Designing Next-Generation Automotive Center Consoles

By Prem Kumar Arora, Product Manager Automotive HMI & Manu Verma, Automotive Biz Dev Manager Asia and Pacific, Cypress Semiconductor Corp.

Executive Summary

With the trend of increased adoption of consumer electronics in the automotive industry, the design of the center console is undergoing a major shift. This article covers some of the emerging trends which are finding increasing adoption in the center console. These technologies not only provide a seamless human machine interface for when the passenger uses a cell phone or the car navigation unit, but also enable automobile manufacturers to save money, improve reliability, and create a shift in the aesthetics of the car.

With greater emphasis being placed on the user experience and an increased need for design differentiation, automotive human machine interface (HMI) has gone through a paradigm shift and is taking the user experience to a whole new level. The center console, located in the center of the front interior of an automobile, has a display and control switches for Infotainment, HVAC, communication modules, and other functions. It is an essential component of an automobile interior as it consolidates access to these systems and provides the user with all the relevant information required for an enhanced and controlled driving experience.

Traditionally center consoles have been a stack-up of Infotainment and HVAC modules with mechanical control switches on relatively flat plastic overlay. These modules work independently of each other, have different design formats, and utilize separate communication channels. To implement this architecture, there are dedicated companies supporting car manufacturers for one or more of these modules. Consumers also have the option of buying these modules separately from aftermarket distributors.

Some of the components generally incorporated in center console include:

**HVAC** (Heating Ventilating & Air Conditioning): Controls inside car temperature, humidity, and air flow, thus making sure that these parameters remain under desired limits.

**Navigation**: Implemented through an LCD screen embedded in the center console. Aids in navigation of the automobile from one place to another.

**Audio**: CD/DVD music player, generally equipped with the latest technologies like MP3, USB, etc.

**Park Assist System**: An optional safety system in high demand. Assists the driver in parking maneuvers where visibility is restricted.
The emerging center console
With the availability of advanced technologies coupled with increased focus on the human machine interface aspect of center console design, a change is being ushered into the design model of center consoles. Technologies prevalent in the consumer space are being adopted for the automotive environment and are enabling engineers and designers greater freedom in design of the console.

The brick model is now giving way to a more HMI-centric, integrated design model. This design model distributes control panels (HMI centric) from the actual electro-mechanical unit of each center console element. Such a design methodology enables designers to focus on the actual HMI of the center console as a whole without having to interface with individual discrete components and create an integrated look and feel. This concept is illustrated in the diagram and explained below.

The brick design model
In the brick design, each center console component is a complete unit comprised of the controls/switch panel as well as the actual electro mechanical box. For example, a center console is composed of a number of independent components including the HVAC, Audio, and Navigation units, and each unit is a complete system comprising the controls, electronic components and mechanical actuators, etc. This design approach enables a distributed development amongst tier one suppliers with each one specializing in one or more of the individual components. The car manufacturer is responsible for integrating each system in the center console almost independently of each other.
The limitations of such a design methodology is that the car manufacturer has only limited control in being able to provide a uniform look and feel. Likewise, the component designers also have limited freedom to design center consoles with various restrictions on styling. There is also an increased cost adder to allow for tooling costs associated with additional grooves and harnesses. Due to the increased number of mechanical components, there is also an increased chance of failure.

**The integrated design model**

With the integrated design model, the control for all elements of the center console are unified into a single front panel with the actual electro-mechanical systems connected through a data bus. The distribution and integration of the control panel allows HMI designers greater flexibility in styling as well as greater control over uniform look and feel. Such a design also reduces tooling charges and increases reliability. Because of overall integration and a reduce set of controls, such designs also reduce the total cost of systems.

Such designs are being made possible by improved HMI technologies which leverage the standard automotive communication protocols for data communication. These HMI technologies include:

**Capacitive Touch Sensing:**

Put simply, a capacitive sensor is composed of a pair of adjacent electrodes. When a human being (or any other conductive object) comes in proximity to these electrodes, there is additional capacitance between the electrodes and the object which can be measured to detect the object’s presence.

Using this technology, it is possible to build touch sensors acting as buttons, sliders, trackpads, etc. Alternately, capacitive sensing can also be used for proximity sensing where no contact is required between the sensor and the user’s body. Such technology becomes even more powerful in conjunction with programmable mixed-signal controllers. These integrated devices enable the measurement of capacitance intelligently to detect human proximity across range, direction of approach, gesture recognition, etc. They also enable the possibility of integrating other functions like controlling motors and LEDs to provide feedback to the user based on touch/proximity.
Capacitive touch sensing can also be used in conjunction with mechanical buttons to provide enhanced, hybrid buttons that respond differently to touch (i.e., a preview function) and to a mechanical button press (activation of the function), as illustrated below.

![Capacitive touch to preview function](image1)
![Mechanical press to select function](image2)

Because of the possibility of integrating a flat panel with capacitive sensors, designers have greater freedom to use curves in the consoles, thereby provide a better overall styling of front panels. Such designs also enhance reliability and reduce system cost.

**Capacitive Touchscreens**

Touchscreens are a great value-add to the center console. Not only do they provide an excellent enhancement to the user interface but also serve as natural integrators of multiple controls onto one system through a flexible and dynamic interface. Traditional touchscreens have been dependent upon mechanical pressure from the user to change resistance levels to enable detection of touches. Such touchscreens, called resistive touch screens, are limited in the fact that they can only recognize a single finger touch at a time. In addition, their accuracy deteriorates over time.

With the proliferation of capacitive touchscreens in the consumer space which enable multiple finger recognition along with gesture decoding, superior light transparency, and increased sensitivity, adopting touchscreens into the car enables further design differentiation and an improved UI. An example of a multipurpose touchscreen dynamically controlling HVAC, Audio/Video and Navigation is shown below.

![Example of a multipurpose touchscreen](image3)

**Use of standard communication protocols:**

Capacitive sensors and capacitive touchscreen controllers now support standard automotive communication protocols like Local Interconnect Network (LIN) and Controller Area Network (CAN). Such support of standard protocols enables direct interfacing of the control panel with the individual electro-mechanical units to enable standardized, robust communication between the HMI and control elements. Such integration of communication protocols with capacitive touch controllers also enables electronic engineers to easily create an integrated control panel.

Some illustrations of an integrated front panel are provided below.
Evolving ecosystem:
Such changes in design methodologies require a changing role amongst each member of the value chain. Car manufacturers traditionally have focused departments for each component of the center console that are responsible for the complete design of the component, including what will show on the front panel. However, the integrated design methodology requires that the user interface be directly handled by a collaborative team focused on HMI. Such changes enable greater focus on the actual HMI design.

Such technologies also require greater cooperation between semiconductor and other technology companies with car manufacturers to enable creation of suitable devices and technologies. Such collaboration is resulting in greater dynamism in the ecosystem and providing a platform for accelerated technology development.

Availability of advanced HMI technologies like capacitive sensing and capacitive touchscreens with support for standard automotive communication protocols are ushering in a change in the design of the center console of the car which is now moving towards an integrated front panel. Such panels provide a number of advantages including better styling, uniform look and feel of front panels, lower number of grooves and mechanical components, lower tooling costs, and increased reliability.

With semiconductor suppliers and technology companies working even more closely with car manufacturers such improvements in panel designs will continue to evolve and enable a superior driving experience.

Cypress Semiconductor
198 Champion Court
San Jose, CA 95134-1709
Phone: 408-943-2600
Fax: 408-943-4730
http://www.cypress.com

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