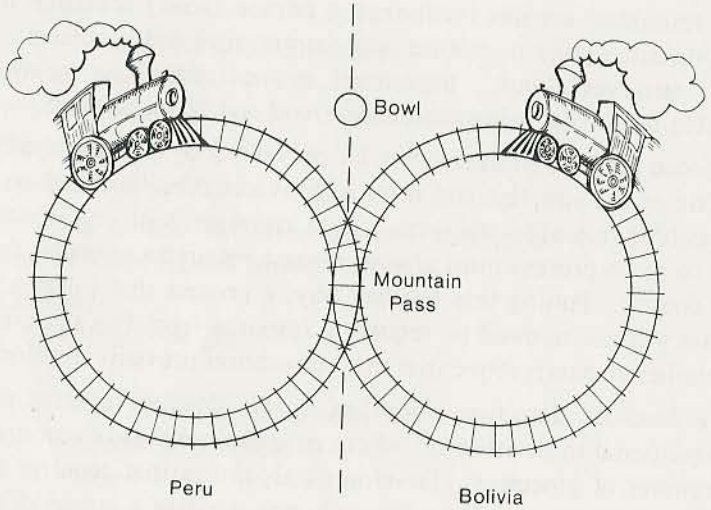
14. High in the Andes Mountains, there are two circular railroad lines. As shown in the diagram, one line is in Peru, the other in Bolivia. They share a section of track, where the lines cross a mountain pass that lies on the international border.



Unfortunately, the Peruvian and Bolivian trains occasionally collide when simultaneously entering the critical section of track (the mountain pass). The trouble is, alas, that the drivers of the two trains are blind and deaf, so they can neither see nor hear each other.

The two drivers agreed on the following method of preventing collisions. They set up a large bowl at the entrance to the pass. Before entering the pass, a driver must stop his train, walk over to the bowl, and reach into it to see if it contains a pebble. If the bowl is empty, the driver finds a pebble and drops it in the bowl, indicating that his train is entering the pass; once his train has cleared the pass, he must walk back to the bowl and remove his pebble, indicating that the pass is no longer being used. Finally he walks back to the train and continues down the line. If a driver arriving at the pass finds a pebble in the bowl, he leaves the pebble there; he repeatedly takes a siesta and re-checks the bowl until he finds it empty.

Then he drops a pebble in the bowl and drives his train into the pass. A smart aleck college graduate from the University at La Paz (Bolivia) claimed that subversive train schedules made up by Peruvian officials could block the Bolivian train forever. (Explain). The Bolivian driver just laughed and said that could not be true because it never happened. (Explain). Unfortunately, one day the two trains crashed. (Explain).

Following the crash, our college graduate was called in as a consultant to ensure that no more crashes would occur. He explained that the bowl was being used in the wrong way. The Bolivian driver must wait at the entry until the bowl is empty, drive through the pass and walk back to put a pebble in the bowl. The Peruvian driver must wait at the entry until the bowl contains a pebble, drive through the pass and walk back to remove the pebble from the bowl. Sure enough, his method prevented crashes. Prior to this arrangement, the Peruvian train ran twice a day and the Bolivian train ran once a day. The Peruvians were very unhappy with the new arrangement. (Why?)

Our college graduate was called in again and was told to prevent crashes while avoiding the problem of his previous method. He suggested that two bowls be used, one for each driver. When a driver reaches the entry, he first drops a pebble in his bowl, then checks the other bowl to see if it is empty. If so, he drives his train through the pass, stops it and walks back to remove his pebble. But if he finds a pebble in the other bowl he goes back to his bowl and removes his pebble. Then he takes a siesta, again drops a pebble in his bowl and re-checks the other bowl, and so on, until he finds the other bowl empty. This method worked fine until late in May, when the two trains were simultaneously blocked at the entry for many siestas. (Explain.)

From: Richard C. Holt. Concurrent Euclid, The Unix System, and Tunis. Addison-Wesley Publishing Company, Reading, Massachusetts, 1983.