by **Dale Maunu** | Optrex America Inc.

BLIND SPOTS AND BACKING UP: CHOOSING THE RIGHT DISPLAY IS CRITICAL

With the amount of information presented to the driver in modern cars, the display has become an important part of the dashboard. Hence, the designer must take into consideration a wide range of issues when developing displays for automotive use. In this article, the author examines concerns when using such displays with a rear-view camera system for blind spots and backing up.

If Hollywood were to remake the classic 1960's movie "The Graduate" today, the young protagonist might receive different one-word career advice. Instead of "plastics," the word today could just as easily be "telematics."

The fact is that vehicle telematics have become an important part of today's transportation systems, and there is every indication that this role will only increase in the future. Traditional information functions of vehicle and diagnostic data have expanded beyond a speedometer needle and some "warning lights" on the dashboard. Speed, average speed, fuel consumption, available range, and fuel economy are common features. Now that cars rely heavily on computer technology for diagnostics, more detailed information is available to the driver when one or more systems need attention.

Figure. 1. It is reported that more than 100 children are backed over and killed in the United States every year. Photo courtesy KIDS AND CARS.

Other traditional functions have become more complex and more integrated. Instead of a pushbutton dashboard radio, drivers have access to complete entertainment systems on wheels that can include radio, satellite radio, multiple-CD changers, audiocassettes, and even Apple iPods and other personal audio devices. Rear seat passengers can view DVDs. Some entertainment systems are even integrated with cellular phone systems, for hands-free operation and automatic muting of audio entertainment when placing and receiving calls.

Navigation information has grown, both on small and large scales. GPS systems can provide routing information, complete with audible instructions. New systems help with traffic avoidance, inadvertent lane-change alerts, and even "blind spot" monitoring. Some can even identify when the driver is falling asleep. These combined systems can greatly improve driving efficiency and safety.

Some systems provide remote diagnostics and alerts, such as the OnStar system that uses GPS data and cellular phone connections to notify the service of mechanical problems or accidents. Other systems can automatically pay road tolls; in some cases, the vehicle does not even have to slow down.

THE DISPLAY FACTOR

The one common thread through all of these applications is information. And as these multiple applications are more widely adopted, efficiency will call for tighter integration of the components. If each function has its own set of controls, the modern automobile dashboard will look more like a jetliner cockpit.

The key to efficient integration is to receive instructions from the driver and deliver information effectively. The information delivery can be handled in part by sound — such as the spoken instructions from a GPS or warning chimes — but most of the information needs to be delivered visually.

With separate devices for the various applications, simple displays can often handle the tasks. For example, a radio tuner need not show much more than the radio frequency and this can be accomplished with a simple segmented numeric display.

Integration can make more efficient use of dashboard space and driver attention. This means that more information will be displayed in a single location than with discrete devices. Displays become multifunction devices that show different types of information in different contexts, as requested by the driver or initiated by the vehicle's monitoring systems.

In such a case, designers will need one or more graphic matrix displays. There are many technologies from which to choose, and many factors to be considered when making a choice. To help make this selection process more concrete, let's focus on one specific application: rear-view video cameras.

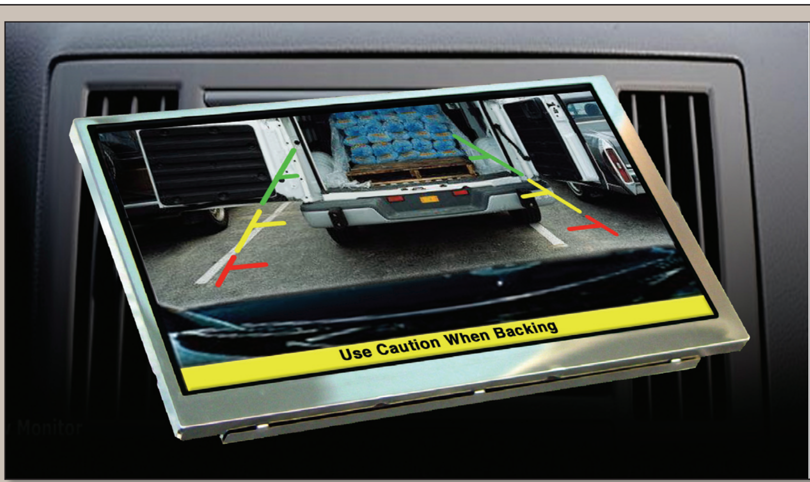

Figure 2. Display panels can be built into the dashboard in a fixed position, such as the center console displays. Photo courtesy Optrex America Inc.

BLIND SPOTS AND BACKING UP

Rear-view video cameras are a rapidly growing application for factory-installed and aftermarket products. They address a serious safety issue. As cars have grown larger — such as the family SUV or minivan — the blind spot behind the car has grown larger. According to tests published by *Consumer Reports*, a 5-foot 1-inch-tall driver may not be able to see any closer than 50 feet behind the vehicle, and even for some small sedans, this distance can be more than 40 feet.

The U.S. Department of Transportation reports that 27% of all accidents occur when the vehicle is in reverse, and that 70% of these could be avoided with a collision avoidance system. The U.S. government does not track non-traffic, non-crash accidents involving children 15 years old or younger, but the non–profit organization, KIDS AND CARS, compiles its own figures (Figure 1).

"At least 50 children are being backed over or into every week in the U.S.," said Janette Fennell, founder and president. "Forty eight of those children have to be treated in hospital emergency rooms, and at least two of that number are killed." Back-overs are 15% of all the auto-related child fatalities tracked by the group, according to Fennell. "Four years ago, this wasn't even an issue," she said, noting that it had become more prominent due to the increase in larger vehicles like SUVs, minivans and pickup trucks. "Over 100 children are being backed over and killed every year," she reports.

Some vehicles are outfitted with ultrasonic devices to help detect obstructions behind the car when backing up, but these do not always reliably detect all obstacles. (And, there is an additional problem of false alarms that can lead drivers to discount the warnings.) A much more effective solution is to use a rear-view video camera: an electronic-equivalent of a periscope covering the blind spot behind the car.

The two key components of rear-view video systems are the camera and the display. The camera is typically a small device — no bigger than a trunk lock when installed — so it can be mounted unobtrusively on a lift gate, trunk lid, body panel or

Table 1: Feature comparison of sample color matrix LCD panels.

Diagonal (inches)	Resolution	Active Area (mm)	Oper. Temp (Deg. C)	Contrast Ratio (25 °C)	FPC interface
3.5	320 x 160	85.94(W)x49.5(H)	-30 to +85	250:1	Digital
4.9	320 x 96	119.99 (W) x 35.985 (H)	-30 to +85	150:1	Digital
6.5	400 x 240	143.4 (W) × 79.320(H)	-40 to +85	350:1	Digital
6.5	400 x 234	143.40 (W) x 79.326 (H)	-30 to +85	150:1	Analog
7.0	480 x 234	154.08(W) x 87.048(H)	-30 to +85	350:1	Analog
8.8	640 x 240	209.28(W) × 78.48 (H)	-40 to +85	350:1	Digital
9.0	800 x 480	196.8(W) 118.08(H)	-30 to +85	450:1	Digital

even a bumper. It can be monochrome or color, and should have a large enough sensor to support a wide-angle lens with sufficient resolution. Some cameras use a less-expensive CMOS imager, but these tend to have low-quality images and poor performance in low-light settings. A better solution is to use a charge-coupled device (CCD) detector, which are found in digital cameras and camcorders.

Some cameras even provide additional illumination, to provide better images at night. A circle of infrared (IR) LEDs surround the lens, providing extra illumination for five to 10 feet behind the car.

Choosing the right camera configuration, however, turns out to be relatively easy compared with picking the display.

DISPLAY DESIGN CONSTRAINTS

Anyone who has driven with a backseat full of toddlers knows first-hand that the family car can be a challenging environment. Design engineers must also take a wide range of concerns when developing displays for automotive use, such as rear-view video systems.

For example, the display must be legible under brightly lit conditions. If the display is to be easily seen by the driver, it is almost certain that the panel could be in direct sunlight under some conditions. As a result, the display must be far brighter than a typical home television or computer monitor. For some applications, up to 600 cd/m2 may be required.

It's not enough to be bright, however. Car displays also must know how to be dim. A display running at full brightness at night would pose a safety hazard, as it would ruin the driver's night vision. For night driving, displays should be restricted to 3 cd/m2 to 5 cd/m2, which is less than 1% of the full brightness level. In addition, the image quality must not be affected by reducing the light output; contrast and color must remain unchanged in order to continue to provide useful images.

The operating environment poses additional challenges. The display must be ruggedized to survive the physical shock and vibration experienced by automotive systems. The passenger compartment can experience temperature extremes of -35 °C to 85 °C, and the display must be able to operate reliably in such extremes. You can't ask the driver to wait for the display to warm up before driving on a cold morning.

Another consideration is electromagnetic interference (EMI). The entire system — including the display — must not be susceptible to interference from the engine's ignition or from other electronic devices. In turn, the system must be a good neighbor, and not be a source of interference for any other device.

Finally, the display must fit the available space, not to mention the budget for the bill of materials.

DISPLAY LOCATIONS

Different display technologies give designers a range of choices for graphics matrix panels. Unfortunately, flexible panels that can conform to curvilinear surfaces remain in the future, so choices are limited to flat, rigid panels. Still, choices of size and shape are available within that limitation.

Display panels can be built into the dashboard in a fixed position, such as the center console displays shown in Figure 2. They can also be designed to flip down from overhead positions or emerge from dashboard or console positions. LCD technology can be transparent when not active, so it is possible to incorporate the display right on the rear-view mirror. The image disappears when not in use, but then appears in a portion of the mirror, creating a natural extension of the normal, reflected image.

APPROPRIATE TECHNOLOGY

At the lower end of the cost options, monochrome LCDs offer some attractive features. A variety of super-twist nematic (STN) technologies are available that work across a wide range of temperatures. Some suppliers, such as Optrex, can provide these panels in shapes other than the traditional rectangle, such as a circular panel. Optrex can also provide panels with holes in them to accommodate the pointer axles for a variety of gauges, such as speedometers and tachometers.

Consumer expectations are set for full-color displays, however. From cellular phones to PDAs, from bank ATMs to portable DVD players, full-color LCD displays are commonplace. A full-color display for a rear-view video system will help the driver identify obstacles more quickly and more accurately.

To get full color, the best solution is to use a thin-film transistor (TFT) LCD panel, though these are limited to rectangular panels at present. These are available in a range of sizes, typically from 4.9 inches up to 9 inches diagonal, with smaller 3.5-inch models likely to become available soon.

Resolutions start at about 320 x 96 pixels, which is about one-tenth the number of pixels as found on a typical TV screen. Larger panels, such as 9-inch diagonal models, can have 800 x 480 pixels, which is equivalent to a standard television with a wide-format screen. This provides plenty of space to display information, and is also suited for showing wide-format DVD movies in full detail.

TFT panels are available with luminance ratings that approach 600 cd/m2, and contrast ratios as high as 450:1. They are ruggedized, able to withstand the rigors of automotive applications. They can operate within typical temperature ranges. They come with a range of interface options, which can make it easy to connect with an off-the-shelf CCD video camera module.

And they have the thin dimensions and lightweight form factors that make it easy to fit them into the most demanding space requirements, whether it is a display that flips down from behind the rear-view mirror or is incorporated directly into a dashboard display.

REAR-VIEW VIDEO DISPLAYS

At present, many new cars offer rear-view video systems as a standard or optional feature. There are also dozens of aftermarket products designed to make it easy to retrofit older cars with such a system.

As driver demand for more information increases, and passengers expect more options for entertainment, we can expect to see increased use of graphics displays in automotive dashboards. Just as modern aviation has abandoned the classic "steam gauge" instrumentation in favor of the "glass cockpit," we can expect to see more cars with one or more full-color multifunctional displays as an integral part of the dashboard design. Drivers will be able to request different information as needed for different situations and conditions, using touch-screen features, steering wheel-mounted controls, and voice-recognition systems.

The displays will be able to provide a full range of information, including navigation, communication, diagnostics, entertainment and safety. And a rear-view video system is a central component of the safety system, likely to become standard on all cars before long.

Key to the success of these integrated information designs will be the selection of the optimum display panel. Fortunately for the designers of tomorrow's cars, the panels that they will need are available today. ■

ABOUT THE AUTHOR

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