

Evaluating the Solution: Since Smith paid up rapidly without major bloodshed, I regard the problem as satisfactorily solved.

In easy problems, we may go through these actions in order and without any difficulties. In hard problems, though, we may have to do a great deal of backtracking. For example, when we evaluate what we have done, we may decide that our solution is terrible—"No, that won't work at all"—and go back to planning. Or while trying to execute a solution, we may discover something about the problem that will lead us to represent it in an entirely new way—"Oh, now I see what kind of a problem it is!" Retracing of this sort is characteristic of problems that are called "ill-defined." We will discuss these in more detail later.

Our success as problem solvers depends on the effectiveness with which we can carry out each of the five actions just described. In this chapter, we will examine the nature of problem representations and the processes people use to form them. In addition, we will describe techniques for improving representations so that they make problem solving easier. In the next chapter we will discuss planning, executing, and evaluating. We will delay the discussion of problem finding until the final section of the book because this topic is closely related to the topic of creativity.

Section 2: What Is a Representation?

By definition, every problem must have a place where you start, the initial state, and a place where you want to end up, the goal. The difference between the initial state and the goal is the gap to be crossed. Every problem that can be solved must have one or more means to get from the initial state to the goal. These means are called operators. Operators act to change one state of the world into another, for example, one checker game position into another. In all but the simplest problems, operators must be applied several times to change the initial state step-by-step into the goal. In many cases, the operators have restrictions; that is, they can be applied only under certain conditions. An adequate representation of the problem, then, must include the relevant information about four aspects of the problem:

In this problem, we have little trouble understanding either the initial situation or the goal perhaps because we have lots of prior knowledge about railroads and railroad tracks. However, finding the right sequence of moves to solve the problem is surprisingly difficult. Remember, in the solution, the locomotive has to be facing left. The answer is provided at the end of the chapter.

Five Actions Involved in Solving Problems

Usually when we solve a problem, we put most of our attention on the problem and very little attention on ourselves—that is, on what we are doing to solve the problem. If we did attend to our own actions, we might notice that they often occur in a characteristic sequence:

- 1. Finding the Problem:** Recognizing that there is a problem to be solved.
- 2. Representing the Problem:** Understanding the nature of the gap to be crossed.
- 3. Searching for a Solution:** Choosing a method for crossing the gap.
- 4. Carrying Out the Plan**
- 5. Evaluating the Solution:** Asking "How good is the result?" once the plan is carried out.

This sequence of actions is illustrated in the following story.

Finding the Problem: I observe Smith, who claims to be too poor to repay the \$50.00 he owes me, buying round after round of drinks for his friends.

Representing the Problem: I conclude that Smith is not sufficiently serious about repaying his debt.

Searching for a Solution: I consider a polite telephone call or a note reminding Smith of his indebtedness, but decide instead to ask three very large friends of mine to call on Smith in person.

Carrying Out the Plan: I call my friends, who then deliver my message to Smith.