Collisions between highway vehicles and trains are very costly. Calculations later in the chapter will suggest that a typical grade-crossing collision causes $450,000 of harm. The physics of a heavy railroad locomotive versus an automobile means that highway users suffer more than ninety-five percent of the harm. The probability of a collision can be affected by the actions taken by both the highway user and the "railroad." The highway user affects the probability by their conduct in checking whether a train is approaching before using a crossing. The "railroad" affects the probability by deciding on the type of warning signs and devices that are installed at individual crossings.

To describe the party that decides on the provision of warning devices as the "railroad" is somewhat misleading. The railroad does not act alone in the provision of grade-crossing warning devices. This responsibility is shared between the railroads, municipalities, state highway authorities and the federal government. The latter provide ninety percent of the costs of providing upgraded warning devices under the 1974 Rail-Highway Crossing Program.

**SOCIALLY OPTIMAL LEVELS OF CARE**

The starting point for the analysis is the determination of the socially optimal levels of due care for the "railroad" (RR) and the highway user (HU). For expositional simplicity the shorthand term "railroad" will be used to represent the whole cast of characters involved in the decision to provide warning devices. Of necessity the analysis will be very simple, and make some very broad and sweeping assumptions about collision probabilities, prevention costs, and the harm caused by collisions.

Both the railroad and the highway user can choose between two levels of care. The railroad can choose between providing passive warning devices, such as crossbucks or stop signs, or a higher level of care involving active warning devices such as train-activated flashing lights or gates. Highway users can either adopt their current level of care, or take a higher level of care. Currently highway users are not as careful as they could be. Railroad lawyers comment that they rarely encounter a grade-crossing case in which the highway user has not been negligent in some way, either by reckless behavior or by inattention. A higher level of care will be defined as that necessary to reduce the number of collisions to only those
where the highway user has inadvertently stalled on the crossing. Adopting this higher level of care would reduce the number of collisions by three-quarters at crossings with passive warning devices, and by eighty percent at crossings with active warning devices (FRA, 1997b).

The first step is to estimate collision probabilities. Based on information on crossing usage in FRA (1997b), one can calculate that at crossings with passive warning devices and with highway users exercising their current level of care, the probability of a collision is 63.5 per billion vehicle crossings. Installing flashing lights at such crossing is estimated by the DOT to reduce collisions by seventy percent to 19.1 per billion vehicle crossings (DOT, 1986). Based on the discussion in the previous paragraph, these two rates would be reduced by seventy-five percent and eighty percent respectively if highway users exercised a higher level of care.

The second step involves an estimation of the costs both parties incur by taking care. Industry sources suggest that the cost of installing flashing lights at a crossing is about $80,000. For simplicity, the initial installation costs will be amortized equally over the twenty-year life of the equipment. There are annual maintenance costs of $1,700, calculated based on inflating figures given in DOT (1986) by a construction price index. Therefore, the cost of care is $15.60 a day.

The cost to the highway user of taking a higher level care is more speculative. When passive warning devices are installed, drivers may have to slow down to observe if a train is coming. The word "may" is used because circumstances will vary from crossing to crossing. At some crossings in prairie states, drivers are able to observe a train approaching from a great distance away and do not need to slow down. At other crossings, curvatures of the highway or the railroad require vehicles to slow down on all occasions. Other crossings will be somewhere in between where vehicles only need to slow down at certain times of day or in certain climatic conditions. The proportion of traffic that needs to slow at a particular crossing in order for road users to take a higher level of care will be denoted by P.

The model assumes that currently nobody slows down, which is clearly an exaggeration. If a driver has to slow down in order to observe whether a train is approaching, the model assumes that the driver will brake from fifty miles per hour to twenty miles per hour when he or she encounters a crossbucks sign at 750 feet from a crossing. This slowing and the subsequent acceleration cause a time penalty of ten seconds. Transportation economists have a long history of estimating dollar valuation of time delays. More recently, researchers have shown that the valuation of time depends on the circumstances in which the time delay occurs. The time taken while driving on a congested highway has been found to be valued higher than the time taken while driving on an uncongested highway (Bein, Miller and Waters, 1994). Certainly time taken slowing for a railroad crossing or waiting at the crossing is as irritating as driving in heavy traffic. This research suggests the value of time in such circumstances is about $13 an hour, which would translate into a time-delay cost of 3.6¢ for each driver who slows down. Therefore if highway users adopt a higher level of care, they would each incur a cost of 3.6P¢, where P is as defined in the previous paragraph.