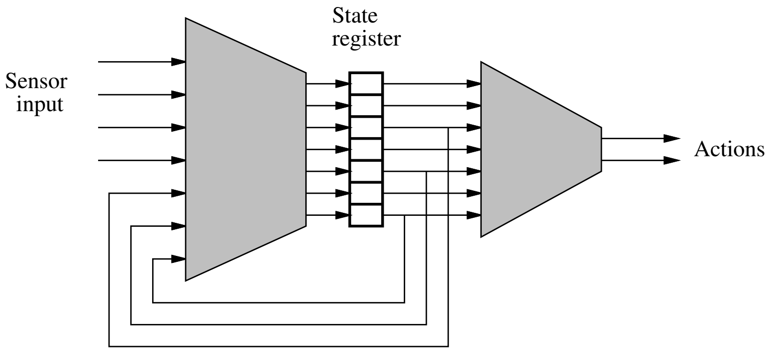

Figure 25.9 The basic structure of Rosenschein's situated automaton design. The shaded region on the left represents a Boolean circuit for updating the current state registers. The shaded region to the right represents a circuit for selecting actions based on the current state.

of "physics" are given to the compiler. Thus, the robot "knows" a set of propositions about the environment, even though it has no explicit representation of the propositions.

Rosenschein's basic design is shown in Figure 25.9. It relies on a theorem to the effect that *any* finite-state machine can be implemented as a state register together with a feedforward circuit that updates the state based on the sensor inputs and the current state, and another circuit that calculates the output given the state register. Because all the computation is carried out by fixed-depth, feedforward circuits, the execution time for each decision cycle is vanishingly small. Flakey, a robot based on situated automata theory, was able to navigate the halls of SRI, run errands, and even ask questions, all without the benefit of explicit representations.

BEHAVIOR-BASED ROBOTICS

Rodney Brooks (1986) has advocated an approach to robot design that he calls **behavior-based robotics**. The idea is that the overall agent design can be decomposed, not into functional components such as perception, learning, and planning, but into behaviors such as obstacle avoidance, wall-following, and exploration. Each behavioral module accesses the sensor inputs independently to extract just the information it needs, and sends its own signals to the effectors. Behaviors are arranged into a prioritized hierarchy in which higher level behaviors can access the internal state of lower level behaviors and can modify or override their outputs. Figure 25.10 shows a hierarchy of behaviors proposed for a mobile robot by Brooks (1986).

The main aim of behavior-based robotics is to eliminate the reliance on a centralized, complete representation of the world state, which seems to be the most expensive aspect of the classical architecture. Internal state is needed only to keep track of those aspects of the world state that are inaccessible to the sensors and are required for action selection in each behavior. For tasks in which the appropriate action is largely determined by the sensor inputs, the slogan "The world is its own model" is quite appropriate. In some cases, only a few bits of internal state are needed even for quite complex tasks such as collecting empty soft drink cans. Similar results have been found in Rosenschein's designs, in which the state register can be surprisingly small.

Behavior-based robotics has been quite successful in demonstrating that many basic competences in the physical world can be achieved using simple, inexpensive mechanisms. At