
</tr>
</tbody>
</table>
can also portray a step-by-step flow of events associated with the use of the designed artifact (i.e., what happens first, what happens next, what happens last). The images used in the storyboard could be photographs, sketches, or other created pictures (Rosson & Carroll, 2001; Stone, Jarrett, Woodroffe, & Minocha, 2005).

**USING INFORMATION TO DEVELOP CRITERIA AND CONSTRAINTS**

Ultimately, designers must determine the scope of the work to be done in order to address the initial problem brief. Creating scenarios or storyboards can help them synthesize contextual information to make decisions about what is within the scope of the project and what is outside the scope. However, these are just two tools that can help designers to make these decisions.

As information about the larger context is analyzed and synthesized, and perhaps depicted through the use of scenarios and storyboards, the information ultimately must lead to the identification and creation of appropriate requirements and constraints. The **criteria** (which include the things that designers would like the artifact being designed to do, or to not do or be) are used to differentiate amongst different options, while the **constraints** (or **requirements**) are criteria that **must** be met for the artifact to

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**BOX 8.1 Example Scenario—Summer Break**

It was six weeks into summer vacation, and Janelle was bored with her toys at home. *Mom, can we go to Chuck E. Cheese? I'm bored.* It was 10 o’clock in the morning, and the sun was shining outside. *It's such a nice day. Why don’t we go to the park instead?*

During the spring, the neighborhood playground had been transformed into a pirate ship, with a climbing net taking children from the ground to the ship’s floor, a telescope and steering wheel installed at the top of a lookout platform, and slides exiting the ship to the lifeboats. Janelle enjoyed pretending that she was a princess captured by pirates, waiting for a rescue party to come. Soon, Janelle, her mother, Nora, and her younger sister, Sasha, were on their way to the playground. Only five blocks from their house, the playground was an easy walk away (even if a bit slow, with three-year-old Sasha as part of the walking party).

Once they reached the park, Sasha’s pace increased considerably as she attempted to keep up with her seven-year-old sister, who was eagerly climbing the net up the ship’s side. Sasha’s mobility and agility hadn’t quite developed to the extent that Nora was comfortable with her climbing up the net like her sister, so Nora directed Sasha to the ramp on the other side of the ship that would allow Sasha to board safely. Nora sat down on one of the benches facing the pirate ship and began to read the magazine she had brought along. Soon she began to wish she had brought along sunglasses and a hat as she was squinting while the sun continued to rise. *Grow trees, grow. A little shade would be nice.*

One of the articles in the magazine got Nora to thinking about Janelle’s birthday next month—perhaps they could hold her party at this park. They could incorporate the pirate theme throughout the party. *Are there enough activities to keep at least 10 kids busy? There aren’t any picnic tables; we could eat and have cake back at the house either before or after we play at the playground . . . or bring along blankets for a picnic on the grassy area.*

Nora was interrupted by Janelle. *Mom, Sasha needs to use the bathroom.* Unfortunately, that meant a trip home—and it would have to be a fast trip home to avoid a potty training accident. Janelle was going to be disappointed. *If only there was enough space to install bathrooms at this park.*
be a viable option. Good criteria have three main features: they are clear, they are measurable, and they distinguish the feasibility, desirability, and viability of options. For example, one might say that the artifact being designed must be culturally appropriate. This would be an example of a constraint that is not clear or measurable. It can be improved through the gathering and use of information related to the cultural norms of the design context. A constraint that is clearer and more measurable would be that the retaining wall should not displace any historical landmarks. Criteria guide initial idea generation as well as later decisions (as the designer chooses amongst possible alternatives). Chapter 11 describes methods of evaluating design alternatives against criteria. Table 8.2 provides examples of criteria derived from contextual information.

### Using Information to Begin Ideation

The how-why diagram is a powerful tool for exploring the context of a given design task and for exploring a much wider solution space. Thus it opens up new areas and avenues for information seeking. Figure 8.2 is a how-why diagram that was constructed around the initial design question: What types of head impact protection can we design for students in class? It seems many were falling asleep and being injured as their heads hit the desk.

If designers simply tackle the design task as posed, then they are seeking ideas about how this problem might be solved. In this case, three possible solutions are suggested: (1) the Wake-Me,
a device that senses the onset of sleep and provides a mild electric shock to wake students before their head hits the desk; (2) the Snooze-o-Matic, a type of airbag in students’ notebooks that inflates upon impact; and (3) the simple solution that the students all wear crash helmets to class. Each of these concepts would require accessing a variety of design information. In turn each of these three solution concepts can be fleshed out to find out how they may be realized in practice. So for example, the Snooze-o-Matic might be made up of four subsystems: a frame, a power source, an airbag, and a trigger. In turn we could ask how might each of these subsystems be achieved, and so on down to each component. Thus, asking how narrows the design thinking to move toward more and more specifics.

However, if instead of asking how, the designer asks why, then the nature of the design task opens up and so does the potential solution space and also the range of information that might be sought. In the example, if the designer asks why we are trying to provide head protection, he or she might see the more fundamental problem of avoiding injuries due to boring classes. Asking why this might be achieved opens up a number of possibilities, including eliminating lectures or making classes more engaging (i.e., tackles the source of

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**FIGURE 8.2** How-why diagram for head impact protection to prevent injuries when students fall asleep in class.
problem). Asking how either of these might be achieved poses a whole different set of design concepts, as indicated respectively by the solid darker blue boxes in Figure 8.2.

**SUMMARY**

A properly developed problem statement is just as valuable as the final solution. When presenting a solution, designers need to show not only what they are proposing, but why the solution meets the needs of the stakeholders and how the solution fits within the stakeholders’ larger geographical, economic, cultural and human, material, and environmental contexts. The more assumptions designers make about their stakeholders themselves, the context the stakeholders work and live within, and the stakeholders’ needs, the more likely it is that designers will make mistakes and come up with the right solution to the wrong problem. Only by gathering information to interrogate those assumptions can designers make informed decisions about what is important to stakeholders. The evidence-based requirements and constraints generated will then lead to better problem statements and ultimately more desirable final design proposals.

**SELECTED EXERCISES**

**Exercise 8.1**

When students have been given a design project that involves changes or modifications to existing spaces, such as classrooms, have the students visit a variety of classrooms around campus with an eye toward the differences in the spaces that impact any design solution or create constraints that may not have been considered. The students can be guided in the review by providing them with a list of suggested classrooms to visit to show a variety of room arrangements, available wall space, seating arrangements, and number of exits/entrances to the room. Once students have completed this review, have them share with the class what they learned, particularly as it may impact any designs being considered.

**Exercise 8.2**

Using Table 8.1 as a starter, create a worksheet for students with a column added to the right. In this additional column, have the students fill in the specific information need for designing a playground or the design project being used in class, trying to find at least one specific source for each type of information. Use the information gathered by the students as a starting point for a class-wide discussion so that everyone is involved in thinking about where different types of information can be found.

**Exercise 8.3**

Create an incomplete version of Figure 8.2, the how-why diagram, using a problem new to the students. Fill in the selected design and the options below it in the diagram, and leave the additional options for solving the problem blank. Have the students work in teams to come up with other options for solving the problem. Have teams share with the rest of the class. Guide the conversation to ensure that the new ideas focus on the why behind the problem to be solved, rather than jumping to a potential solution.
ACKNOWLEDGMENTS

The Snooze-o-Matic was a witty idea originally proposed in an issue of MAD Magazine. The how-why example in Figure 8.2, created by David Radcliffe, was developed around this concept.

REFERENCES


