

CHAPTER 1

INTRODUCTION

Intelligent cruise control (ICC) has been introduced into the automobile market as a convenience option with potential safety and throughput benefits. It is a step up from conventional cruise control (CCC), maintaining both a selected speed and a time headway. This thesis uses data gathered from an ICC field test to investigate the throughput and safety impacts of ICC.

1.1 The Problem: Roadway Safety

Millions of accidents occur on American roadways every year. In 1994 the cost of motor vehicle crashes was estimated at \$150.5 billion (Blincoe, 1994). A variety of statistics are available categorizing crash data by severity of injury, road type, vehicle type and crash type. In other words, safety is a major concern that receives a great deal of attention.

A variety of automobile options have been developed in order to improve safety. This has included the introduction of seatbelts, antilock brake systems (ABS), and airbags. ICC is yet another option with potential safety benefits. ICC attempts to assist drivers in better maintaining a safe headway under normal driving conditions.

1.2 Thesis Objective

As described in the previous section ICC has the potential to improve roadway throughput and safety. The first step in determining whether or not ICC has an effect on the system is to determine what differences exist between ICC, CCC and manual driving modes. Specifically, this thesis attempts to answer the following:

1. Does driver workload (number of cruise control button presses) change with ICC use?
2. Does ICC result in higher usage of cruise control compared to CCC?
3. Does ICC result in a higher accident risk as measured by surrogate measures (near encounters)?
4. How does ICC compare to CCC and manual car-following behavior?

1.3 Methodology

This section describes the approach used to answer the questions raised above. As indicated, this thesis used ICC field data for analysis. The data were obtained from a year long Field Operational Test (FOT) performed in Ann Arbor, Michigan. A total of 108 drivers were allowed to drive 10 ICC equipped Chrysler Concordes for 2 or 5 weeks. Both groups of drivers experienced one week of driving the Concorde in a standard configuration (no ICC) before ICC functions were made available. The 108 volunteer drivers performed approximately 11,000 trips. Speed, acceleration and other measures (GPS coordinate, range, range rate, brake status, usage of the cruise control, etc.) of the ICC-equipped vehicle were recorded every deci-second for each of these trips. A trip summary file was generated from these raw data, which included the trip length and duration, the number of times various cruise control buttons were pressed during a trip, the number of brake presses during a trip, and the number of brake interventions and close encounters during the trip.

The initial step was to extract similar trip data from the Field Operational Test database. These similar trips were defined as trips conducted by the same driver, within a pre-defined time-of-day temporal window, and originating and ending within a pre-defined spatial window. Once these trips were extracted, workload changes (buttons pressed and brake interventions) were determined through a macro-level analysis (aggregated over trip). The objective of the macro level analysis was to identify any aggregate differences in driver behavior between ICC and CCC.

Based on the differences that were found in the macro analysis, a micro-level analysis was conducted. The micro-level analysis investigated differences at the deci-second level in order to characterize the differences that were found at the macro level. Micro-level analysis results were based upon deci-second data extracted from the similar trips described above. The purpose of this data extraction was to isolate the effects of a particular driving mode. Correlation values were determined in order to quantify day-to-day variations for speed, acceleration and headway. In addition, percent distributions of speed, acceleration and headway and plots showing the probability of using ICC or CCC (based on speed) were created. Speed-headway plots were used to determine differences in car-following behavior.

1.4 Thesis Organization

Following this introduction, Chapter 2 is a summary of the literature review performed for this thesis. This includes an initial description of both conventional and intelligent cruise control systems so that a comparison between capabilities can be made. Further information on several ICC systems is described showing that not all ICC systems are alike. Following a description of the various types of ICC applications, this chapter synthesizes the results of evaluation studies of these ICC systems. Also included are several descriptions of car-following models reflecting various approaches to car-following modeling.

Chapter 3 is the first of two data analysis chapters. It provides a description of the Field Operational Test (FOT) performed in Ann Arbor, Michigan. Also included is a description of similar trips and the similar trip extraction process. Furthermore, macroscopic analysis compares intelligent cruise control usage to conventional cruise control usage.

Chapter 4 furthers the analysis of similar trips. An initial description of the data extraction process is followed by several micro-level analyses. This includes a day-to-day variation analysis based on speed, acceleration and headway. In addition, the most probable speed, acceleration and headway as well as the probability of using cruise control (ICC or CCC) for two selected road facilities is determined. The final analyses of the chapter are car following behavior comparisons. One is based upon aggregated speed-headway data while the other is based on fitted speed-flow-density relationships.

Finally, Chapter 5 summarizes conclusions made in data analysis chapters as well as provides recommendations for further research.