The Curling Draw

What sport skills use open- and closed-loop systems of motor control?

Curling is a sport played on ice. It is similar in concept to games such as shuffleboard, bocce, horseshoes, and darts, in which the goal is to propel an object toward a target. However, what makes curling unique is that, unlike these other sports and games, players have some control over the object once they have released it. In shuffleboard, the person who pushed the disk along the floor or table has no control over the location of the its final resting spot after the disk is on its way. The same is true for bocce, horseshoes, darts, and most other target games. But, this is not so in curling.

The basic goal in curling is to slide round granite rocks along a sheet of ice toward a bull's-eye. Two teams of four players alternate sliding each of their rocks. The goal is to have as many of your rocks as close as possible to the center of the concentric rings painted on the ice. Sometimes the appropriate strategy is a take-out, in which you run one of your rocks into your opponent's rock(s); at other times the appropriate strategy is to play a draw, in which you try to propel the rock with just the right amount of force to have it stop at an exact spot on the ice. Figure 7.1 illustrates a curling draw.

The ice sheet in curling is about 50 yards (45 m) long, and a rock weighs about 44 pounds (20 kg). Therefore, a considerable amount of force is required to slide the rock the full length of the sheet. One member of the team starts by pushing off from a fixed start point and sliding along the ice while holding on to a handle attached to the rock. The curler must let go of the handle at some point before crossing a line that is painted on the ice. At that point, the curler is about 30 yards (28 m) to the middle of the rings. We know from research concerning Fitts' law (see "The Calculator" in chapter 3) and Schmidt's law (see "The Gimme Putt" in chapter 3) that accuracy and consistency in aiming tasks degrade quickly as the distance to the target increases, or as the force applied to an object increases. In the case of curling, a heavy object is being propelled a long distance, over a duration of 10 to 20 seconds, to a very small spot on the ice—a very challenging task indeed!

To make the draw shot a little more precise, the rules of curling allow any or all of the members of the team to use broomlike objects to rub the ice just ahead of the curling rock. Rubbing with the brooms causes the ice to melt temporarily, reducing the friction between the ice and the rock and thereby

causing the rock to lose speed at a reduced rate and to slide straighter than it would otherwise. Many players use this strategy, sometimes starting and stopping the brushing as appropriate, to ensure that the rock achieves its final targeted resting point.

In shuffleboard, archery, darts, and most other targeting games, players have no control over the object once they have released it. The control of the flight of the object in these games involves what is called an open-loop process: the performer's influence over the final position of the object is complete once the performer is no longer in contact with the object. The take-out shot in curling is an open-loop process too, because the rock is slid with considerable speed (faster than the sweepers can keep up) and force (leaving little opportunity for melted ice to have an effect on the path of the rock). In contrast, the control of the speed and path of a draw shot is accomplished by what is called a closed-loop process. The process is illustrated in figure 7.2.

Essentially, figure 7.2 represents a closed-loop process in which there is a continuous assessment of the status of the rock with respect to its intended final position on the ice. If the rock is moving too fast, nothing can be done to slow it down. The curling team has to hope that the friction between the

From T.D. Lee, 2011, *Motor control in everyday actions* (Champaign, IL: Human Kinetics).

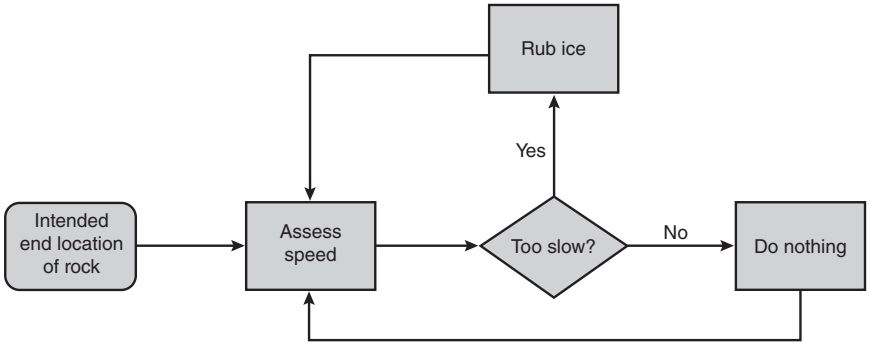

Figure 7.2 The closed-loop process of achieving a final location in a curling draw.

rock and the ice will be sufficient to stop the rock in time. However, the team must continue to monitor the status of the rock, because if it slows down too much, players will need to rub the ice to maintain its speed. This is a closed-loop process because the players are continuously assessing the status of the rock and comparing it to its intended goal. It is called a closed-loop process because all lines of communication feed back to a decision maker to maintain equilibrium with respect to the intended goal. Hence, a closed-loop system is one that depends on feedback.

Curling is a nice example of both the open-loop and closed-loop processes and provides an effective illustration of one of the important systems of motor control used by humans. Essentially, given sufficient time, we use information feedback derived from our senses to modify actions after they have been initiated. As the curling rock demonstrates, we need sufficient time to process the feedback to use the information effectively. Therefore, closed-loop motor control processes depend on the total duration of the movement and speed with which we can use sensory feedback. Consequently, researchers have spent considerable effort trying to understand how motor control is influenced when closed-loop processes are available, and the modes of control that are available when closed-loop control is unavailable. In the next story ("Cool Papa Bell"), I describe how one type of information feedback (i.e., vision) is used to regulate movement.

SELF-DIRECTED LEARNING ACTIVITIES

1. In your own words, define and distinguish between an open-loop system and a closed-loop system.
2. Modify the closed-loop flowchart in figure 7.2 to describe how you would use visual feedback to thread a needle.
3. Aside from vision, what other types of sensory feedback are commonly used for the closed-loop control of movement? Give examples of situations in which these forms of feedback would be used.

From T.D. Lee, 2011, *Motor control in everyday actions* (Champaign, IL: Human Kinetics).

4. Search the literature to find a study in which researchers determined the minimum amount of time required to use visual feedback to control movement. Describe the specific methodology used.

Notes

- The dimensions of a curling sheet are shown in this diagram:
  www.mycurling.com/articles/curlingsheet.html
- Although called curling "rocks," they are actually finely made pieces of rounded granite, concave on the bottom and highly polished to slide easily along the ice.
- A few things about the flowchart: decisions are denoted by triangles, actions are denoted by rectangles, feedback and lines of communication are denoted by arrows.
- The senses studied most in human motor control are vision and proprioception, although auditory feedback and tactile feedback are very important sources of information as well.
- This Wikipedia article provides a nice overview of the sport of curling:
  http://en.wikipedia.org/wiki/curling

Suggested Readings

Bradley, J. (2009). The sports science of curling: A practical review. *Journal of Sports Science and Medicine, 8,* 495-500.

Schmidt, R.A., & Lee, T.D. (2011). Sensory contributions to motor control. In *Motor control and learning: A behavioral emphasis* (5th ed., pp. 135-176) Champaign, IL: Human Kinetics.