Chapter 1

Appetizers

Designed Environments: Places, Practices, and Plans is about analyzing and designing environments. This chapter provides an introduction to the meaning of *environment* as it is used in the concepts and activities you'll find in subsequent chapters. We start with a list of environmental design problems generated in a brainstorming session with some teachers. It is a wide-ranging list of activities that suggests a very broad definition of *environments.* We give structure to the concept of environment through three categories: the environment of space—the places of our lives; the environment of our practices, shaped by rules, procedures, rites, laws, conventions, and so forth; and the environment of time, which we structure through our schedules and plans. Following these are four examples of environmental design. The first example is of a redesign project that we encourage you to carry out in your own home or at school. This is followed by examples of *Designed Environments* projects that are based in classroom settings.

What Is a *Designed Environments* Problem?

Think about some of the minor (and not so minor) annoyances that complicate your daily life. Do you waste time looking for things that are not where they ought to be? There are the keys you can't find in the rush to leave for work. You know a memo is among the papers on the desk, but you have to shuffle through the whole pile several times before you find it. Misplaced keys and lost memos are problems of how things are organized—where they are kept. Is there a pile of papers you don't really have a place for? How will you deal with the overflowing catchall drawer? These too are problems of how things are organized. To solve problems like these you first have to analyze how and why they came about in the first place. Only then can you design new, more effective ways to organize things. Problems resulting from the way things are organized are as common in the classroom as in the home. Teachers and children lose or misplace things. Teachers and children have problems putting things away in such a way that they can easily be found and retrieved when they are needed next time.

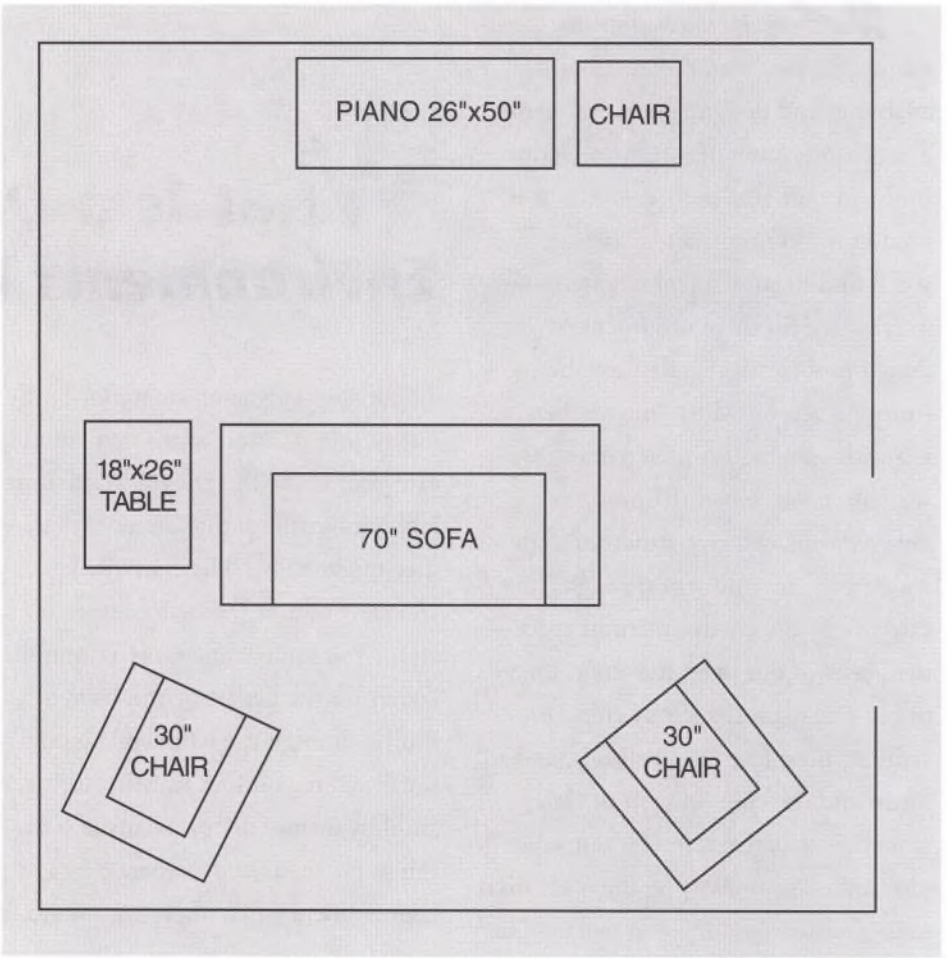
The range of environmental design challenges in the classroom and in the home goes far beyond problems of storage and retrieval. Decisions about the furniture in the room and how to arrange it are design decisions that influence the sort of environment you create. Recurring problems in the classroom can be indicators that something in the design of the environment or the way it is used is not working. Here are some clues that tell you there may be an environmental design problem for you to analyze and solve:

- Conflicts between students frequently arise in a particular area of the room.
- Certain rules are frequently broken.
- There is never enough time to finish certain activities.

When we asked teachers to brainstorm ideas for environmental design projects, they came up with this wide-ranging list:

- Rearrange the living room furniture.
- Develop rules for watching TV.
- Adapt the class schedule to accommodate a two-hour science investigation.
- Plan a shopping trip to several stores.
- Design a closet organizer.
- Invent new ways to display children's work.
- Change the rules of a game to make it easier or faster.
- Add new folders to a filing system and rearrange the contents.
- Set new procedures for using the pencil sharpener.
- Move children's seats to control behavior.
- Change activity centers in the classroom.
- Modify a game to fit a different-sized play area.
- Decide where to place things in kitchen cabinets.
- Develop ways to control classroom temperature.

1-1: **Plan for rearranging the living room**



What do the things on this list have in common? They all involve doing something to improve a situation. They do not involve creating a new product or building something. Environmental design activities involve rearranging the things that are already at hand, or establishing new procedures for how things are to be used or done. The activities in the list above involve different environments, but we live in all of them and to varying degrees they are under our control. In *Designed Environments: Places, Practices, and Plans,* we categorize environments under three headings: space, time, and rules and procedures.

The starting point for spatial design activities like these is usually a problem, a need, or a sense that things can be improved. The trigger for each designed environment activity in this guide is the identification of a problem that the class can solve, a need that can be met, a situation the class can improve. The word *trigger* is appropriate for these spatial design situations because they propel us into action:

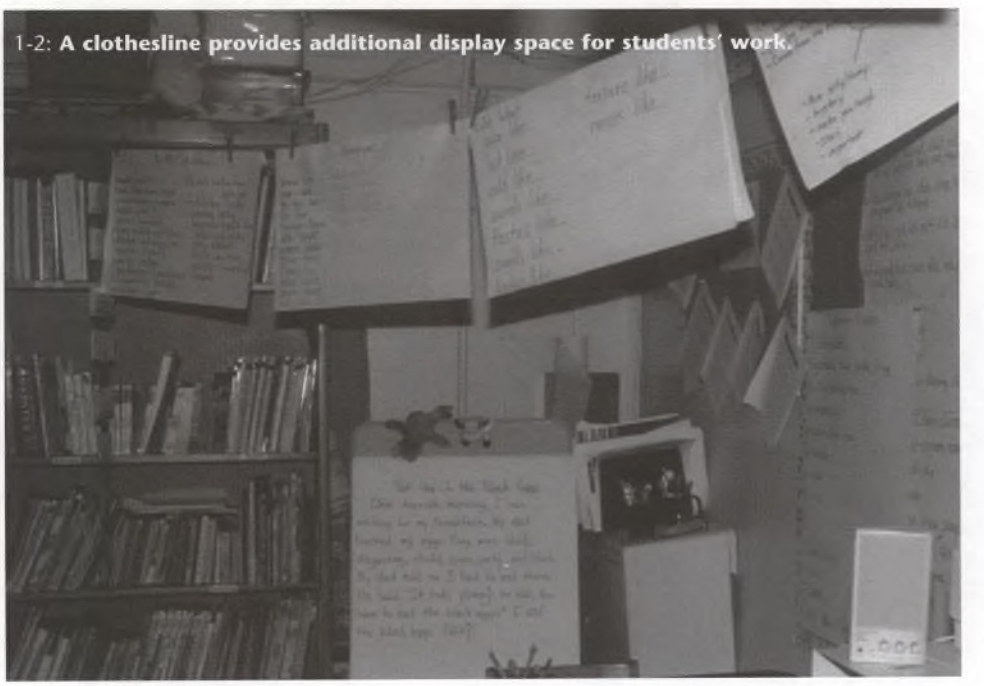
- Storage space is hard to get to.
- Drawers are cluttered.
- There are frequent spills in the lunchroom because it's poorly organized.
- The rug is getting dirty because of too much traffic.
- The block area is a mess.
- There is not enough sunlight in the science area.
- There isn't enough storage space.
- There's no place to display projects.
- Where can we hang student work?
- Where can we keep work in progress?
- How can we have block building carry over from day to day?

Space

"Spatial environment" is what we usually mean when we say "environment." It encompasses everything we can see: the natural environment and the built environment.

The spatial environment is the focus of the engineer, architect, and interior designer. It's also frequently the focus of the classroom teacher. For example, you are engaged in designing the spatial environment when you...

- Plan storage spaces for learning materials;
- Rearrange desks and tables;
- Develop display spaces;
- Organize bulletin boards.



1-2: **A clothesline provides additional display space for students' work.**

Any of these could lead to a design project that would engage the best thinking and problem-solving of a class. Design projects promote a variety of important skills:

- identifying problems in the environment;
- deciding what information is needed to understand the problem, and gathering it;
- creating possible solutions, selecting the best, and implementing it;
- evaluating the solution, then redesigning it if necessary.

There are other equally important outcomes of designed environment projects. When children engage in solving real problems, they take responsibility for the solutions. Through them they practice democracy and they develop social responsibility. What's more, some of the nagging problems of the classroom get solved!

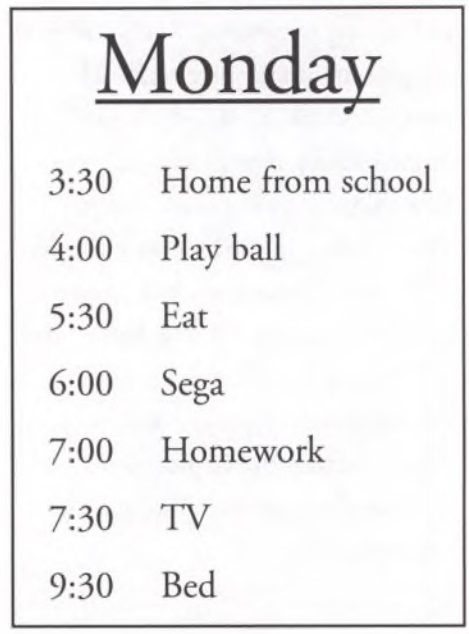
Time

Time shapes our lives as much as space does. We can be as constrained by time schedules as by spatial structures and boundaries. We can't escape the demands of time, but we can do a better job of organizing the way we use it.

Schools vary greatly in the organization of the day, the week, and the year. Some teachers are told the exact times they must teach reading, writing, and arithmetic each day. Others are less rigidly constrained. All teachers use their creativity to adjust class schedules to meet the needs and interests of children. For example, some are able to rearrange the time spent in each curricular area in order to provide a double period for special projects. Others revisit a topic, such as mapping, throughout the year rather than studying it more intensively over a few days. Teachers regularly deal with the problem of too many curricular demands and too little time. Classroom *Designed Environments* projects can also begin with problems relating to time:

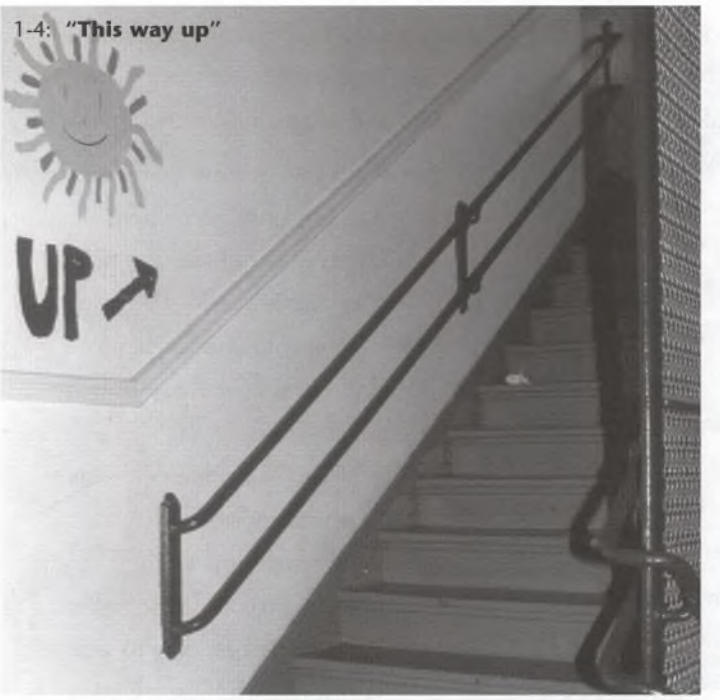
- There's not enough time to finish this project.
- We wasted 10 minutes on the cafeteria line because too many go to lunch at the same time.

1-3: **Time planning**



- We lose too much time between reading and math.
- Why don't we ever do social studies in the morning?
- I hate it when the intercom keeps coming on.
- I always have to take work home: there's not enough time to do it in class.

After school, many children are free to decide what they do until dinnertime. Even in the evenings when parents are home, children decide how to divide their time among television, hanging out, talking on the telephone, using the computer, and doing homework. Children's use of time is fertile ground for analysis and planning. An interesting activity is for children to keep track of how they use time. As children collect data on how they use time, they are at the same time making categories: one may record time spent in the broad category of "watching television"; another might have a category for each show watched. Children's time data provides the context for reflection on how they use time. Real-life time data is the starting point for plans of alternate ways to schedule after-school time. Figure 1-3 is one child's plan for how to use time.



1-4: **"This way up"**

Rules and Procedures

Here is another list of common teacher activities:

- Plan a lesson.
- Modify a game.
- Set rules for use of the pencil sharpener.
- Develop guidelines for Internet use.
- Plan a class trip.

Activities like these, while they have spatial and temporal connections, do not fit neatly under our first two categories. We list them under the heading: environment of rules and procedures.

Rules and procedures make a different sort of environment than space and time. Rules and procedures shape how we live in space and time. From the time we get up until we go to sleep, we are guided, constrained, freed, and frustrated by rules, laws, customs, regulations, and procedures. Consider the following rules and procedures.

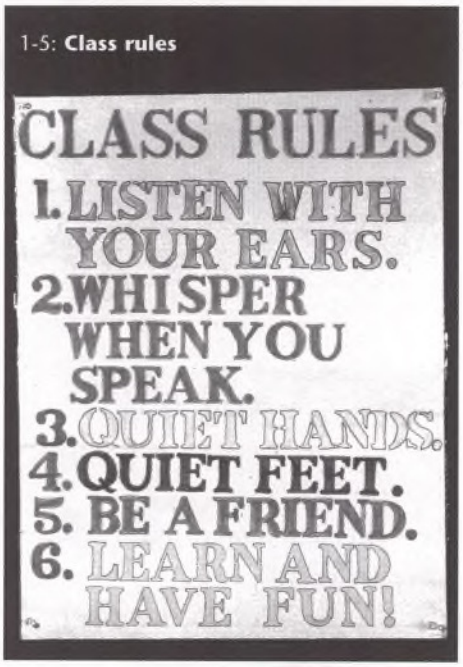
- Drive on the right side of the road.
- Stop at the red octagonal signs.
- Take a number at the deli counter.
- Knock before you enter.
- Raise your hand if you want to say something.
- Go to the end of the line.
- Everybody gets just one piece of cake.
- Fill out insurance forms at the doctor's office.
- Leave the building for the fire drill.
- Stand for the Pledge of Allegiance to the flag.

This list barely does justice to the multitude of customs, laws, regulations, accepted practices, rules, and procedures that shape our lives. We live in environments that guide, encourage, and restrict what we do. Often we are not aware of the rules until they are broken—i.e., when someone cuts into line or takes too much food. Rules and procedures provide the structures that some feel as freedom, others as constraint. Rules and procedures are as much a part of the classroom environment as are the time schedule and the classroom layout. (See Figure 1-5.) More important, classroom rules and procedures are largely under the control of the teacher. They represent an area where students and teachers can analyze their own environment, figure out what works and doesn't, and actually come up with a better design. Here are some questions that can trigger projects to design improved rules and procedures in the classroom:

- Who and/or how many may go to the bathroom and when?
- When may one use the pencil sharpener?
- Who gets to speak when?
- How do we get ready to leave the classroom?
- How do we decide who gets to use the computers?
- Should we allow eating/chewing gum in class, and if so, when?
- What is the best way to deal with those who interrupt?
- What ought we do to those who bother others?
- How should we decide who goes to which activity area?
- What is a quick way to get homework corrected?

The flip side of developing rules and procedures is enforcing them. What happens when a child breaks a classroom rule? A teacher may react by ignoring the behavior, encouraging the child to conform, cajoling, or punishing. The ways that teachers deal with rule breakers is of particular interest to children. During the later elementary years, fairness becomes the criterion children use to judge teacher discipline. How do they feel about the ways their teacher deals with rule-breaking and other misbehavior? Is there a place for their input?

1-5: **Class rules**



Designed Environments and You

You could now be saying, "This isn't hard. I'm already an expert at rearranging things, making schedules, and deciding how to do things. I do this all the time." That is the point. All of us engage in designing places, practices, and plans, but most of the time without reflection. However sometimes we do ask: "How can I do this better?" or "How can I improve this situation?" Such questions lead from a "making do" approach to environmental design issues to the sort of analysis and design activities that characterize this guide.

Getting Started: Redesign Your Desk

This is an introduction to designed environments that you can do on your own. By the nature of teaching, almost all of us have messy desks. "Redesign your Desk" takes you through these steps in the process of analysis and design:

- Identify the problem.
- Gather and analyze information about the problem.
- Determine the criteria for a redesign to meet and identify constraints on the design.
- Design possible solutions.
- Select the best solution and implement it.
- Evaluate the new design. Does it meet the criteria?

Try reorganizing your desk in school or at home, but do it with attention to analysis and design by following the steps listed above. You may find that some steps overlap others. You will find that you have to go back and forth between steps. That's because the order represents a linear sort of thinking that doesn't apply to the way you approach problems or that doesn't necessarily work for this particular project. So be creative in your thinking, but try to employ each step at some point as you're working on the problem. The description below goes through the steps in the design process in the order listed above, but it will be clear that the order would not be followed in real life designing.

1-6: **Desk before redesign**

Identify the Problem

Clutter, lack of space, poor organization: these are a few desk problems. Typically there is one overwhelming problem that triggers the desire to redesign or to fix a situation. For this example, we will redesign to solve the problem of desk clutter. This does not mean that clutter is the only problem addressed in the redesign activity. As we think about how to improve the desk, we will think of other issues. Clutter is simply the problem that triggers redesign in this instance.

Gather Information and Analyze the Problem

There is a pile of things on your desk: school papers, mail, newspaper clippings, unread journals, and so forth. What does it mean to gather information about this clutter? First, sit down at your desk. Go through the items on the desk to see what you have. Resist the temptation to try to put them away as you go along. If putting things away were easy, you would have already done it. As you look through the clutter to see what you have, the natural thing is to begin to sort it out. So, categorize the clutter. Categorizing is an essential step in analysis.

Now look at the various places you have available for putting things away. As you think about where you would place each item, you think of places at your desk or away from it in terms of how convenient they are, how adequate. For some things there may be no appropriate place. What is needed in order to take care of these? And what about the things that you've kept for a long time but don't use? Why did you keep them? This analysis is necessary before you can identify the limitations within which you must work and figure out what criteria a new design should meet.

1-7: **Would this help organize the clutter?**

Information gathering and analysis goes beyond examining your own experience. You need to go to new sources of information in order to bring new knowledge to solving the problem. There are two ways to do this for the desk redesign. First, gather information on different ways desks are organized. Talk to friends and colleagues about how they organize their home office. What do they have on the desktop? What sort of files do they keep and where?

Second, get information about the kind of products available to make desk organization easier. These include stacking trays, drawer organizers, sorters, pencil holders, portable filing

systems, and so forth. Visit an office supply store. Note the sorts of organizers that are displayed with desks. Check what is available through office supply catalogs. This additional knowledge leads to a broader range of design solutions.

Select Criteria and Determine Constraints

Criteria and *constraints* sound technical and, in fact, they distinguish technology design from everyday design.
Setting criteria for a design means being explicit about what a design is to accomplish. Criteria develop from the needs a design is expected to meet. Criteria specify how well, or to what extent, a need is to be met in order for the design to be considered acceptable or successful.

Constraints are limits on the designing process. They might include:

- Time available to develop and implement a solution;
- Resources such as money, materials, or expertise;
- Existing rules and regulations, including requirements for authorizations.

Constraints are guidelines within which designs are developed.

It makes sense to create a list of criteria and constraints while you are gathering and analyzing information about your desk (the previous step). In fact, it's a good idea to keep a list of the various needs that you become aware of as you sort the desk clutter into piles of bills, papers and the like, and as you try to figure out where to put all these things. A list of needs to be met by a design might look like this:

Needs

- Create space to spread out work.
- Find a place to organize bills, plans, and records.
- Find space for current files.
- Create a place for the phone at the desk or next to it.
- Keep the pencil sharpener and stapler easily accessible.
- Keep a place for the keyboard, mouse and monitor on the desk, and computer under it.

The criteria are set in terms of these needs:

- How much space do you really need for your work?
- How will you know that you have been successful in designing places to put the things that made up your desk clutter?

The answers to these questions become the criteria to be met by the design. Criteria developed from the above list of needs might look like these:

Design Criteria

- A clear work area of 12" x 24"
- Easy to decide where new papers go so they don't accumulate
- Use computer and phone without leaving desk
- Have access to what I need while working

As you set design criteria, be aware of features in the current desk design that are working well. You will want to keep these features in a new design. They too should be cast as design criteria. Design criteria are not set once for all time. Don't be surprised if, as you use the desk, you discover another function that the desk should accommodate. Add it to the list of design criteria.

The constraints on redesigning your desk are probably based on the structure of the desk (size, cubby holes, drawers), where it can be placed, and resources available to buy files or desk accessories. There may be additional constraints if other family members use your desk. (If they do, they will be happy to see the clutter gone.) Here is a list of typical constraints.

Constraints

- Limited desktop space (30" x 42")
- Limited improvement funds: $50
- Computer to be used by others in family
- Total filing space: two drawers – letter size
- No phone jack near the desk
- Desk must stay against the same wall, and within three feet of its current location.

There is another type of constraint. It arises from several needs competing for the same resource. For example, clear space for working competes with the space needs of a monitor, mouse pad, keyboard, pencil sharpener, stapler, and desk organizer. Limited desktop space means one of two things. Either you make tradeoffs among the things you want on the desktop or you find ways to use desktop space more efficiently. A more efficient use of space is to have the keyboard out of the way when not in use. However, using available funds for an accessory to store the keyboard limits money available for other things—so you're back to making tradeoffs.

Design Possible Solutions, Then Select and Implement One

Now begin the redesign process. Brainstorm different ways to accommodate all the things you want at your desk. Think also about the things or functions that might be moved away from the desk, temporarily or permanently. For example, do you really need to keep bank statements from the past five years at your desk? Is this really the best place to store your maps or photos?

There are several ways to explore alternatives. Sometimes it is easier to play with alternate designs using pencil and paper. Sometimes it is easier to simply move things around on the actual desk, seeing how they fit. Sometimes the final design is the result of a series of trials, each guiding and shaping the next until you reach what you believe to be the best. Whatever the process for generating possible designs, select and implement the one that seems to best meet the criteria you have set out.

Evaluate Your Redesign

There are two ways to evaluate a redesigned desk. Both are important. The first is unstructured, informal, and done almost automatically: "This seems OK," or "I don't know if I can get used to this," or "I need to change this." Sometimes in the process of implementing the redesign, unforeseen problems arise. If this is the case, modify the redesign or select another of the redesign options. For example, the desk may have been moved to a new location without planning for adequate lighting. Design modifications for this problem may be simple. Other unforeseen problems may require a whole new design. The informal evaluation of the redesigned desk is ongoing. Every new activity at the desk gives its own feedback as to whether the desk accommodates that activity as well as the old design did.

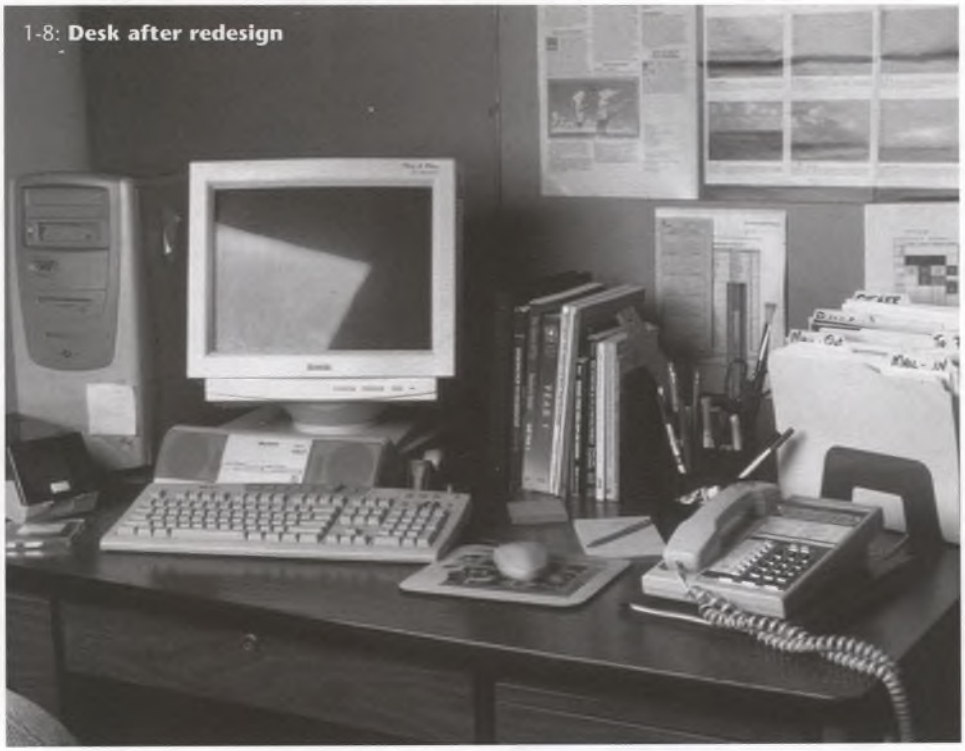
The formal evaluation comes after the redesigned desk has been used for a few weeks. It addresses the question, "Does the new design meet the criteria for a functioning desk that you set out (and perhaps augmented)?"

Here is a restatement of criteria listed above. To the right is a list of the sort of things that might be accepted as evidence that the criteria are met. Sometimes the evidence that a criterion is met is implicit in the design criterion. Nevertheless, as you develop design criteria, think about what it means to fulfill each one. This is the evidence you'll use to evaluate the redesign

The important things to experience in the "Redesign your Desk" activity are the thoughtful aspects of a designed environment activity. You didn't simply sort out the clutter—some to the wastebasket, some to a file, the rest to another stack whose destination you hadn't decided. Rather, you thought about how you use the desk and what the current problems were. You planned how you would change it and how you would know if the changes worked. These design criteria, alternative design options, and evaluation are all processes that raise everyday design experiences to the level of understanding and using technology.

Table 1-1
EVALUATING DESIGN SOLUTIONS

Design Criteria	Evidence
A clear area of 12" x 24"	Whenever I want to spread out my work, space is available without first cleaning up.
Easy to decide where new things should go	There are few, if any, unsorted things on the workspace. Little time is needed to put papers in their places.
Use computer and phone without leaving desk	It is easy to switch from paperwork to computer work and back again. The phone is within reach.
Have access to what I need while working	Ability to complete work without having to leave the desk for office supplies or tools. Ability to find these articles quickly while working.



1-8: **Desk after redesign**

Designed Environments in the Classroom

Everyday classroom life surrounds you with opportunities for environmental design. In the preceding pages you have begun to see what the opportunities are. The curricular decision is to select the opportunity to exploit. Preparing to teach designed environments is not the typical task of becoming familiar with a new curriculum or the materials that accompany it. Rather, it is looking at the things you already do in a different ways. To prepare to do designed environments with children, you need first to step back, think about things you automatically do as a teacher, and ask, "What would happen if the children and I did these things together?"

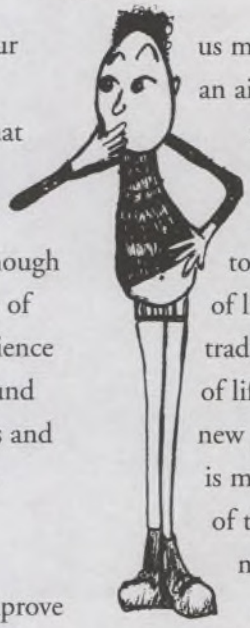
Here are some of the things teachers ordinarily do themselves, without involving children:

- Prepare the classroom at the beginning of the year;
- Choose the posters to put up and decide where to put them;
- Decide where tables and chairs should go;
- Select activity areas and the things to go in them;
- Arrange for class trips, selecting destinations;
- Set up the procedures to:
  - take attendance;
  - determine lunch preferences;
  - get information to the office;
  - regulate the talking in class;
  - control the use of the pencil sharpener and/or other scarce resources;
  - control access to the bathroom;
  - set the classroom time schedule.

These are some of the ways that teachers structure the learning environment and keep order in the room as part of their jobs. Each decision shapes the environment the children will experience and each presents an opportunity for involving children in an environmental analysis and design activity.

You cannot engage children in every one of these decisions, or even a significant percentage of them, and still have time to do other things in the classroom. Depending on the students' maturity, you may feel that some areas should be off-limits. You can begin by involving children in the redesign of only one procedure or rule, time schedule or cluttered area. Children can learn to analyze what is wrong with the current procedure, set criteria for what a new procedure should accomplish, then design, implement, and evaluate a new procedure. They learn by doing it. As they gain experience, they become more proficient in all of these processes. Later, when another issue comes up that could benefit from student thinking, they will be more skillful in addressing the new problem.

Is This Really Technology?



Is redesigning how you use your desk really an application of technology? Remember first that technology goes far beyond computers. Technology is even broader than science, although technology may use the results of science as well as make new science possible. Technology is all around us and includes all the artifacts and most of the environments and systems of our daily lives. It includes all the efforts from prehistory to the present to improve the conditions of human life. The results of technology range from improved transportation systems to doorknobs that are easier to use, from signs that direct us more clearly through an airport to designs for more efficient use of space. The constant aim of technology is to improve some aspect of life, mindful of tradeoffs in other areas of life. The success of the new product of technology is measured by a weighing of the improvements made against the costs of the improvement. Although the redesign of a desk has a limited impact, it nevertheless addresses a goal of any technology: to improve a particular aspect of life with reasonable tradeoffs.

Design of Space in the Classroom

Monda's third grade classroom had a problem. The rug was getting dirty because people kept walking across the rug with shoes on. Of course there was a rule: "Don't walk on the rug with your shoes on!" But those who knew the rule usually didn't remember it until they were halfway across the rug and visitors to the room didn't know the rule. The fact that people kept crossing the rug was a clue that it was in a place where paths naturally crossed. The problem seemed more a spatial problem than one of rules and procedures inadequately enforced. Since the children were involved in the problem, it was a good one for them to solve. Simply stated the problem was this: How can we reduce or eliminate shoe traffic across the rug?

Gathering Information: Analysis of the Problem

Initially the children and teacher brainstormed about what information might be useful and how they might get it. To get the brainstorming started, Monda asked, "Where are people going when they walk on the rug?" She asked questions that further narrowed the focus of the children's ideas:

"Where are they going if they are in stocking feet?"

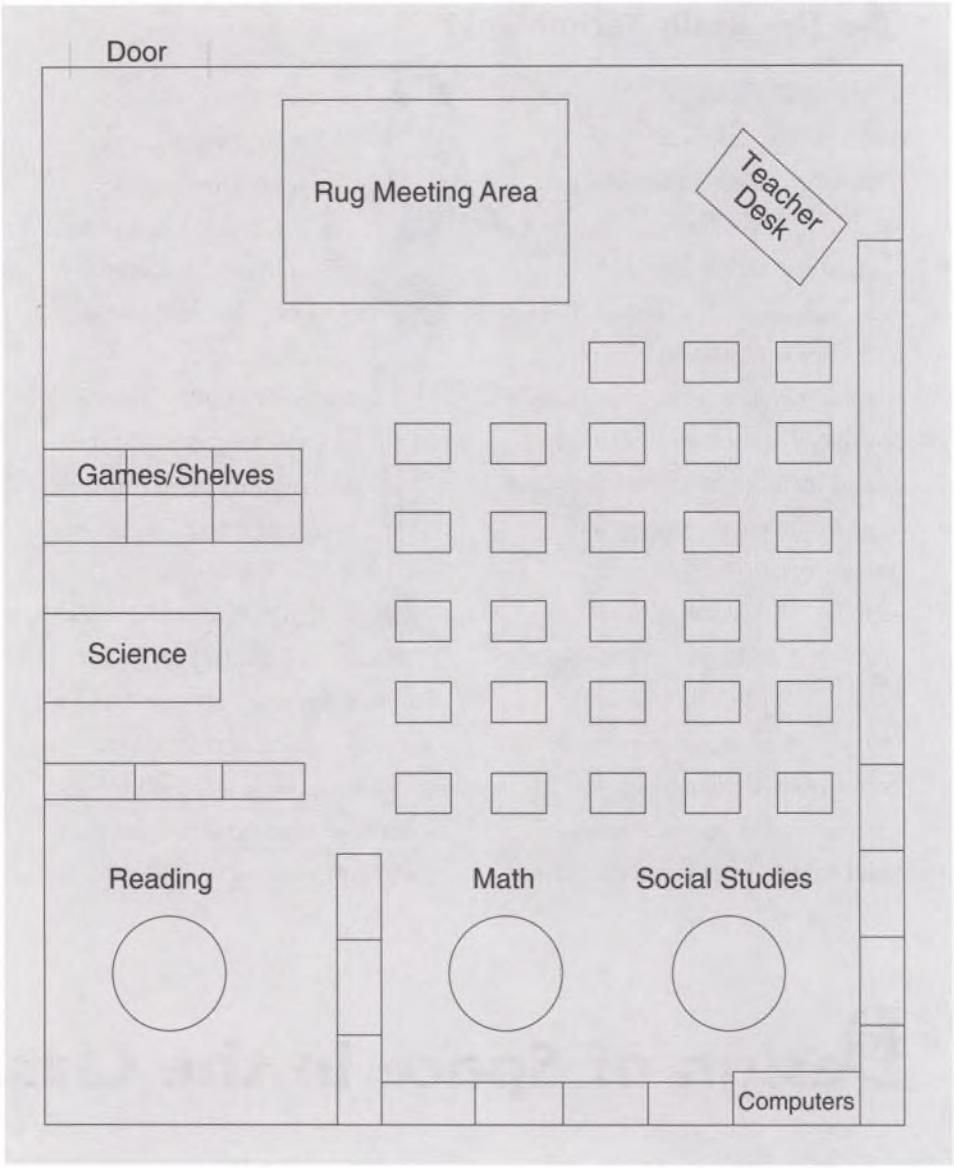
Class meeting
Circle time
Play games

"Where are they going when they have shoes on?"

To Ms. Monda
Out of the room
To the math area

The teacher wanted the children to see that when the rug area itself was the destination, there was seldom a problem. The problems arose when people were trying to get somewhere else. She wanted them to really see the nature of the problem, so she introduced the idea of recording the paths people were taking when they crossed the rug with shoes on. Drawing each pathway was a way to collect data on their problem. She gave them a data collection aid: an 8 1/2" x 11" classroom map (Figure 1-9). Each time someone crossed the rug with shoes on, the rug monitor for that day drew a line showing where the person had walked. The teacher also taped a large-scale copy of the map on the board in front of the rug. The class collected all the daily data on this large map and discussed the growing body of information during class meetings. After the first day the data appeared as in Figure 1-10.

1-9: **Data collection aid: a map of the classroom**

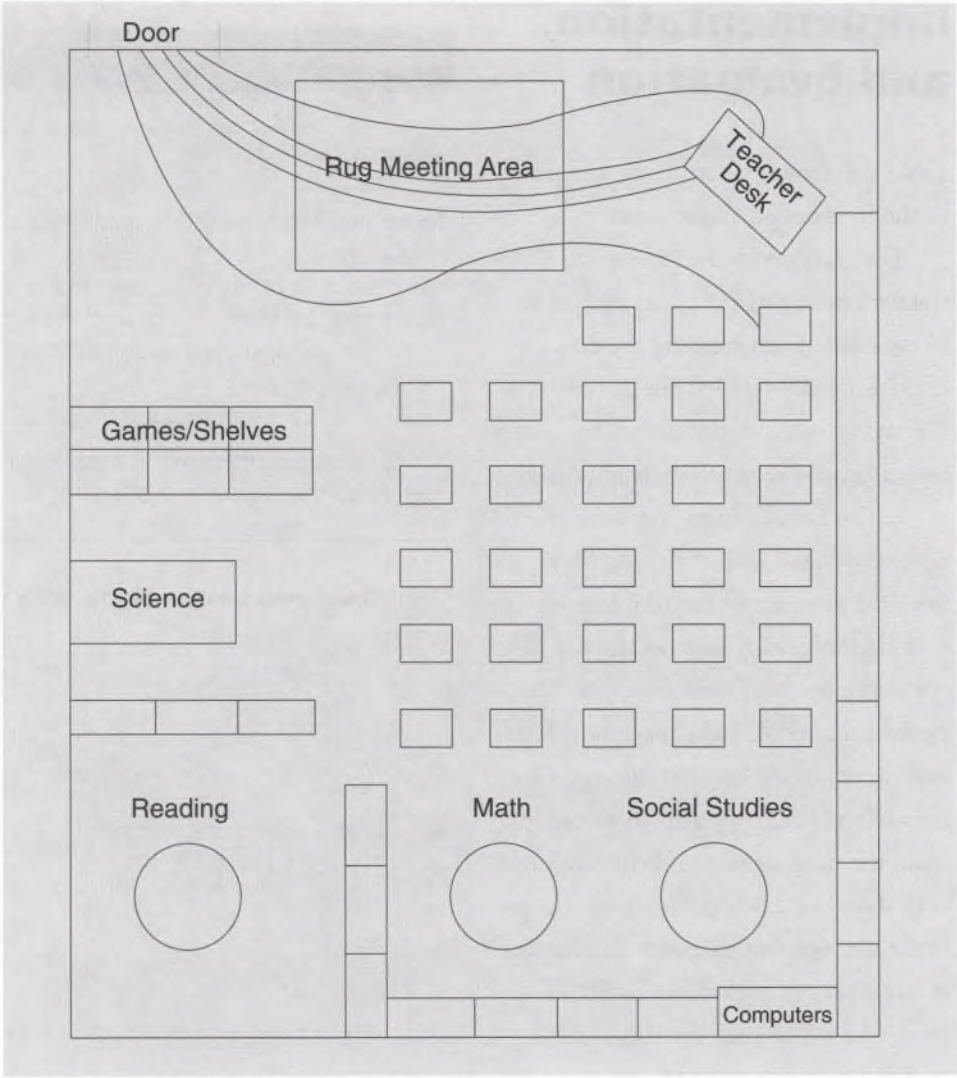


After a week had passed, the class discussed their data. They agreed on these general results.

- When visitors come to the room and cross the rug, it's to get to the teacher, not to a special area.
- People cross the rug to get from the desks to the door.
- People cross the rug to get from the science area to the sinks.
- More kids have been detouring around the rug since we started data collection.

In order to think about possible solutions, the children needed broader background knowledge. Their teacher provided some of this by taking small groups to other classrooms, which were organized in different ways. These visits provided images of different classroom arrangements.

1-10: **Classroom map showing traffic across the rug**



Design Criteria and Constraints

The class met for pre-design brainstorming to stimulate thinking about many different design options. Then they broke into groups of four to begin to design solutions to the problem. They were told to think quickly of at least three different plans, but not to choose any of them. Then they reassembled as a class and the teacher helped them think about the things they could and couldn't change in the room. These became the design constraints.

- They could move the desks, tables, and shelving that served as dividers.
- They could not move anything attached to the floors or walls.
- No additional furniture was available.
- The rug could not be placed where it might get wet from art or science activities.

The teacher also led them to think about the functions the rug was to serve. These became the design criteria.

- The rug was to be used for class meetings. This meant a chalk board or marker board had to be available where the rug was.
- The rug should be easily used for lounging while reading, or for board games.
- The design should make it difficult for people to cross the rug without thinking about it.

Design Solutions

The children proposed a variety of solutions to the rug problem. These included:

- Put a rope barrier around area, leaving all else the same.
- Move the shelves so they would block one side of the rug.
- Move the rug to the reading area, leave the group meeting by the board, and have kids bring mats to sit on during group meetings.
- Move the rug and the group meetings to the reading area, using a portable easel in place of the wall mounted chalkboard for class lessons.

Selection, Implementation, and Evaluation

Table 1-2 shows the students' reactions to the four design suggestions:

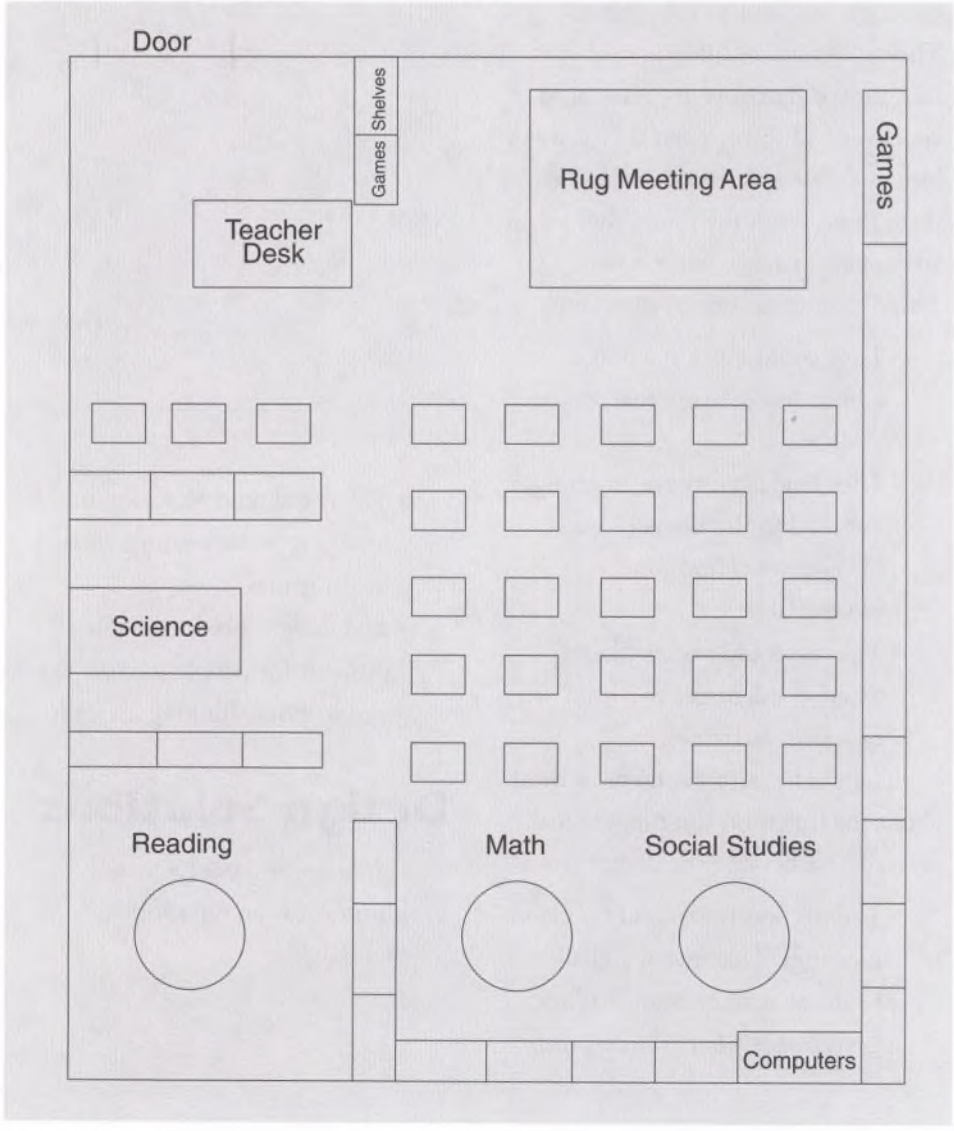
The class decided to move the teacher's desk and the game shelves to block traffic from crossing the rug. Everything else was left the same. This was a status quo solution, involving only a "tweaking" of the existing design.

As can be seen in Figure 1-11, the selected design blocked the pathway from the door across the rug, and it was no longer necessary to cross the rug to get to the teacher's desk from the door. By the time people had passed the shelves, they were already beyond the rug. The class selected rug monitors to record again the number of people on the rug with shoes on. Their criterion for success in the redesign was to reduce the number of rug crossings with shoes by 80%. After two weeks they examined the data. They had seen no one at all cross the rug with shoes on!

Table 1-2
REACTIONS TO PROPOSED DESIGN SOLUTIONS

Suggested Design	Reaction to Design
Put a rope barrier around area, leaving all else the same	Would look "tacky"; nothing stable to fasten it to that wouldn't fall down
Move the shelves so they would block one side of the rug; move the teacher's desk to the other side of the rug, closer to the door	Best solution
Move the rug and the group meetings to the reading area	Prefer to keep class and group meetings in current place
Move the rug to the reading area, leaving the group meeting by the board	Don't have individual mats, and they would not be as good as the rug if we did

1-11: **The chosen solution to the "dirty rug" problem**



Redesign of Time in the Cafeteria

The children were complaining as they returned from lunch: "We had to wait a really long time again." Fiona, their teacher, had heard the complaint before—and it was justified. The lunch periods were poorly planned and not everyone followed the schedule. This could be a good problem to analyze, perhaps even one the children could help to solve. She decided to open the topic for brainstorming. Her intent was to have the children further define the problem so she could gauge their interest in studying it. If it seemed appropriate at that stage, perhaps they would lay the groundwork for further information gathering. She led a class discussion to get started:

FIONA (TEACHER):
Josh said you had to wait a long time again today.

SAM:
Yeah, it took forever.

MEG:
We were stuck on the stairs for an hour.

FIONA:
Did all of you have to wait on the stairs?

PAT:
No, the ones in front were O.K.

TOM:
But even the ones in front had to wait a long time.

FIONA:
Why do you think it was so long?

TOM:
Mrs. D's class is supposed to be behind us, but they sneaked in front of us.

SAM:
The lunch ladies are really slow.

FIONA:
Is it usually this bad?

MARY:
Monday it didn't take so long.

TOM:
Who decides when classes have lunch?

FIONA:
That's something we can find out. How many of you would like to study this, to see if we can make it better? ... Good. Let's begin by thinking about the information we need to really understand the problem.

When a system is not working well, it is easier to see the various components of the system. The lunch schedule, a system with several interacting components, was not working well. Thus the poorly functioning schedule provided an opportunity to see what was necessary for a schedule to run smoothly. Fiona guided the discussion and data collection decisions so children would understand what things were important to the schedule not working. In the discussion the children decided that they needed information in these areas:

1. How long do we wait? Is it the same each day?
2. How fast do they serve food? Is it the same for every meal?
3. When do other classes arrive for lunch? How many are in each class?
4. Who plans the schedule? What is the schedule?

Gathering Information and Analyzing the Problem

Fiona set up eight groups to gather information, two groups for each of the four sets of questions. First, a group had to define its problem further. For instance, a group addressing the first question, "How long did they wait on line?", decided they would measure the time from when they joined the lunch line until they got to their tables. Similarly, the children in each group had to decide how their group would collect the information they needed.

Fiona had to help a group addressing question 2 figure out how to collect their data on speed of service. They finally decided to see how many kids came out from the serving area during two-minute periods. They collected data over two-minute periods each day for a week and then compared the results for each day. The data showed that the number of kids served on average in a two-minute period was different each day.

Table 1-3
AVERAGE NUMBER OF CHILDREN SERVED IN TWO MINUTES

	Monday	Tuesday	Wednesday	Thursday	Friday
Number served	12	10	11	8	10

Data on question 1, how long children had to wait in line, also showed a variation from day to day.

Table 1-4
HOW LONG CHILDREN WAITED TO BE SERVED

	Monday	Tuesday	Wednesday	Thursday	Friday
Wait time	4 min. 40 sec.	7 min. 10 sec.	10 min. 0 sec.	8 min. 10 sec.	7 min. 15 sec.

Fiona wanted the class to see the relationship between how many children were served in two minutes and how long children had to wait in line. She had the class compare the findings on questions 1 and 2. The shortest waiting time was on Monday. This corresponded to the day when the most children were served every two minutes. Similarly, long waits went along with the fewest children being served in two minutes. The children started to see how these variables were related.

Not surprisingly data on question 3, when classes arrived for lunch, also varied from day to day.

Table 1-5
WHEN CLASSES ARRIVED FOR LUNCH

	Monday	Tuesday	Wednesday	Thursday	Friday
Mrs. F's class	12:05	12:05	12:05	12:05	12:05
Mrs. D's class	12:08	12:10	12:00	12:06	12:10

The children discovered that the day when they had to wait the longest was not the day when the service was slowest, but the day when Ms. D's class got in ahead of them.

Design Criteria and Constraints

Children working on question 4 did more than just get a lunch schedule. They talked with the principal to find out how the lunch schedule had been designed. They found that all the lunches were scheduled between 11:00 and 1:15, that the lower grades had to go first, and that each class had 45 minutes for lunch. When children reported to the class on question 4, these parameters set by the principal seemed like reasonable constraints for any redesign. The class discussed how long it was acceptable to wait on line for lunch. They decided that five minutes was the upper limit. A successful redesign of lunch scheduling would result in children waiting no more than five minutes from the time they arrived until they began to be served. This became their design criterion.

Design Solutions

The next step was to figure out what changes could be made to reduce the waiting time. Working in groups of four, the children were asked to design possible solutions. Fiona decided to change the groups in order to maximize the number of ideas considered by each group. She assigned one student from each of the four question areas to each new group. The groups brainstormed possible solutions in class. Then for homework, each child designed a possible way to reduce the time spent waiting for lunch. The next day the children shared their ideas with their groups. The groups did what amounted to mental experiments to see how well they thought each of the plans would work. They then chose what they thought was the best solution and presented it to the rest of the class.

Selection, Implementation, and Evaluation

The plans presented by the groups were:

- Adjust the time when each class goes to lunch according to the menu. On slow food days, there would be more time between the arrival times of classes.
- Get more help in the kitchen on slow food days.
- Schedule more time between the times classes arrive.
- Make the teachers follow the schedule.

On the day when each group shared its solution, the assistant principal joined the class to ask questions of each group and to help them work through the implications of each plan. The assistant principal convinced the class that the schedule could not be changed according to the kind of food being served. She didn't think there was room to add an extra worker in the cafeteria line, and there might not be money to hire another person. She agreed that the schedule could be more staggered and suggested that the children make a proposal for new cafeteria arrival times. She also invited the children to think of ways that teachers could be encouraged to follow the schedule.

It was a major project to design a new schedule. First the children determined how much time they had in all. If the last group had to be done by 1:15 and lunch periods were 45 minutes, then the last class had to start lunch by 12:30. That meant all the classes had to go to lunch between 11:00 and 12:30, a 90-minute period. A total of 14 classes went to lunch: three each at the first and second grade levels, two classes each for grades three through six. The first schedule was designed by dividing the 90 minutes by the 14 classes. This yielded lunch periods that began at six- or seven-minute intervals. Table 1-6 shows the original schedule and two proposed modifications.

Table 1-6
TIMES FOR CLASSES TO GO TO LUNCH

Class	Original Schedule	First Proposal	Second Proposal
1a	11:00	11:00	11:00
1b	11:10	11:06	11:07
1c	11:20	11:13	11:14
2a	11:30	11:19	11:21
2b	11:37	11:26	11:28
2c	11:45	11:32	11:35
3a	11:53	11:39	11:42
3b	12:00	11:45	11:49
4a	12:05	11:52	11:56
4b	12:10	11:58	12:03
5a	12:15	12:05	12:10
5b	12:20	12:11	12:17
6a	12:25	12:18	12:24
6b	12:30	12:24	12:30

Children developed the first proposal by alternating six- and seven-minute intervals between lunch times. At first they couldn't figure out why that only took them to 12:24 rather than 12:30. Then they discovered that while there were 14 classes, there were only 13 intervals, not 14. When they divided the 90-minute period by 13, they found they could have 7 minutes between classes for all but the last class. This then was their proposal.

They presented the proposal to the assistant principal. Her first reaction was that younger classes needed more time, and the original schedule provided this. The children responded that the younger classes had fewer children so they didn't need more time. Finally all admitted that they didn't know how much time each class was actually using. They chose a group to gather data on how much time each class used to get their lunch. They based the final schedule proposal on this added information. In the presentation of the proposed schedule (Table 1-7), the children included the time the classes actually took to be served as well as class size. The combination of class size and grade level helped make sense of the variations in the time it took to serve a class.

After reviewing the final proposal, the assistant principal asked the class to present the results of their study to the school and to explain their recommendation for a new lunch schedule. The schedule was implemented at the beginning of the next quarter. The children evaluated it by again collecting data on how long classes waited from the time they arrived for lunch until they were all served. They found that some teachers still did not follow the schedule, but in general the waiting times were shorter.

Table 1-7

FINAL SCHEDULE PROPOSAL: BASED ON TIME CLASSES TOOK TO BE SERVED

Class	Number of Children	Time to Serve Class	Final Proposed Schedule
1a	20	8	11:00
1b	18	7	11:08
1c	19	8	11:16
2a	19	5	11:24
2b	21	5	11:30
2c	21	6	11:36
3a	32	8	11:42
3b	30	7	11:48
4a	29	6	11:56
4b	31	7	12:03
5a	31	6	12:10
5b	30	7	12:17
6a	29	6	12:24
6b	28	6	12:30

Rules and Procedures in the Classroom

The telephone in Bret's room was frequently interrupting his teaching. He had fallen into the practice of always answering it himself. Now he wanted to involve the class in finding a better solution. Bret also wanted the class to experience math in real-world contexts. This could be a good opportunity for working with data. One problem was that the class had little experience collecting and sorting data on everyday things. So he developed an initial procedure that both produced baseline data and gave the children experience in recording data.

1-12: **Who called and why**

Who Called?	Why?
Ms. Abrams	Go to office

Gathering Information: Initial Analysis of the Problem

Bret began the project the next day, immediately following the first phone interruption. After the call he said:

> "That was Miss Abrams from the office. She wants someone to take the attendance sheets down right now. We're going to keep track of who calls on the telephone and why. Draw a line down a new sheet of paper. Label one side 'Who called' and the other side 'Why.' On the first line, write 'Miss Abrams' in the first column and 'take something to the office' in the second. Every time someone calls today, I will tell you who called and why they called. At the end of the day we are going to look at all this data and begin to figure a way to deal with these interruptions."

Toward the end of the day, the class came together to review the data they had gathered. They listed reasons

for the calls and classified them into groups based on similarities. They listed callers and tallied how many times each one had called. Bret asked everyone to spend some time that night thinking of a way to deal with phone calls so that the class would not be interrupted.

A Preliminary Design and Design Criteria

The next morning the children shared their solutions.

- Tell the principal to take the phone out.
- Tell the secretary she can't call during the class.
- Don't answer, just let it ring.
- Have a phone monitor answer the phone instead of the teacher.

Bret helped the kids think about the different solutions. The phone had been installed as a safety device, and it couldn't just be removed. If they just let it ring, the phone would still be disturbing the class—and besides, there might be an emergency. As the class considered the solutions, they were also beginning to see some constraints on the designs. They finally decided to try a phone monitor. Then they came up with preliminary instructions for the monitor, and a procedure for deciding who would be the monitor each day.

More Information-Gathering, Problem Analysis, and Solution Shaping

The monitor for the day was responsible for recording who called and why. The class would look at this new data after one week. By the second day, Bret decided it was time for the children to consider how the phone should be answered. The class decided on "Hello, this is Mr. Lenk's class." When the caller asked for Mr. Lenk, the reply was "I'm sorry, Mr. Lenk is busy teaching. May I take a message?" If a child had to report to the office, the monitor quietly told the child. When the monitor was uncertain how to respond, she or he interrupted Mr. Lenk for assistance. Whenever a monitor was presented with a new situation and didn't know how to respond, the class talked about it later and decided how to deal with the new request. They made up a booklet of requests that came by phone and the response for each type of request. This was the phone answering protocol.

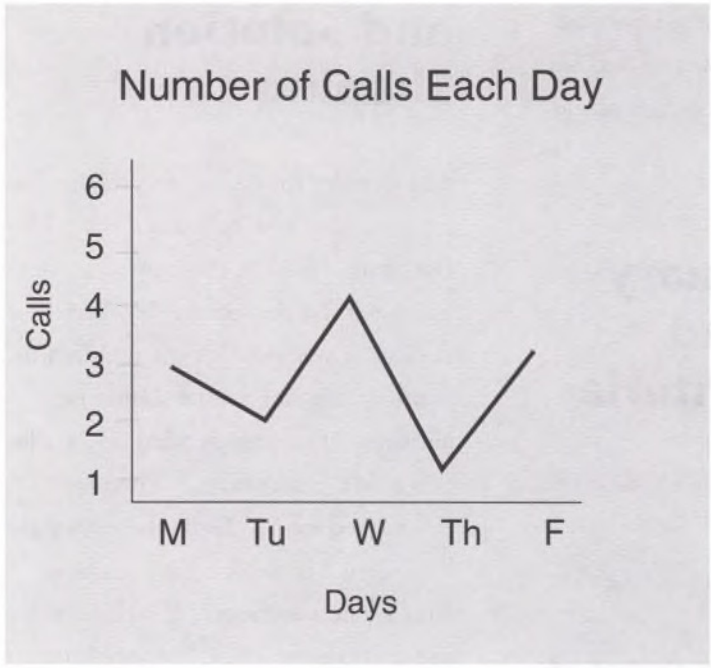
Design Evaluation and Redesign

At the end of a week, the class held an evaluation session. The main issue was: Did the phone interrupt the class as much as it used to? Did Mr. Lenk have to stop teaching as often? They looked at their data. They saw that there were many more reasons for calls than they had realized. They saw that most of the calls were from the school secretary. They also saw that the actual number of calls seemed to be decreasing. They didn't, however, have data on how many times Mr. Lenk had to be interrupted.

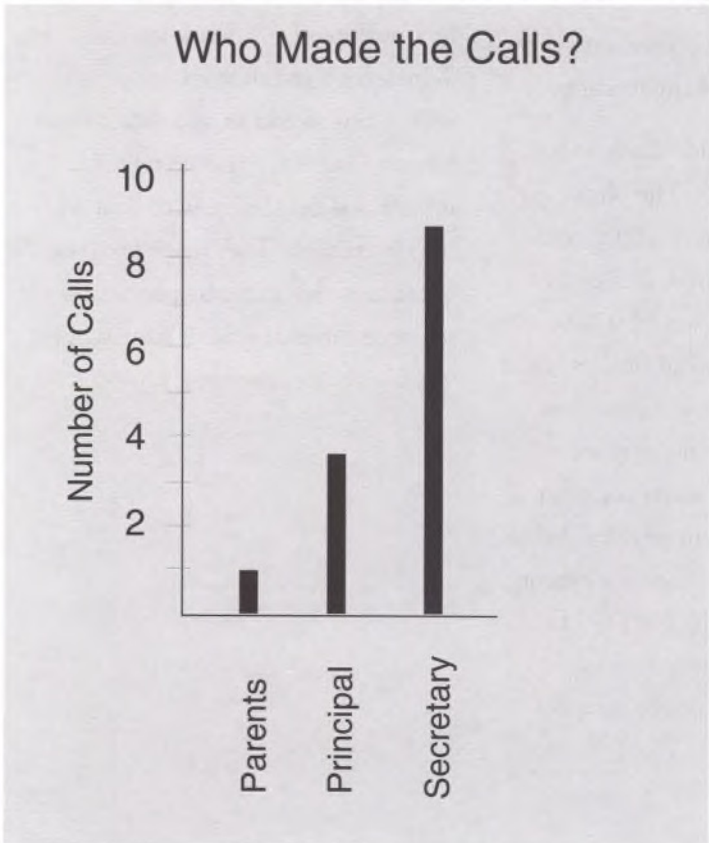
The design solution had been subject to continued evaluation and redesign during that first week as the class developed a telephone answering protocol. They decided to continue with the same system for the following week, but with a change in data collection. In addition to collecting data about the caller and the reason for calling, the monitor would also indicate whom the call was for and if that person had to be interrupted.

After the second week Bret worked with the class to think about how they might represent their data. They made line graphs to show the number of calls each day and bar graphs to show who made the calls.

1-13: **Number of calls each day**



1-14: **Who made the calls**



The class also made bar graphs to show the reasons for the calls.

Bret also asked students to whom they would like to show the data, and what the reaction to the data might be. Since most of the calls were from the secretary, they decided to discuss their results with her. They weren't sure what the results would be. Since many of the calls were for administrative information such as the lunch list and attendance list, the secretary helped the class think of how they could get the information to the office before it was needed. The secretary probably also became more sensitive to her calling, because the number of calls decreased.

The telephone-answering project differs from the other design projects we looked at in this chapter. The class did not gather all the information they could on telephone calls, analyze it, develop a protocol, try it out, and then evaluate it. Instead, they implemented an initial way of responding to phone calls that they continually revised. The adequacy of the protocol was evaluated with each phone call. When the monitor could respond to the call, the protocol was successful. When the monitor had to interrupt Mr. Lenk, the protocol was inadequate. Then the class had to change the protocol to address every new type of phone request. Each time the protocol was amended, it provided responses to more requests. The design processes used in the first three examples of this chapter are frequently referred to as constituting a design cycle. The development of a phone answering protocol is an example of design by repeated, short-term, design cycles. It is characterized by immediate evaluation and redesign of each new phone answering protocol. This represents a technology design project just as much as do the first three examples of design projects.

Designed Environments Projects and Life in the Classroom

Children and teachers in these three classroom vignettes see problems in the classroom and school as being their problems and they see themselves as able to address the problems together. These are real problems of telephone interruptions, excessive waiting for lunch, and a rug that is being worn too quickly. These are classrooms where teachers encourage children to think about real situations, and to work collaboratively to gather information and figure out ways to improve school and classroom environments.

Many teachers worry about control issues, especially when children are invited to share real responsibility in the classroom. In the above examples, however, none of the teachers relinquished control. Control was shifted to the analysis and design process. That process requires criteria to define what is meant for a procedure, schedule, or furniture layout to be functioning well. The design process also requires that there be an evaluation to see if the criteria have been met. By inviting their students' participation, these teachers shared the responsibility with their students, while teaching children how to design and how to evaluate a solution democratically. By helping children establish reasonable criteria for evaluation, the teachers guaranteed that the new design met their needs as well as those of the students.