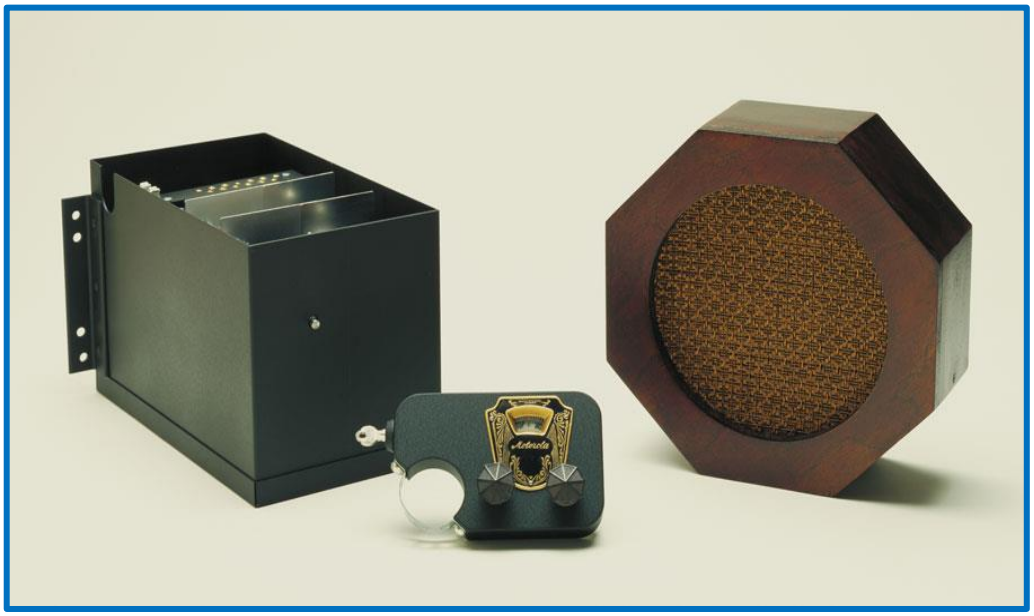
The Third Dimension

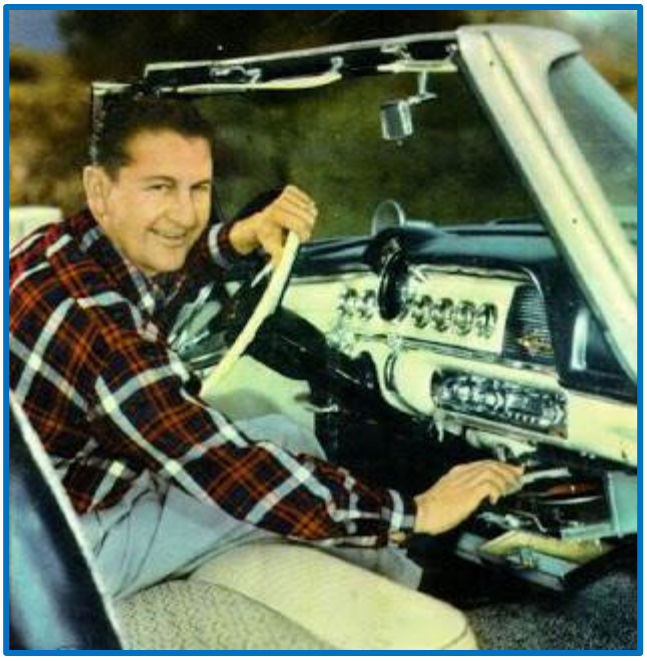
Using IMD to enhance the integration of consumer electronics into vehicle interiors.



When we step into our modern day cars and our cellphone or iPod automatically synchronizes with the vehicle's system, we are really just at the latest point in a process which started over 80 years ago. The fusion of the automotive and consumer electronics industries began as early as 1930 in the USA when the Galvin brothers released one of the first commercial car radios; the Motorola 5T71 shown here.

Here in Germany, Blaupunkt fitted their first radio to a Studebaker in 1932, and the following year the British company Crossley started offering factory installed car radios as an option on their vehicles.

The technology was pretty primitive by today's standards with these radios offering only the AM band and, since this was before the days of the transistor, these systems employed vacuum tubes meaning that not only did you have to wait for your car to warm up in the morning but you had to wait for the radio system to heat up too.



Broadcast radio does, of course, leave the choice of the music to the radio station and so there were early attempts to give the driver control of the content by installing record players in vehicles. And those of you that think your DVD system to entertain the kids on long journeys is the latest in high technology should take a look at this early in-car TV system.

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By the time this 1965 Pontiac "Banshee" radio system was introduced the technology had come a long way and the concept of 'in-car-entertainment' was well established.

This particular part shows a number of the themes we'd like to consider today as we discuss how modern manufacturing techniques can be used to enhance the process of integrating consumer electronics into vehicles and how that process is perceived by the driver.

The first point to note is that this radio forms an integral part of the vehicle. It's no longer a bolt-on accessory. The radio here is part of an early 'center stack' in which the audio and HVAC controls are combined into a single driver interface panel.

Notice too that this part carries the Pontiac brand. In 1965 this may have been acceptable but these days the discerning driver is looking for brand names that are recognized as being high end audio manufacturers rather than just the same brand as the vehicle itself. This is part of a major consideration in vehicle interior design which is the "perception of value". In other words, thinking less about what it costs to produce something, and more about what the buyer thinks it is worth.

Another significant point about this part is the flat, two-dimensional nature of the panel. Control panels and instrument clusters in vehicles were basically flat panels from the earliest days all the way up until the turn of the century when complex curved surfaces began to appear. Today we are in danger of returning to predominantly flat surfaces with the growth of the use of flat panel touch screens in vehicles.

A question we might want to ask about this panel is how easy is it to use? As vehicle electronic systems become more sophisticated it is important that designers make them intuitive for the driver to use. Otherwise, if the system is difficult to operate, the driver won't use it and he's unlikely to want to pay for some complex, hard-to-understand interface which he doesn't use. I suggest to you that, for the driver who had a radio at home, this system was really easy to operate and the real question is, how can we make our more complex modern systems just as easy to use?

The final point to note about this panel is the use, or the lack of use, of color in the interface. The surround uses a red color to match the rest of the interior of the vehicle, but the interface with the electronics is very typically automotive: all black and chrome.

What we hope to demonstrate today is that by giving consideration to all these matters, then applying good design techniques with a holistic approach to the complete vehicle system, and employing modern manufacturing techniques such as in-mold-decoration, it is possible to overcome many of the challenges in interfacing our consumer electronic products with our vehicles. Modern driver-to-vehicle interfaces can integrate all the functions including audio, HVAC, navigation, and mobile telephony, in a perfectly seamless fashion without sacrificing style and without making the system so overly-complex that the driver will not use it. Perhaps even more significantly, it is possible to produce control interfaces which have a very high perceived value by the driver at a lower cost than the current disparate systems.

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One of the lessons that the consumer electronics industry can teach the automotive world is in targeting particular types of product interface to particular types of buyer.

Looking at the familiar microwave oven we can see that the control panels generally fall into two categories: the electro-mechanical rotary control type on the right, and the electronics based 'touch control' type shown on the left. If we look at the sales of these two categories it is apparent that rotary control types sell better amongst the older age groups of consumer while the touch control version is more popular with younger age groups. This is pretty easy to understand given that rotary controls have a longer history while touch switches have a 'high tech' appeal.

There are two other interesting lessons to be learned from the microwave oven:

Firstly, the electro-mechanical rotary control version is considered to be more robust and reliable than the touch switch in spite of the fact that the electronic version has considerably better reliability performance figures.

Secondly, the touch control version can command a higher selling price in spite of the fact that it is cheaper to produce than the rotary control. The touch control type's high tech appeal gives it a perception of value in the market that allows it to earn a premium.

A more modern example of this perception of value situation can be found in Apple's iPod Nano product. The earliest version of this product featured the electro-mechanical selector wheel while the most recent two versions have the touch screen interface normally associated with Apple's higher end products. The latest versions of the product sell at the same prices as the previous versions but are regarded by the consumer as 'more' for the same amount of money. For Apple this allows them to maintain their revenue but extend their margin for a similar number of units shipped.

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What can we as vehicle interior designers learn from these examples?

We can learn that complex, high-tech control panel interfaces are more likely to appeal to younger drivers/buyers than to the more mature consumer.

We can learn that chunky, electro-mechanical switches are regarded as being more robust than 'delicate' touch controls and so they may be more appropriate for rugged types of auto such as 4x4s, SUVs and working vehicles. This is in spite of the fact that test data contradicts the buyer's perception.

We can learn that a high tech appearance can command a price premium but actually have a lower overall system cost when properly designed.

Looking at these three radios we can see that they are basically the same product and yet they carry three completely different brands and chose to use the vehicle maker's marque.

These radios were most probably made by the same company and then were 'badge engineered' to suit their end customer.

In modern terms however, this is badge engineering gone badly wrong.

By taking a system made by someone else and adding their own marque to it the vehicle maker has effectively reduced the perceived value of the product since Chevrolet, Ford, and Volvo are not names the consumer associates with high end audio products.

In this VW radio (next page) the manufacturer has gone to great lengths to incorporate his customer's logo but since this radio was built by Blaupunkt I highly doubt that VW would want their marque to be used these days.

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These days the situation is reversed with the trend being for the audio system to feature the brand which the consumer would more readily identify with high quality audio. It is now the case that on some occasions the audio brand will actually license their name to be used on the audio system even though they may not be involved in the actual production of the system. The audio brand will, however, often be heavily involved in the design and quality requirements in order to ensure that their brand reputation is maintained.

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One of the current issues facing vehicle interior designers is what we at ADS call the "form v function dilemma'. As the process of integrating the automotive and consumer electronics industries continues it is obvious that car drivers and their passengers are going to have a growing number of facilities in the vehicle. In addition to the humble audio systems we've been looking at so far, current leading edge vehicles include:

GPS Navigation systems.
Hands free cell phones.
DVD entertainment systems.
Synchronization with media on MP3 type devices.
Rear view video screens while the vehicle is in reverse.
Remote locking.
Remote starting.
Garage door opening.
Full internet connectivity.
Automatic billing for toll road/bridge use.

The issue for vehicle interior designers is that if each of these systems is added as a standalone unit then the cockpit of the car becomes a very complex area which could end up looking something like the flight deck of the Boeing 777 above. This would make the driver's seat a pretty intimidating place to be for many of us.

At the same time as this trend towards integration is occurring, the trend among interior designers is towards clean, uncluttered surfaces which are intuitive to interface with and completely unthreatening. A typical example is the Jaguar CXF concept shown above.

The solution, of course, is to present the driver with only those options which he needs at any particular time. So, if he wants to interface with the audio system then only the audio controls should be visible. When he is done with that, those controls should 'disappear' to be replaced by the HVAC interface or whatever else he needs.

Currently this is being done with ever increasing use of touch screens in vehicles. On the face of it, this is a seemingly perfect solution: the touch screen allows the driver to select from a menu based system and deal with only the controls he wants. The downside of touch screens is that it's a return to flat surfaces that the automotive market worked so hard to escape from in the 1990s, and it's hard to differentiate one touch screen from another. Part of the job of vehicle interior designers is to set their product apart from the competition and give it some 'wow' factor when the potential buyer sits in the vehicle in the showroom.

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Looking back at Ford interior we considered earlier featuring the SONY branded audio system we can see that this is a combination of a flat touch screen area integrated into a more stylized panel that features at least a little use of 3D form to avoid completely flat surfaces.

Looking at the Visteon concept interior below we can see a pretty neat implementation of this. In the passive state the interface is clean and uncluttered. When the driver brings his hand close to the panel, proximity sensors detect that he is about to interface with either touch screen or the touch panel and it switches to active mode until he is done and proximity controls return it to the standby mode.

It's a little bit hard to see in the pictures but the touch panel portion of this interface is actually 3D in nature with the system 'twisted' towards the driver for ease of use and to add some styling to the product. As you can see, the switches on the touch panel area are 'dead front' or 'secret-till-lit' meaning they only light up when required. This is the same technology that ADS uses as the market leader in instrument cluster displays to make warning lights only visible to the driver when they are required.

When ADS produced these panels for Visteon one of the disappointments was that they used a typical black colored approach. This may have been because of the automotive industry's long history of black colored control surfaces but it also may have been because the thought was that dead front effects could only be produced out of dark colored backgrounds. However, in recent years we have seen automotive control systems picking up on the use of color from the consumer electronics industry and ADS has developed the ability to produce dead front effects out of white and metallic silver backgrounds.

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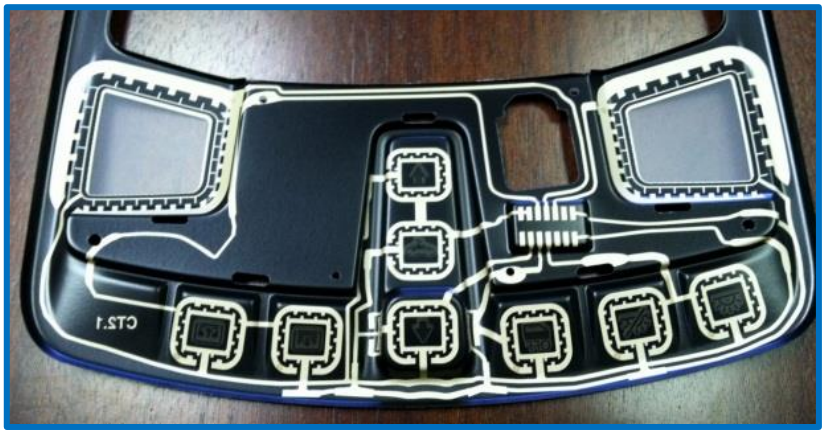
These panels are produced using the InMold Decoration technique (IMD) in which images are printed on flat sheets of plastic film before being thermoformed into a 3D shape and inserted in the cavity of an injection mold tool where they become fully decorated rigid panels. This technique was developed for the automotive industry in the 1990s and was then adopted by the consumer electronics market and the cellphone market in particular.

In the first generation version of these panels the sensor element required to detect a 'touch' by the user was a completely separate piece which might be adhered or otherwise connected to the plastic component. There are a number of different first generation systems currently being installed in vehicles.



In the second generation version the sensor elements are actually printed on the rear surface of the same film which carries the printed image which gives the panel it's appearance.

The benefit of this approach is that the system component count is reduced and the need for secondary operation to apply the sensors is avoided.

In addition, the fact that the circuit elements are thermoformed into shape means that they can take on much more complex shapes unlike the first generation versions which were 'not much more than flat'.

A further advantage of printing the sensors on the film is that they are effectively much closer to the user when he touches them. This has the effect of increasing their sensitivity and means that they can even be operated by a driver wearing gloves.

Printing of these sensor elements requires conductive inks which can be successfully thermoformed into 3D shapes without losing any significant conductivity and a comprehensive understanding of how the sensor shape will distort as it changes from 2D to 3D.

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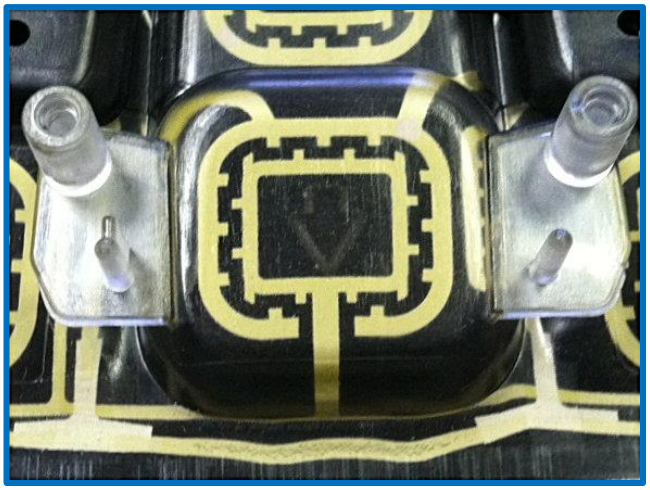
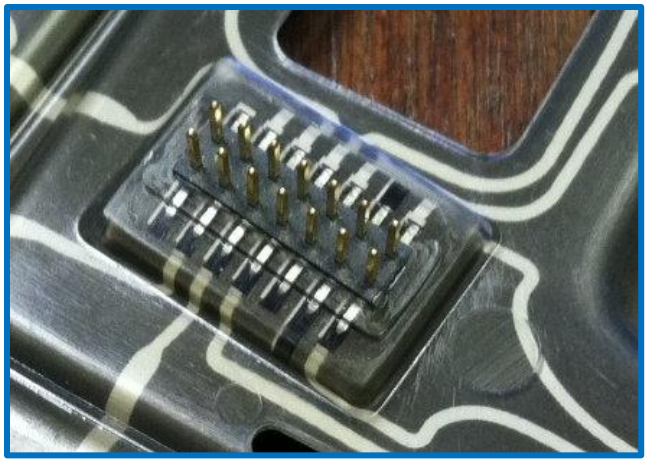


A further technical difficulty lies in the fact that the IMD process effectively embeds the sensor circuit between the plastic film and the injected resin. This has the effect of making the completed circuit very robust but difficult to make a connection with. ADS has successfully developed a molding technique to integrate connector systems into the construction.



In the next generation of this type of panel ADS envisages that more electronic components will be integrated into the product. This could be simple LED indicators or sophisticated encoder chips to carry out much of the electronic "magic". We also foresee other 'sensitive surfaces' appearing in vehicles such as locations where the driver's cell phone could be laid down to inductively recharge, or to otherwise connect with the vehicle's control system.

Although there are many sophisticated integrated systems already being shipped in production vehicles, it is our opinion that the integration of the automotive and consumer electronics markets is still in its infancy and that it will continue to develop rapidly in the short term.

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