An Interactive, Reconfigurable Display System for Automotive Instrumentation

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Author(s): Jesse Ortega Claude Barker Cary Wilson Robert Kruse

Affiliated: AC Spark Plug, GMC BOC-Flint Engineering, GMC

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ABSTRACT

The decision to improve consumer interface with on-board vehicle systems in the new Buick Riviera presented many challenges. The major challenges were how to display the information and how to optimize the driver's interface with the display. Challenges were met with the development of an interactive and reconfigurable display system based on CRT (Cathode Ray Tube) and transparent membrane switch technologies. Human factors concerns were resolved, design requirements were met, limitations in existing technologies were overcome, and testing has verified that original design goals were met or exceeded.

IN THIS PAPER WE WILL SUMMARIZE the development of the Graphic Control Center (GCC). The GCC is standard equipment on the 1986 Buick Riviera. It combines many display and control input systems into one reconfigurable system. We will first present an account of the evolution of the overall design concept from a systems viewpoint. We will then show how human factors and testing augmented the development of the display/control system. Then we will discuss the design features of the CRT controller and the CRT monitor assembly. Finally we will present an overview of the test program used to validate this system.

EVOLUTION OF DESIGN CONCEPT AND VEHICLE SYSTEM GOALS

Need for a Versatile Control Unit - The 1986 Riviera electrical system started as a list of possible Electrical/Electronic features and functions being considered for the mid and late 1980's. Initial design objectives indicated that the vehicle would be smaller, including the instrument panel area, and that the theme of the vehicle would call for "Cockpit" styling. The intent was to consolidate the controls in the upper portion of the panel for good "eyes on the road" controls position. The image of the vehicle required that the displays and controls be as contemporary, and as advanced as possible. Also, styling and human factors allowed for the controls/displays area to be moved closer to the steering wheel for ease of reach in activating controls.

As the architecture of the electrical/electronics system solidified it defined that the vehicle system would utilize a central processing module that would allow for increased vehicle diagnosis, ease of feature interaction and versatility for future expansion. This fact led to the need for developing a control system that would be as versatile and expandable as the vehicle system itself.

The initial developmental control panels utilized Vacuum Florescent displays in conjunction with conventional control buttons. Each feature, therefore, required instrument panel real estate dedicated to each specific control/display panel. Based on the final decision of content on the

1986 production intent Riviera, the dedicated display requirements numbered a minimum of eight (8), and the controls were in excess of 100 individual switches.

In order to achieve the initial program objectives of styling and system architecture, the decision was made to provide a universal display that would be reconfigurable, [thus allowing for the ability to share display/controls amongst many features]. This led to a study of functions in the instrument panel system to determine which items were adaptable to a shared display/control format. The outcome of the study concluded that the controls would be split into two types:

Primary - Required for the normal operation of driving the vehicle, and;

Secondary - Feature or function controls and displays not specifically required to operate the vehicle.

The secondary controls were to be integrated into the reconfigurable control system. They include:

Radio
Heater/Ventilation/Air Conditioning (HVAC)
Trip Monitor
Sidereal (including Clock, Day, etc.)
Gages
Diagnostics (vehicle status, failure codes, service, etc.)

Selection of the Display Technology - The next program decision required was to decide which technology should be utilized for the display. System architecture for the vehicle was defined to be a central logic processing module that would interface with other "dumb" modules via a Universal Asynchronous Receiver Transmitter (U.A.R.T.) data link. The dumb modules would only include enough intellegence to interpret the link data, perform minimal local tasks (such as displaying information to the vehicle operator) and provide information to the system, (including putting switch or sensor status into the system via the link). Thus, the secondary reconfigurable display/control device would also be a "dumb" module. Since the system was digital in format, and the display should be universal, it was obvious that a "Dot Matrix" type of display was desired.

An analysis was conducted to determine the state of readiness of various "Dot Matrix" type displays. The following technologies were reviewed.

L.E.D. (Light Emitting Diode)
L.C.D. (Liquid Crystal Display)
Neumatic Technologies
Plasma Displays
Gas Discharge Displays
C.R.T. (Cathod Ray Tube)

A criteria chart was developed to measure the acceptability of the various technologies to vehicle parameters. The major parameters were brightness, design flexibility, development adaptation, packaging, weight, support electronics, durability, environmental compatability and cost. After much evaluation the decision was made to use CRT as the display media.

Selection of the Switch Technology - The other major decision was the form that the controls, or switches, would take. Again, in order to achieve the reconfigurable requirement for the system, not only would the displays have to be reformatable, the controls would also have to be reconfigurable.

As a result of further analysis, it was decided that the controls or switches would be displayed on the CRT monitor, and a transparent switch would be mounted in front of the monitor. This allowed us to define the required controls utilizing software. The controls, including location and function could be changed, or reconfigured, by changing the displayed video. This type of control became known as a soft switch. The two main technologies considered for the transparent switch were an I.R. light matrix and one based on membrane switching. The selected form is a transparent membrane switch which will be discussed later in this paper.

Screen Format Selection - The CRT touch screen uses a free format display as opposed to segmented diaplays. The most important issues in the development program became the display "Graphics", and the priority of information and control functions. Controls were to be grouped by major features. The motive was to include all of the controls of a particular feature on a single display. This display was to be called one "Page". The Radio, for example, would have one page of controls, as would Climate controls, Trip Monitor, etc.

In order to select the desired page of controls, perimeter switches (located on the periphery of the CRT display) were added. They were identified as "Hard Switches" since their function never changed, and were always exposed to the vehicle operator.

Due to the human factors input only a specific density of controls were to be allowed on any one page. This soon led to prioritizing of controls within

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