Reconfigurable Displays Used as Primary Automotive Instrumentation

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Author(s): Kim M. Corsi Walter J. Sattler

Affiliated: General Motors Corp. Delco Electronics Corp.

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Kim M. Corsi
Advanced Engineering Staff
General Motors Corp.
Walter J. Sattler
Advanced Instrumentation Engineering
Delco Electronics Corp.

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Kim M. Corsi
Advanced Engineering Staff
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ABSTRACT

Application guidelines were established to structure the driver interface required for a reconfigurable automotive primary display. An advanced driver information system incorporating these guidelines was integrated into a concept car. This paper describes the design, integration, implementation, and ongoing evaluation of this system.

ENTERTAINMENT FUNCTIONS, DRIVER INFORMATION, and driving aids are proliferating in today's automobiles. This actuality inspired the conception of an advanced driver information system which utilizes a reconfigurable display located in the instrument panel directly in front of the driver. Application guidelines were established to use as a basis for designing and implementing this system in a functional concept car.

The factors driving the acceptance of reconfigurable displays in cars of the future are derived from two realities: the computer revolution in the workplace and the trend toward marketing advanced information features in cars (1)*. With computers in daily use in the workplace, people are accustomed to managing the vast amount of information that they need to do their job. Automotive designers believe that many drivers similarly may desire a vehicle that allows them to select the information they need to start their trip and to get new, possibly important, information while enroute.

*Numbers in parentheses designate references at

The primary function of the automobile is to provide land transportation for people from one location to another. Designers must preserve this simple objective when features are added to the car to assist the driver in getting from point A to point B. Several advanced information features were added in this concept vehicle. The challenge is to simplify the visual and tactile loading in the driver interface in spite of the features added to the standard information displayed in today's cars.

Efforts are ongoing to improve the driver interface, consisting of a display system and mode selection controls, to: 1) optimize information presented to the driver, 2) simplify driver tasks and 3) minimize distraction.

DISPLAY SELECTION

DISPLAY SYSTEM DESIGN REQUIREMENTS - Guidelines (2,3,4) were established by the authors to discern which display technology best suited the need of this specific project.

These guidelines, which are itemized below, assume that the reconfigurable display will be the primary information readout in the vehicle. These guidelines were derived to assist in the selection of the display and graphics for the concept vehicle.

- Location - Position the panel within a visual cone defined by a 15 degree angle from the driver's line of vision looking down the road.
- Size - Panel area is determined by the maximum amount of graphics to be displayed at any one time. This concept vehicle required

- o Shape - Panel contour is determined by the styling theme and the need to minimiz obstruction by the steering wheel.
- o Legibility - Alphanumeric characters and other symbols should occupy an area subtending at least 20 arc minutes of the drivers vision.
- o Resolution - Graphic displays should appear to be continuous, i.e. the individual picture elements' construction should not be obvious. The resolution/addressability ratio should be 1.0 to 2.0.
- o Response Time - The display should reconfigure within 1/8 second including switch recognition time.
- o Contrast Ratio vs. Ambient Illumination - The panel should have a minimum of a 10:1 contrast ratio in direct sunlight and should be dimmable to 2 footlamberts or less in total darkness. Refer to Fig. 1.
- o Effective Use of Color - The following advantages result from the appropriate use of color: functional linking, eye appeal, traditional warning codes, and varied emphasis by selecting colors based on their visibility as indicated by the position of the color on the photopic curve.

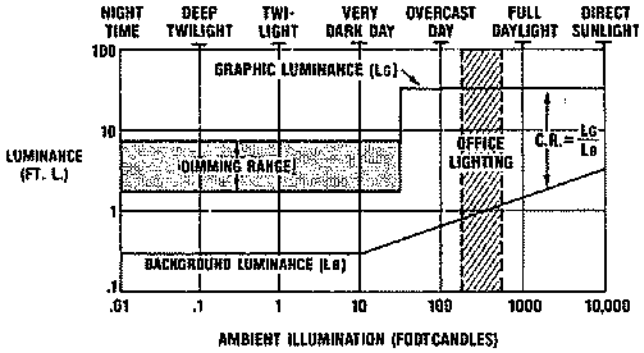

Fig. 1 - Contrast ratio vs. ambient

DISPLAY TECHNOLOGIES VS. REQUIREMENTS - Many reconfigurable display technologies were considered for use in this project. They were reviewed with respect to the extent to which they meet the guidelines listed above. Some were dismissed immediately since prototypes that were available without additional development effort totally lacked certain important qualities.

The two display technologies that best met the requirements, Liquid Crystal Shutter/Cathode-ray Tube (LCS/CRT) (5) and Thin-film Transistor/Liquid Crystal Display (TFT/LCD) (6), are compared on the "snowflake diagram" in Fig. 2. This snowflake diagram was developed by the authors to aid in the selection of a display. Each spoke of the diagram represents a display requirement. The spokes shown were sufficient for this "concept" project. However, additional requirements such as cost, life and environmental resistance must be added for production intent projects. Each spoke is terminated at the level beyond which no significant benefit is derived. Also, it is true that any technology could be adapted to optimize one or two parameters at the expense of other important requirements. The data charted on the diagram was taken from LCS/CRT samples and from TFT/LCD manufacturer's data.

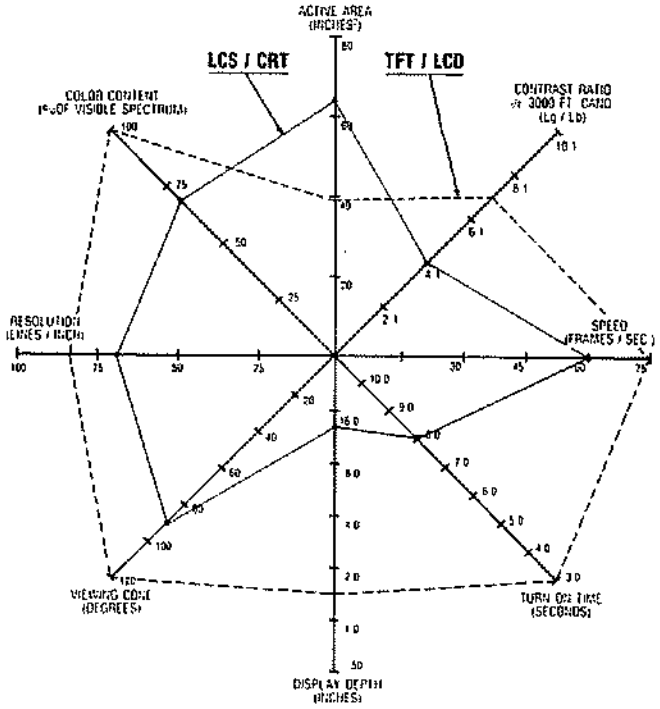

Fig. 2 - Display technology comparison

THE DRIVER INTERFACE VEHICLE DISPLAY - Although the TFT/LCD display surpasses the LCS/CRT in all but one parameter on the snowflake diagram, the LCS/CRT was chosen. This display was selected because its viewing area, (67.7 square inches), is significantly larger than the viewing area of TFT/LCD display (36 square inches) that was available at the time this comparison was made. The larger area is required to display all the information desired for this project. Although the LCS/CRT's parameters did not meet the authors' ideal specifications, they were sufficient for this project. The display's main function here is to demonstrate the concept of positioning a reconfigurable display directly in front of the driver and to demonstrate various functions which can be be supported by such a display.

The LCS/CRT display chosen consists of a

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