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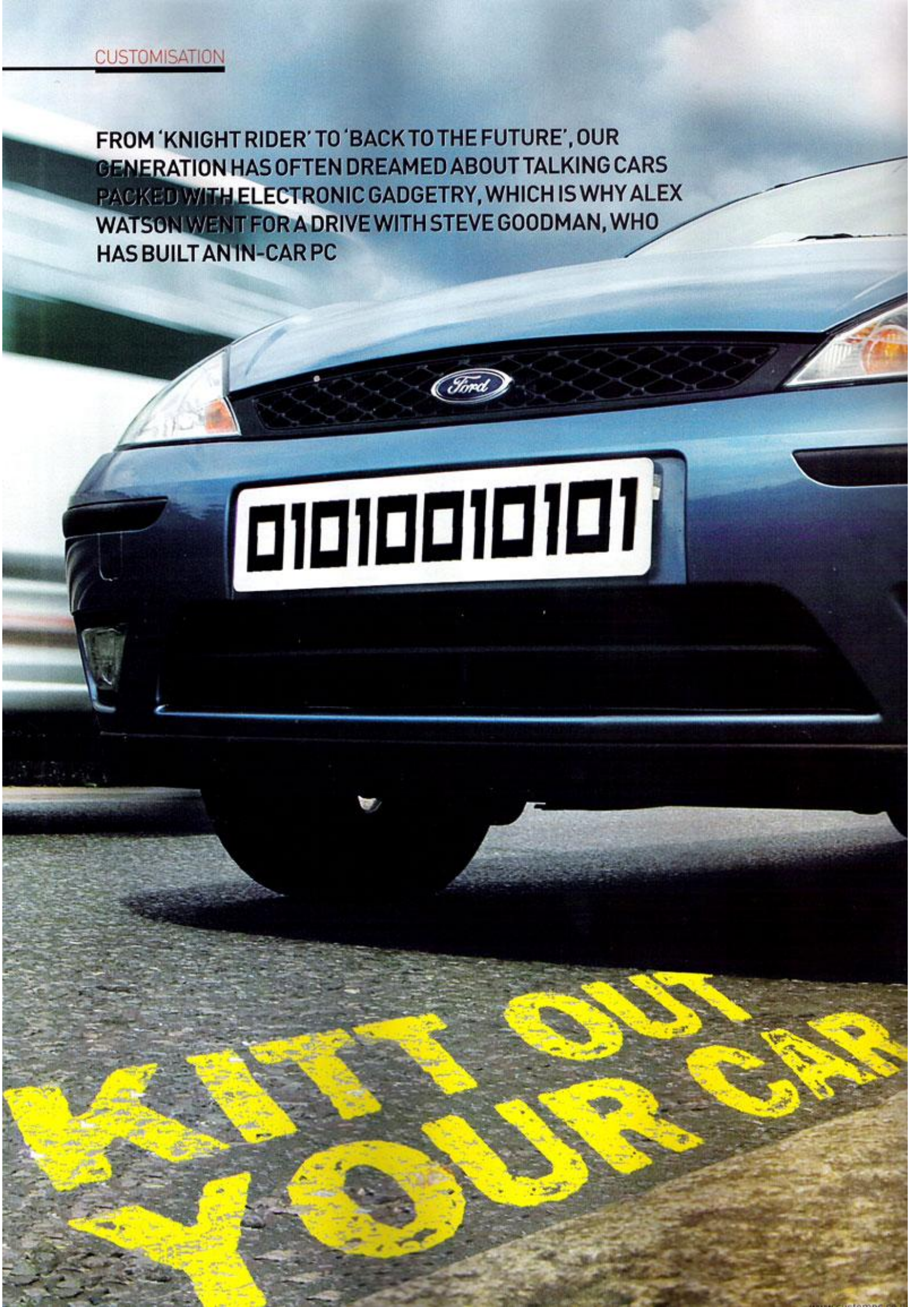
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FULL REVIEW ON
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CUSTOMISATION

FROM 'KNIGHT RIDER' TO 'BACK TO THE FUTURE', OUR GENERATION HAS OFTEN DREAMED ABOUT TALKING CARS PACKED WITH ELECTRONIC GADGETRY, WHICH IS WHY ALEX WATSON WENT FOR A DRIVE WITH STEVE GOODMAN, WHO HAS BUILT AN IN-CAR PC



Steve Goodman's car is an 800MHz Ford Focus with 256MB of RAM and a 20GB hard disk. It's driven by a dashboard-mounted touch-screen, comes with satellite navigation, and can provide current traffic and speed camera information. It also has a library of digital music and movies, a wireless LAN connection, integration with Steve's Bluetooth phone, and he plans to add external video cameras and satellite tracking in case of theft too.

It's also a fully functioning 1.8 litre engine hatchback that Steve drives to work down the M6 every day.

While Steve's Focus might sound like it's bristling with technology and has an interior dripping with wires, it's surprisingly plain at first sight. Having grown up with the sparkling looks of Doc Brown's time-travelling DeLorean and Michael Knight's crime-foiling KITT, you expect to sit in the cabin and be surrounded by banks of blinking lights, flip switches and flux-capacitors. However, only the 7in TFT sitting innocuously next to its steering wheel indicates that the car is anything other than normal.

As we pull out and start driving through central London's labyrinthine streets, the navigation system starts reading directions out in a robotic voice, but it's nowhere near as chatty or sarcastic as KITT. MP3s play in the background and the map updates our progress on the screen; car computing feels obvious and even ordinary. However, this normality is a testament both to Steve's neat installation and the advances in car computing over the past couple of years. Thanks to increasingly available hardware and dedicated programmers writing the applications that link it together, in-car computing is leaving its homebrewed, jury-rigged origins behind very quickly. But while the big car manufacturers are trying to keep pace with the growing appetite for high-tech cars, at the moment it's the enthusiasts who really define the possibilities.

WHY WOULD YOU PUT A COMPUTER IN A CAR?

If you think about where most people spend their time sitting down, it's clear that a lot of persuasion is needed to keep people in one place, whether it's in the form of a drink in the pub or a TV in the lounge. Remaining immobile without something to occupy or distract us is not an experience we endure willingly, and car journeys – especially long, boring trips up the motorway – can be incredibly tedious. It's only natural that we should want as much in-car entertainment as possible, and a mobile library of digital music and video is one of the most obvious reasons for installing an in-car computer system.

This is why many car manufacturers, such as BMW and Ford, have begun offering more computerised and complex in-car entertainment systems, and after-market car stereo manufacturers are also releasing more computer-friendly products. These include Pioneer's DEH-P9600MP CD system, which offers MP3 and WMA playback, and Kenwood's Music Keg, which has a hard drive in a cartridge for digital audio storage. However, compared with a fully-fledged PC, these stereos are about as advanced and expressive as semaphore. There's no chance of adding OGG Vorbis, lossless CODEC playback, or DVD and gaming abilities. Nor is it possible to exceed the storage limits of a single CD, and the customisation options are limited too.

The other big draw for an in-car computer, though, and the one that was most attractive for Steve, is satellite navigation. 'I've just been on holiday, and I really missed the car PC when I was driving the rental car. I get completely lost without a navigation system,' he admits. While car and after-market manufacturers' computer





systems are stronger in this respect, their options still have limitations. 'I looked at all-in-one satellite navigation systems, but they cost about £1,000,' says Steve. 'I really didn't fancy paying that much for something that only does one thing. They're closed systems,' he adds. 'You see posts on forums from people trying to integrate them into a PC or expand them, and they never have much luck making it work. In-car computing is something I've always been interested in, even before I saw the mini-ITX boards. Of course 'Knight Rider' and the Bond movies had some influence, but it's an interesting challenge too.' If you drive and have a little technical knowledge, then one of the best projects to get into at the moment in terms of functions and value is a self-built car PC.

KITTED OUT

However, while the list of features that car PCs offer is impressive, there are still many reasons for not putting a PC in a car. Cars are expensive, complex and people generally aren't willing to alter them. PCs are bulky, often unreliable, sensitive to vibration, and difficult to operate quickly and easily. It's hardly a match made in heaven. But Steve claims it's nowhere near as difficult as you might think. 'Nothing about the install is overly complex. Most CPC readers wouldn't need to think twice about the issues you face,' he says. 'When I first got the Focus, my girlfriend saw that it came with an MP3 CD-compatible stereo, and she told me I wouldn't need to put a PC into it. However, when I'd finished installing the current setup, she was smiling. She didn't want to admit that the PC is actually really good and usable.'

As Steve says, on a hardware level there's surprisingly little difference between the setup that powers his Ford Focus and the average desktop machine (see Steve's car

Steve's install is very neat. The touch-screen TFT sits above the air vents, close to the driver, and wires are neatly routed under the steering wheel

Car batteries and car PCs aren't the best of friends

PC hardware, opposite). The relative simplicity and everyday nature of many of the components also contribute to the neatness of the install. The biggest part of the car PC system is the main box, which is housed in the boot. It's based around the familiar shape of VIA's mini-ITX board, which has been a modder's favourite ever since its release, because it's compact (it measures just 17cm by 17cm) and doesn't use much power. It also comes with on-board sound, audio and networking, and needs few additional components. Steve's Focus uses the 800MHz Eden version of the board, and although this has now been superseded by a 1GHz variant, Steve claims the 800MHz CPU is up to the task.

'My system doesn't have a problem playing MP3s while running the navigation software, or showing DivX movies,' he says. 'I did have a lot of spare RAM, though, so it has 512MB of PC2100 memory, which helps.'

The PC also only uses a 20GB Maxtor hard drive. 'I'd had that for a while. I knew it was reliable, but at the same time, I wasn't going to be too upset if it got broken,' says Steve. All of this is assembled in a VIA Sereniti 2000 case, an inexpensive off-the-shelf mini-ITX chassis. 'I messed around with a lot of other potential housings, such as empty car-stereo CD changer cases, but they just caused too much work in terms of fitting in all the components. You'd end up with fans on top of hard drives and lots of other problems.'

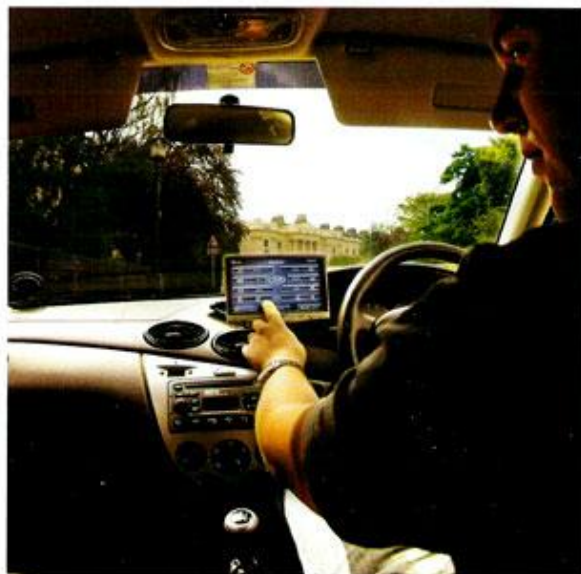
The case fits snugly into the corner of the boot, and at the moment it's secured in place using Velcro strips. Surprisingly though, there's no damping or shock-proofing in his car PC at all. 'The PC has been fine,' he says, grinning. 'It survived a handbrake turn. There was a big crash as it flew across the boot, but it was okay. There's been a blown tire as well but the PC wasn't phased at all.'

However, while most of the components in Steve's car are the same as those in a desktop PC, the power supply is significantly different. This is because car batteries and car PCs aren't the best of friends. It's hardly surprising when you consider that a car battery's primary role is to provide a massive jolt of energy to start the motor, rather than a smooth and constant burble of power to delicate electronics. Before getting the Focus, Steve had a black Toyota MR2 with which he began his first experiments with in-car computing. 'There was something Knight Rider-esque about that car,' he admits, 'but I really messed up its battery trying to get inverters to power the PC. The voltages from a car battery range between 8 and 18V during different stages of operation, such as ignition and normal running. Inverters are an inefficient way to deal with it, and they're arguably unreliable in the long term.'

In the end, Steve opted for a specialist PSU from American company Opus. 'The Opus PSU is live all the time,' he explains, 'but has built-in battery protection, so it won't totally kill the car battery, and there will always be enough power to start the car. The Opus has a PCB with a variety of jumper settings, so you can set it up as you like. I've also wired it to the power button on the PC, and configured Windows so the power switch triggers the standby mode. It puts the PC into standby when the ignition is off, so the computer starts up very quickly when I turn the key.'

But while a dedicated car PSU such as this makes the job easier, it's still important to get the power wiring set up correctly. As Steve explains: 'The Opus PSU has three wires. One is wired to the live ignition under the steering wheel. Another requires a suitable permanent live connection, and the third has to be an earth. After testing the resistance of several spots in the car with a multi-meter, I used the rear cigarette lighter for both of these wires, as this was where I found the resistance to be

Media Car's touch-screen interface can launch third-party apps, and has integrated WinAMP



lowest, and you shouldn't use the chassis.' For more information, including a diagram of Steve's set-up, check out 'How to install a PC in a car' on p90.

The wiring from the PC then goes under the carpet lining of the boot, past the back seats and along the right-hand side of the car towards the driver's seat. Underneath this is a small USB hub that connects to Steve's Bluetooth-enabled mobile phone via a Belkin 10M Bluetooth adaptor, and when necessary, a Netgear WG121 802.11g adaptor. All of this gives the car the ability to connect to the Web when it's on the move, or via Steve's home network when it's sitting on the driveway, providing a convenient way to update software, drivers and the media library.

The USB hub also connects to the dashboard-mounted Lilliput touch-screen TFT, which reads Steve's on-screen taps back to the computer.

'It cost me about £250, but they're slightly cheaper now,' says Steve. 'It's a 7in, 16:9 widescreen model, so its native resolution is 800 x 480, but it runs fine at 800 x 600. That's important, because if I wanted to use a non-standard resolution I'd need a PCI graphics card instead of the VIA on-board graphics.' The screen is attached to the dashboard using a mount designed specially for the Ford Focus, so it looks very tidy. Not only that, but the VGA and control wires from the screen quickly loop out of sight underneath the steering column, and join the rest of the wires running under the carpet by the driver's seat.

Completing the car PC's hardware is a small GPS transponder, which is a USB gadget that connects directly to the PC in the boot and sits underneath the tax disc at the corner of the windscreen.

It's worth noting, though, that Steve hasn't made any changes to the car's sound system and the PC makes full use of the car's pre-installed stereo and speakers. 'After-market stereos tend to have auxiliary ports, but if it doesn't, you can get an adaptor that converts the CD changer input into an auxiliary port, which is how I've hooked my PC up to the sound system,' he says. 'You should use decent audio cables to minimise the noise, though, and a sound card with a low signal-to-noise ratio is a bonus too.'

'I've also used a ground loop isolator, which is a little box that fits between the RCA connectors and connections. This helps stop whine and feedback from the power circuits coming through the speakers, which can be a problem with electrical equipment that's not necessarily designed to go in a car.'

STEVE'S CAR PC HARDWARE

This is the hardware inside Steve's in-car PC system, and where you can buy it, although it's always worth searching eBay too. However, some of the variants are specific to Steve's Ford Focus, so check that the components will be compatible with your own car model first.

- VIA Eden mini-ITX motherboard with 800MHz C3 CPU (£71.68 inc VAT from www.linitx.com. For more information, see www.viavpsd.com)
- 512MB PC2100 DDR RAM (£56.39 inc VAT from www.crucial.com/uk)
- 20GB Maxtor EIDE hard drive
- Opus 150W Automobile PSU (£151.58 inc VAT) from www.linitx.com. For more information, see www.opussolutions.com)
- Lilliput 7in SVGA touch-screen TFT (Approx £200 inc VAT from www.cartft.com. For more information, see www.lilliput.cn)
- Globalsat BU-303 USB GPS 'mouse' (Approx £30 from eBay. Also £70.50 inc VAT from www.easydevices.co.uk. For more information, see www.globalsat.com.tw)
- Belkin 10M USB Bluetooth adaptor (£23.45 inc VAT from www.expansys.com)
- Netgear WG121 USB 802.11g wireless LAN adaptor
- Connects2 AUX interface adaptor (For more information, see www.connects2.com)
- VIA Sereniti 2000 Case (£41.13 inc VAT from www.linitx.com)
- Ford Focus vent dashboard mount for TFT (£23.44 inc VAT from www.dashmount.co.uk)
- ECU serial port adaptor (Prices from approx £45 from www.scantool.net)
- Motorola V500 Bluetooth mobile phone

THE CAR MANUFACTURERS

CUSTOM PC TAKES A £50,000 BMW FOR A SPIN TO SEE WHAT THE PROFESSIONALS ARE DOING ABOUT IN-CAR COMPUTING



Driving round the M25, we realised there was a moth inside the car. 'Isn't there a button for dealing with that? Some little lasers?' asked my passenger. It was a reasonable request – after all, the BMW 7 series has a button for everything else. There's a button that tells the boot to close, and one to turn on the parking radar. There are four buttons, and a joystick and dial to control the front seats. There's even a button for dealing with boy racers. It's called 'Sport Mode', and it sets the gear ratios aggressively and tightens the steering, providing ludicrous levels of acceleration.

However, the cavernous cabin is surprisingly uncluttered with switches. There's just a TFT screen, discreetly positioned between the driver and passenger, and a large silver dial where the handbrake normally sits. This is the iDrive system. As Duncan Forrester of BMW explained: 'If you've seen a luxury car without an integrated computer, the dashboard is covered in buttons, because the number of functions requires more and more controls. It was becoming overwhelming for the driver, so we see systems such as iDrive as the way forward.'

BMW's iDrive was one of the first in-car computer systems, but it received a rocky reception. 'We were the first to market with an integrated controller, so we received the initial criticism,' admits Forrester. 'It was a revelation when it was launched, and it takes some time getting used to.'

The iDrive's combined joystick, scroller and button operation is a huge step forward. It also unifies an awful lot of functions (a maximum of 700 individual options) that control satellite navigation, air conditioning, the radio and multiple CD players, an integrated mobile phone, on-board data, and maintenance and car configuration options.

Despite its prickly reputation, though, during a week of driving the BMW 730dSE, I found the iDrive easy to use. You use the controller as a joystick to enter one of eight modes. Pulling it down, for instance, accesses the radio and CD players, and pushing it to the top right displays the on-board data. Once you're in a mode, rotating the dial moves the selector, while pressing it down selects an option. Some modes have menus with options running down both sides of the screen, which can be confusing, but generally the navigation is pretty easy.

But while I found the iDrive easy to use, I'm hardly a typical BMW 7 series driver. Custom PC would have to outsell 'The Sun' before I could afford the 730dSE's £48,000 price.

'The people who buy the 7 series are middle-aged businessmen who don't want to spend time figuring out technology. They just want to fit their golf clubs in the boot,' says Richard Yarrow, associate editor of Auto Express. 'The people interested in computers in cars are younger, so I think you'll see companies such as BMW adding it to less expensive models in the future.'

The new BMW 1 series, which starts at just over £15,000, does indeed feature a version of iDrive as an option, which just goes to show that computer technology's march from elite vehicles to mainstream models is gathering pace. As Christof Kellerwessel, chief engineer of Ford Europe's electrical and electronic systems engineering department says, 'Touch-screens are available as options on our new models such as the C-Max and the Mondeo. Ford is one of the few volume car manufacturers that offers touch-screen technology, and it's been very successful. We're surprised by the level of take-up. Drivers are attracted to it, because it's both techy and usable.'

Kellerwessel's work involves overseeing research into in-car technology. 'New technology always takes time to get accepted. There's a learning curve, but we're surprised by the market's enthusiasm so far,' he says. 'In the future we'll see an improvement in the interfaces and more personalisation, such as the ability to bring your own media into the car. However, you have to maintain reliability and quality. There's a lot of work to be done with the interface, because people don't want to spend hours reading manuals. It needs to be intuitive.'

With this in mind, it's interesting that BMW didn't opt for the touch-screen approach favoured by Ford and the enthusiasts. However, one advantage of the iDrive's joystick controller is that it changes modes very quickly, and the whole TFT can be used for displaying information rather than menus. That said, it can be frustrating when entering data such as destinations, as you have to scroll through an alphabet on-screen, although there's at least a predictive text feature. Also, separating the monitor and controller could add to people's confusion – in a car, we're used to pushing a switch or pedal and seeing the result. 'The Human-Machine Interface is key in a vehicle,' says Kellerwessel. 'Touch-screens are intuitive, and Ford vehicles are mass-market products, so their systems need to be very easy to comprehend and operate.'

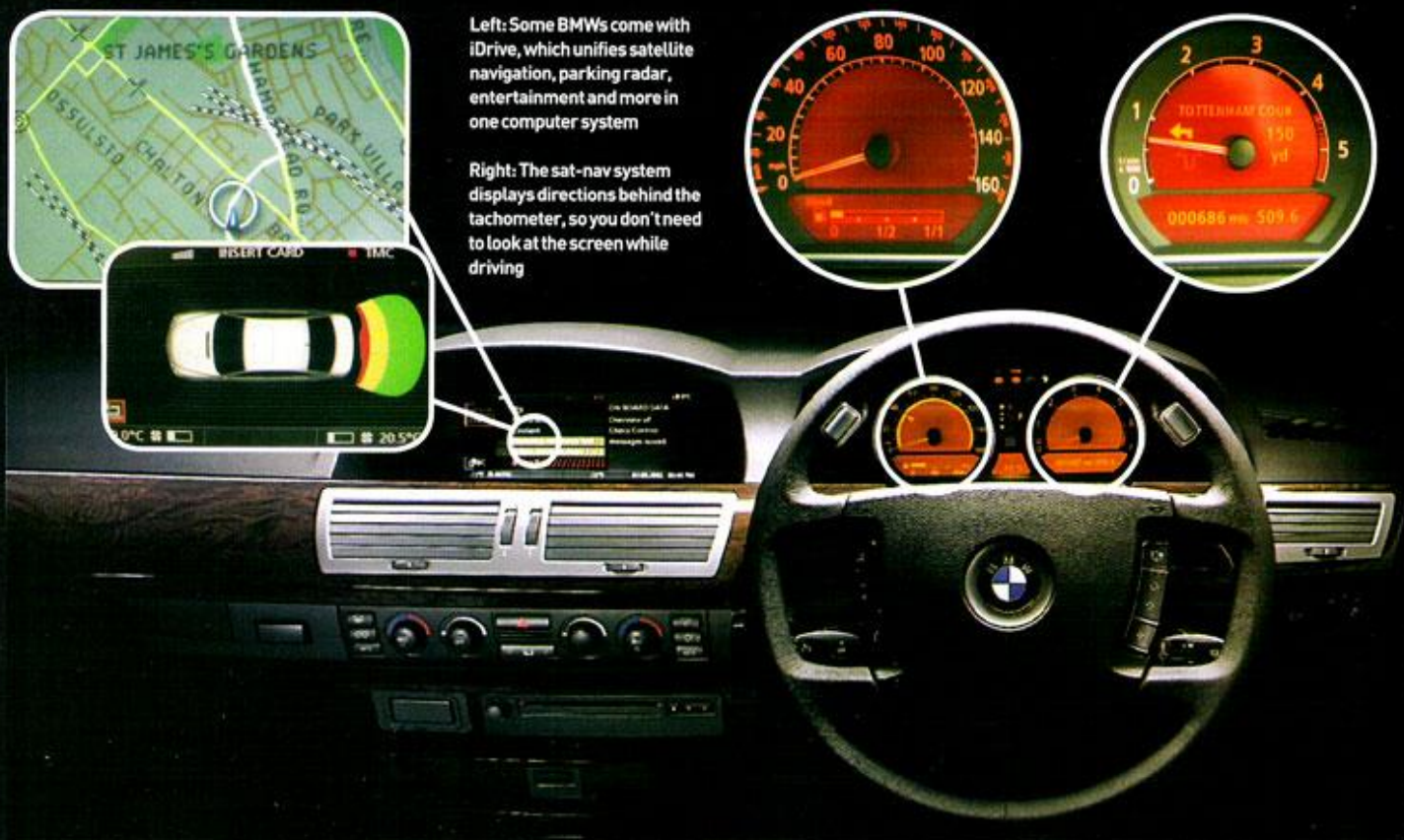
The other consideration with an in-car computer system is that it should never distract the driver. 'Yes, you can implement tons of features, but you can't compromise safety, it's a very strong design consideration,' says Kellerwessel. 'We've focused a lot on audible guide features so that the system reads out directions. You shouldn't take your eyes off the road when you're driving. We have a speed-lock feature on the navigation system, so you can't, for instance, try to input a new destination at speed.' BMW's iDrive system also functions well on this level, with several neat touches. Once you've set your destination in the sat-nav system, a female voice reads out

directions, automatically lowering the volume of music. Meanwhile, the directions are displayed behind the tachometer, as the back of the dial turns into a hi-res display.

The system also meshes well with a mobile phone. Slot your SIM card in, and you have full access to your phonebook. Then, when you make a call, the music volume automatically lowers, the call comes through over the speakers, and an integrated microphone picks up your voice. It's simple, hassle-free and your eyes never leave the road. What's more, the voice functions aren't one-way either. The 7 series also includes voice activation. Kellerwessel says that this will 'be key' for Ford too, because 'it's very safe and convenient'.

The smoothness of the integration of numerous different features is perhaps iDrive's single biggest advantage over a homebrew car PC. However, iDrive doesn't have a hard drive, so there's no MP3 library, and the optical drives can't read data CD-Rs with MP3s either. Also, customisation only extends to allocating functions to two shortcut buttons, and there's no way to add your own programs. Plus, while it's available with in-car Internet access, it's limited to a BMW portal, as there's no virtual keyboard for controlling full access.

However, iDrive remains a good example of how ideas pioneered by desktop PCs are expanding the motoring experience. Kellerwessel thinks there's lots more in the pipeline. 'Hard disks will come, and we're considering USB too. This could allow you to listen to MP3s, look at photos and customise the system.' Yet he's sceptical as to whether car PCs will ever be mainstream. 'We won't see PCs in cars, but there will be some shared features,' Kellerwessel says. 'Normal PC software wouldn't pass the test for in-vehicle applications in terms of stability. You can't interfere with the driving of the car.' While there are plenty of developments to come, systems such as iDrive show just how effective computerised systems can be in cars, and how integrated they'll be in future.



Left: Some BMWs come with iDrive, which unifies satellite navigation, parking radar, entertainment and more in one computer system

Right: The sat-nav system displays directions behind the tachometer, so you don't need to look at the screen while driving

SWITCHING ON

While the hardware side of the install is quite easy and recognisable to anyone who has tinkered with a PC, the software requires a significant amount of tuning. 'There's a lot of playing with the settings,' admits Steve. 'As all of the software is modular, it can be tricky getting it to work together. There are a lot of quirks and bugs that need ironing out beforehand because you can't mess around while you're driving. I've put a lot of work into the car PC, and it's very reliable now, to the point that other people can easily use it.'

Reliability is also a critical safety consideration. The law still hasn't had much contact with complex in-car computer and entertainment systems, although in the USA, a driver was recently acquitted of causing death by dangerous driving after allegedly watching a DVD in his truck. While car view-screens are legal, anything that distracts the driver can be a potential hazard. Car manufacturers such as Mercedes and Ford have even fitted motion locks to their in-car navigation systems, so that the screen freezes or dims at driving speed.

'I've never had any trouble with the police,' says Steve. 'After all, a lot of cars have satellite navigation systems. If you're watching a movie while driving, you deserve to get pulled over. As with all things, you need to use it with common sense.'

In terms of software, though, surprisingly it's Windows XP that gets the vote from most car PC enthusiasts as the best operating system to use. 'The problem with Linux is that there's not really any decent satellite navigation software available for it,' says Steve. 'Some people use Windows XP Embedded, which has a very quick start-up time, because the install is built around your specific hardware. However, you need to rebuild the image every 90 days, unless you buy the development kit, which is incredibly expensive.'

Steve's install of XP is relatively lean, and it automatically loads Media Car, a touch-screen friendly front-end with WinAMP integrated. Media Car can also launch third-party applications, such as DVD players. However, Steve isn't too bothered about playing DVD movies. 'My car PC can't play DVDs because there's no optical drive in the PC. It's easy to do, but I just use DivX rips. I thought I'd have problems with jitter when driving over bumps, and as the PC's in the boot, it would be difficult to change the disc anyway.'

STEVE'S CAR PC SOFTWARE

- **Media Car:** The touch-screen compatible front-end that runs Steve's car PC. www.media-car.fr.st
- **Destinator:** A standalone, commercially produced satellite navigation system. www.destinator1.com
- **ExternalDest:** A plug-in for Destinator that integrates WinAMP and speed/bearing information. www.my105e.com/carputer/MediaCar/ExternalDest.zip
- **VOICES:** Voice Operated In Car Entertainment System is a freeware car PC program. Currently in BETA, it uses Microsoft Mappoint's navigation data, and is highly customisable, with the ability to add points of interest such as speed cameras. <http://voices.techworldonline.com>
- **MobileWeb:** A small application coded by Steve, which downloads data (such as traffic information) from a pre-defined webpage. www.stevegoodman.plus.com/mobileweb.zip
- **PhoneControl.NET:** A program that allows control of a mobile phone from the PC. <http://zoran-horvat.de/private/CarPC>
- **Virtual Keyboard:** A handy touch-screen keyboard application. <http://voices.techworldonline.com>

Media Car also integrates well with several satellite navigation packages. Steve uses Destinator, which can calculate routes quickly and displays the route as a red trace on top of a grid of streets. However, as it's a commercial package, it's not as customisable as Steve would like it to be.

'You can download files with the locations of speed cameras, but you can't add their specific locations to Destinator, because it doesn't let you add points of interest,' explains Steve. This also makes it impossible to add live traffic data to Destinator, even though it's available on the Web from sites such as Traffic Master (www.trafficmaster.co.uk).

Another piece of software that Steve uses is VOICES [Voice Operated In Car Entertainment System], which is a BETA program being coded by a member of the car PC community. Steve is working on adding live traffic updates to it, and it supports customisable points of interest too. The software uses Microsoft's Mappoint application as a base for its navigation software, and this has a programmable interface, so it's quite easy to build different front-ends and extensions for it. VOICES uses Mappoint's data and reads out directions.

'It's very good, but since it's in BETA, it takes a long time to work out routes,' says Steve. 'By default, Mappoint shows a 2D "North up" map. I'm messing around with DirectX to interpolate that into a 3D view, and after that, I want to add elevation data. My drive to work is full of hills, so it should be interesting when it's finished.'

Steve's own website, www.stevieg.org, has a full project log for his car PC install and a download section with some of the small applications he's written himself. MobileWeb, for example, is a Flash program that displays traffic information from Traffic Master. 'It downloads the data using my mobile phone's GPRS connection, and it takes about 30 seconds,' explains Steve. Steve also uses a nifty virtual keyboard program, which was programmed by the author of VOICES, to quickly enter data and provide a more precise level of control than Media Car.

With a worldwide community coding and adapting PC applications for in-car use, there are plenty of options regarding front-ends, media players and other utilities. If you're interested in having a look, then check out the

VOICES is only in BETA, but shows hints of how powerful it will be as a navigation tool, sharing and reading out directions

VOICES uses Microsoft's Mappoint application as a base for its navigation software

