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XBox | PSOne | PS2 | Dreamcast | GameCube | GScube | G4 Cube | Game Boy Color
PC | Game Boy Advance | Wonderswan Color | Ericsson R380s | Palm IIIc | GP32
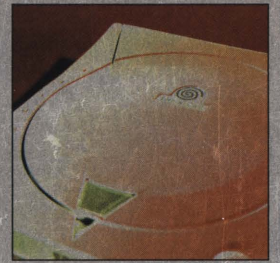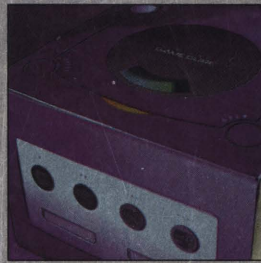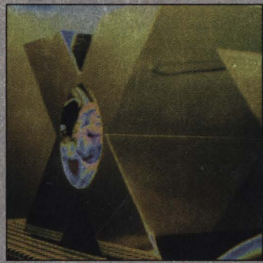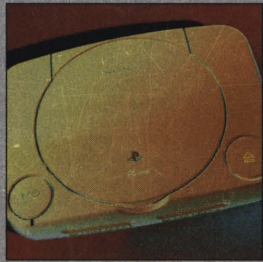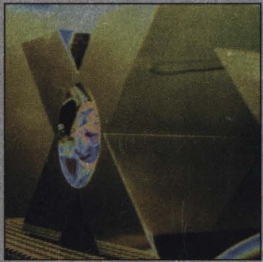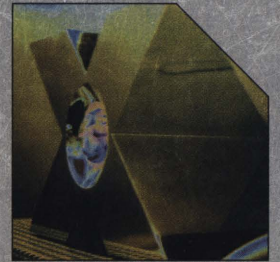
Essential hardware guide 2000

A definitive companion to the gaming platforms of today and tomorrow
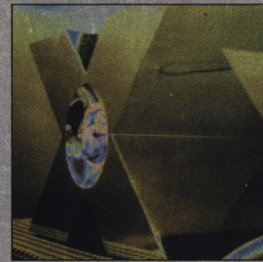
In an ideal world, there would be no game consoles. Joypads, perhaps, and screens for the foreseeable future. But in an ideal world we'd play games as we watch movies – with barely a thought given towards the machines that make them possible.

"Any sufficiently advanced technology is indistinguishable from magic," said Arthur C Clarke. By this measure, game hardware belongs in the Dark Ages. Each new generation issues forth games that are little short of miraculous, but which are nevertheless clearly the result of a young, imperfect science. (To PC gamers this is particularly apparent).
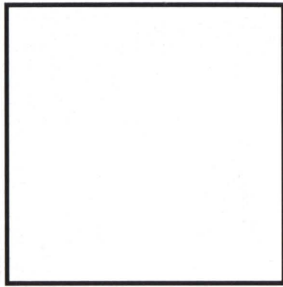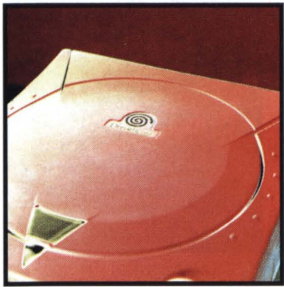
"We are building the hardware out of necessity," says **Seamus Blackley**, director of Microsoft's X-Box advanced technology team. Microsoft, as a software company, would rather be making software – making the tools and libraries to ease game creation, or better yet the games themselves. Today, though, making the kind of games it wants means building and selling a machine to a viable number of consumers.

But while we play games for the games, not for buttons or for blinking lights, a new machine is undeniably an event. First, there's the rush of playing games on new silicon, a thrill only a little removed from the inexplicable excitement that watching 'The Matrix' on DVD provides that's wholly absent from viewing the VHS version. But it's also the sense of fresh experiences to come. The N64 opened up a new 3D world with *Mario*, just as the ZX Spectrum gave voice to a very motley, very British

enter

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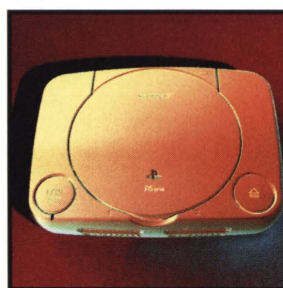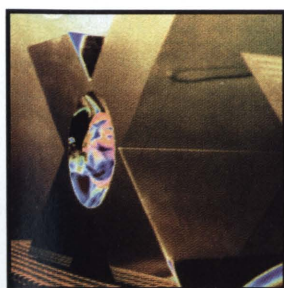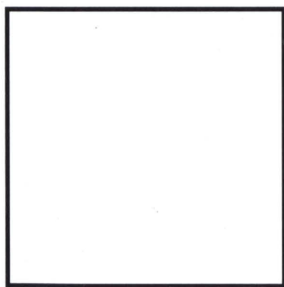
one. The same will be true of PlayStation2, X-Box and GameCube.

Problems arise because games are wedded to technology in a messy way. Just as creating games is as much about engineering as imagination, so game platforms shackle game designers with limited resources, business issues, and an audience that wouldn't be as unpredictable if you could sell games as promiscuously as books. Since purchasing every machine is prohibitively expensive for consumers, technology forces them to make risky bets on one platform over another and, worse, miss out on great games released for rival systems.

Still, while game developers might sometimes look enviously upon movie makers or even TV producers, in reality those industries are also facing a similar upheaval, albeit more subtle. As all forms of media go digital, they become subject to the inexorable laws of upgrade and obsolescence. Digital networks also start to change what's possible – and what's expected of them. Interactive TV and 110-channel cable services can bring audiences almost as fickle as gamers.

Episodic games will one day change soap operas, just as persistent online worlds will change the High Street. But then, the pursuit of gaming has long pushed the limits of technology. The new platforms featured in this special issue of **Edge** present a glimpse from the far periphery. Further on lies magic.

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FEATURES

Better by design?

Where do consoles sit in the style-sensitive world of the modern gamer? **Edge** asked some of the UK's top design experts whether the next generation of consoles would be as cool for Paul Smith as for Joe Public...

Console design is coming of age. With the unveiling of PlayStation2 and GameCube, the epoch of stylish consoles has arrived.

Unquestionably, both Sony and Nintendo's machines are a bold departure from past designs, with PlayStation2 exciting the style and technology press almost as much as gamers. But in an industry that's vying for mainstream adult attention, do they go far enough?

Edge gathered together a panel of industrial designers for insight into consoles as objects of desire (see over for details of the participants). Opinions were fiery, and posed serious questions that console designers seem to ignore.

Software and joypad ergonomics will always come above exterior appearances in **Edge**'s gaming priorities, unquestionably. But that's no reason to ignore contemporary design. **Edge** wants it all.

Given the collection assembled here (Dreamcast, PlayStation2, GameCube, Game Boy Advance, Ericsson R380s, and PSone), what stands out to you about their design?
Adam White: My first impression is that, other than the PS2, no one has made an effort to separate themselves from the herd. Most of these machines would look yawningly uninteresting to anybody over the age of 12. I have a G3 Mac at work with games that complement its fantastic looks. Judging by their designs, I'd expect games like *Pong* on the PSOne or Dreamcast – they lack any sophistication.
Mike Exon: Remember the Atari machine [VCS]? It had character.

"Gamers are being short changed. Compare these consoles with the other gadgets they buy. Everything else is really snazzy"

AW: Yeah, it had attitude. Nowadays gamers are being short-changed. Compare these consoles with the other gadgets they buy, such as mobiles phones or Walkmen. Everything else is really snazzy – you've got huge choice, endless materials, different designs and quality.

Martin Riddiford: But consoles are just vehicles to enter a virtual world, they're not fashion accessories.

AM: Then you could say that a mobile phone is just a vehicle to enter the network.

ME: The people buying these things aren't buying the consoles for the design or the style, they're buying the brand.

AM: You're probably right. But as a designer you must always look after an object's looks. And if they're looking to appeal to a more mature market then they've got a real problem.

MR: These companies are leaders in their technologies because so few people make game consoles. They are all trying to differentiate themselves because there are so few options, so it's quite interesting to see how they express that.

Look at them separately, then, starting with Dreamcast.

ME: Dreamcast was the first of the next-generation consoles stepping forward from the PlayStation. It says slightly chunkier to me.

MR: But does 'slightly chunky' mean 'next generation'? With technology, surely not.

ME: It's the technology that sold the Dreamcast.

AW: It can only have been the technology, because you wouldn't buy it to have that thing in your house. What on Earth inspired them to make it look like this? For a start, why didn't they pay more attention to the fact that the console is the box plus the handsets? If they managed to build them into the console somehow then you'd have a much more intelligent design, without this horrible pile of wires plonked in a mess in front.

MR: In Woolworths they sell these plastic boxes which you can sit the console on, so you can tidy away the controllers by stuffing them underneath.

Daniel McInnes: Dreamcast really doesn't give you the feeling of 'next generation'. In fact, it makes you think you've gone back a few stages.

AW: It reminds me of a cheap CD player. Look at the gorgeous CD players around, where they've invested in aluminium

pressing and sophisticated paint finishes. Why does this look like a waste-disposal unit? Inside it's brilliantly clever, but when you look at it you wouldn't have a clue. Your £40 'pay-as-you-go' mobile phone offers you choice and finishes way beyond what you have here.

DM: In Sega's defence, it's a massmarket product. They don't expect people to buy it for its looks.

AW: But appearance is so profoundly important.

MR: It's not just appearance, it's quality. Projections on the sales of these devices are into the tens of millions. If you're churning out product at that rate, the effort to make things look sensitive to the market is comparatively negligible.

Catherine McDermott: It looks to me like a bedside alarm system, or a mini electric portable heater.

MR: They've imitated the original PlayStation shape – which was a fantastic bit of design – only the result is rather poor.

CM: I suppose the colour is neutral and unobtrusive.

DM: Well, the original PlayStation was grey too.

CM: People learn to understand a certain language about the colour of goods – TVs are black, fridges are white – and that may be why they chose grey.

Catherine McDermott
Reader in Design History, Kingston University

CV: A consultant curator at the Design Museum, McDermott has lectured and published widely in the field of contemporary design, including 'Street Style' and 'British Design In The '80s'. Her exhibition on Erotic Design in 1997 was the most popular show ever staged at the Design Museum. In 1998 she was commissioned by Lord Spencer to work on an exhibition celebrating the life of his sister, Diana.
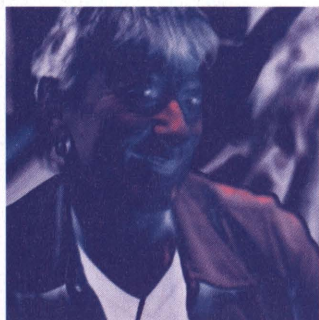
Martin Riddiford
Designer and founder of therefore Ltd

CV: Riddiford began his career at Frazer Designers, where he helped design the '80s game box Coleco: My Talking Computer. His ideas won Frazer the contract to design Psion's first palmtop computer. He has since designed all of Psion's handheld products, including the award-winning Psion III, and the revolutionary Series V, as well as gadgets for NEC, Motorola, Hasbro, and Symbian.

Adam White
Designer and founder of Factory Design

CV: White's portfolio ranges from the Saitek X36 flight-sim joystick to the InterCity 250 locomotive. An industrial designer by training, he has worked for British Airways, Lever, Faberge, and London Transport. He recently redesigned the interiors for British Airways' Concorde, including new seats, galleys, and bathrooms. He is a judge at the Royal Society of Arts and a self-confessed games luddite.
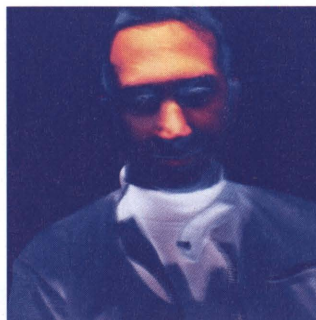
Mike Exon
Head of special projects, Design Week

CV: A journalist for design industry bible *Design Week*, Exon writes frequently about technology and product design as well as multimedia and branding. He has a special interest in digital media, and has written on the subject for *The Guardian*. Now running special projects at *Design Week*, he has edited publications including the 'Design Week Web and Multimedia' book.

MR: That may be true, but this is a teenage market and that looks like old computer equipment.
AW: It is quite solidly made – I imagine to withstand fits of passion in the middle of a game. Someone has definitely tried to beef up the vulnerable parts.

So, does Sega fail the aesthetic test?
ME: I don't even think it was an issue of aesthetics, it was the 'do-it-cheap' impulse.
AW: The problem is you'd never guess that inside something as dull looking as this are

hidden those wild games and fancy technology. Design should reflect function.
DM: They could at least have used a slot-loading CD player, instead of that horrible-looking flap.

Moving on, there's no mistaking PlayStation2 for a bedside clock radio.
MR: No. But it's a risky design for a kid-centred industry. It could alienate as well

as attract. We received a version of this in our studio and my kids came up to have a look – they were excited about the games but doubtful of the styling.
DM: I think PS2 is aimed at older people who want to play DVDs and go on the Net as well as play games.
ME: In terms of design I'm not impressed. If you compare PS2 with computers like the iMac and the Apple Cube then it looks

Daniel McInnes
Junior designer, therefore Ltd

CV: Having racked up design experience at Nortel Networks, Frazer Designers and therefore during his degree course, McInness walked straight into a job at of the UK's top hi-tech design houses. In 1999 he won the Royal Society for the Encouragement of Arts design award for the LINN Internet hi-fi, and has been described as a gamefreak.
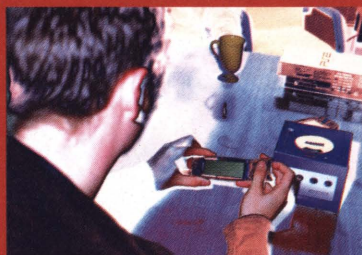
totally retro. It completely ignores the current fashion for curves and colours.
AW: PS2 grabbed everyone's attention because it was stood vertical and photographed very dramatically, so that you didn't notice it looked like an upturned '80s Amstrad computer.
ME: Yeah, it's a triumph of marketing over design. What people have bought into is

something out of 2001, like the monolith. It looks monumental, like a war memorial. It evokes a serious quality. I don't agree about the metal, I think it looks great.
DM: It looks horrible in front, where the DVD slot is.
CM: I think the venting design is great. I love it. Okay, black is perennial, but I think Sony chose a colour that makes it

comfortable with the PS2 standing upright in my lounge, but I'd build a cupboard to hide the Dreamcast.
CM: Is this to appeal to a late-'20s/'30s market then?
MR: At that price I imagine so.
CM: It seems to be aimed at a market of adults who want to have sophisticated leisure toys. I really like the technique of the logo in the style of 'hand-carving' letters. It's a terribly clever reference, like coming across a memorial stone, or some sort of cultural icon. And the colour blending on the PS2 is really beautiful. It's very discrete.
MR: It's very understated.
CM: Even more than that there's a beautiful element of proportion, the shape of the fonts, the size, and the scale and the colours. With just these few letters the impact is fantastic. That combination of that little touch of colour and modernist digital type with that reference to a letter carving tradition is there – not that those references will necessarily be picked up by a consumer – and create a very interesting set of responses to the design.
MR: I find it difficult to embrace because of the retro feel.
DM: And the side view is a bit horrible.

"I think PS2 represents quite an interesting style trend. It's a revival of late-'50s/early-'60s Dieter Rams-style modern aesthetics"

the photograph, not the real object. This is the first time I've seen PS2 in the flesh, and I think it's pretty disappointing.
AW: To me the problem is it doesn't look worthy of the £300 price tag.
MR: Also, it looks like it should be made of metal, but it isn't.
ME: It looks like a cheap CD player.
CM: Well, I think it looks brilliant. I think Sony is the master of aesthetics in these products. The whole thing is incredibly clever. Looking at it upright, it looks like

look controlled. I think the whole placement of graphic information is very clever. It's the most interesting console on the table.
AW: If you lie it down it loses all those qualities.
CM: As soon as I saw it I thought it looked brilliant.
AW: Up close it doesn't look like classic Sony – there's something low-quality to it.
DM: It's going to collect dust in the grooves, too…
AW: Of the collection we have I'd be

CM: I don't think it's so bad, and I like it standing up. It looks very much like a book, or a folder. It has a reference to being on a shelf and being serious. It looks like a smaller version of a stylish filing box or something you'd keep something serious or important in.

MR: To me Sony knows how important this is, and I feel that's not as good as it should have been.

CM: I collect contemporary design for the Design Museum, and I'd definitely select it as an example of its genre.

Nintendo's GameCube is still under armed guard, but from Edge's mock-up, what do you make of it?

AW: It looks unquestionably like a piece of contemporary electronics gear.

CM: I think it's quite an interesting style trend. It's a revival of late-'50s/early-'60s Dieter Rams-style modernist aesthetics [the German industrial designer Rams designed many of Braun's products]. Obviously Sony looked at that kind of tradition, which got sidestepped in favour of the funky retro look. This is a return to that world. It's quite an exquisite geometrical formation. It's also a very beautiful-looking object.

DM: I think it's a nice idea that you can connect the Game Boy Advance with the GameCube. But the buttons on the Game Boy Advance are tiny. I've got the old one and the pads are bigger – you can get your whole thumb over it. This one's got nothing to it, and even the L-R buttons are too soft for my liking.

MR: I agree, I am very disappointed with the new Game Boy design.

CM: I think anybody over the age of 16 found playing with the Game Boy Advance will be seen as seriously sad. I think it's aimed at little kiddies' hands and is supposed to appeal to them. In that sense, for a child, it's rather nicely designed. I assume it is for the 10-16 market.

DM: At an £80 price tag?

AW: It's a shame that they've looked like that for years. That market is increasingly playing with mobile phones. There's a lot of talk today about brand and to me this says 'Woolworths'. It's a 'pile 'em high, sell 'em cheap' message.

CM: Well, it fits in your pocket nicely, and I think the blue-silver [of this particular example] is a very successful choice of colour scheme.

MR: It needs hollowing out at the back – you need some room for your fingers when you hold it.

Do you think mobile phones like this Ericsson supersede Game Boy?

AW: I can't imagine that Game Boy will disappear, though mobile phones will probably take over most mobile gaming.

ME: Mobile phones are a complete waste of time for games. The screens are useless.

MR: But the new generations will have screens like the Game Boy.

AW: You can see these two [mobile phones and portable consoles such as Game Boy] converging.

DM: I can't see anyone playing games on a mobile phone.

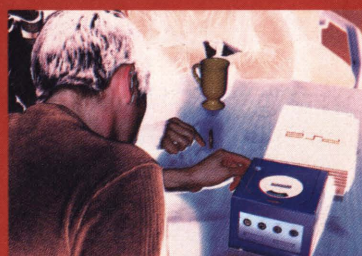**MR:** Yet most people who bought a Nokia 3310 did so because of the new version of *Snake* on it. My son wanted the phone just because all his mates had the new game.

Finally, Sony's PSOne…

ME: Well, this looks like it's aimed at primary school kids.

MR: Honey, I shrank the PlayStation…

Sony is producing an LCD screen unit which can be attached to it, and an optional jack which can be plugged into the cigarette lighter in your car.

DM: The market's obvious there, then.

Which brings things around to the absent guest: Microsoft's X-Box. What would you care to speculate?

AW: The X-Box needs to try and come up with an attitude and a manner. That's clearly the problem these companies have had when designing their consoles. They need to work out how to represent gaming as a three-dimensional product, and in a way the PS2 – standing upright as a monolith – comes closest to telling you that there's a depth to the thing.

MR: I think I'd go down the route of controlling the screen using a cordless device. That will need charging and stowage space. So, one early view would be that you'd create a console where you could clip the controllers on to the box.

ME: Microsoft is facing an uphill struggle. The main reason for every console's success isn't its design, it's the technology inside and the quality of the games you can play on it. You'll ultimately buy PS2 or X-Box because of the quality of the games you can play on it, not because it looks nice under your TV.

Upload: Future lag

Nighteen months ago, the videogame industry finally woke up to the Internet. Not in the 'Gee, killing Orcs is more fun with your friends' sense, but in the 'Hey, this could kill my business' sense.

The realisation hit the music and movie industries at about the same time, prompted perhaps by the success of MP3, Napster and the Web-based promotion of 'The Blair Witch Project'. So-called TMT (Technology, Media and Telecommunication) shares were booming, and Net companies soared to stratospheric heights. Before crashing to Earth in March, they looked like changing overnight not just games and music distribution but the world.

Net-mania saw trade magazines like *Music Week* and *MCV* run features on 'The End of the High Street' and editorials lambasting their readers for sticking their heads in the sand. (Having only just taken their heads out of the sand, the journalists were well placed to comment).

Meanwhile, game companies scrambled for Internet partners. Publishers made alliances with Web portals. Developers set up WAP teams before their publishers knew what WAP was. There was an air of panic. Despite the technical fluency of games developers, most games industry bigwigs have a retail background. Their experience is box shifting: once they were finally convinced that games might be one day downloaded straight to console, sans boxes, they overreacted.

Pockets were bruised, as well as egos. Electronics Boutique is one of Britain's most popular retailers, with some 300 stores, yet its shares crashed to a fraction of their highs, largely on fears for the future of traditional retail stores.

Those shares are now worth three times what they were at that low point. Was the death of the High Street exaggerated? Perhaps, but only a little. The dotcom bust has deflated the hype, but it still seems inevitable that games will eventually be downloaded into users' homes. The arguments are too persuasive.

No, what occurred was collective Future Lag.

It's the logical evolution of Future Shock, the tendency first revealed in Alvin Toffler's book of the same name, which noted that people were increasingly alienated by the rapid rate of change in their 20th century lives.

Future Lag is a more highly evolved malaise. Sufferers see we'll be living in a different world tomorrow, but, surrounded since their teens by rapidly evolving computers and timetabling their businesses according to Moore's law, they overestimate the rate of change. Used to galloping 'Internet time', they wrongly correlate that advances in technology bring equally quick changes in consumer habits.

In another 12 months' time, broadband will finally be a reality and X-Box will be out there with its hard disk, ready to accept games from the Net.

But the technology is just the first and the easiest part. The High Street stores will be there for some time to come – certainly until X-Box2. Nowadays, the future always arrives much later than you think it will.

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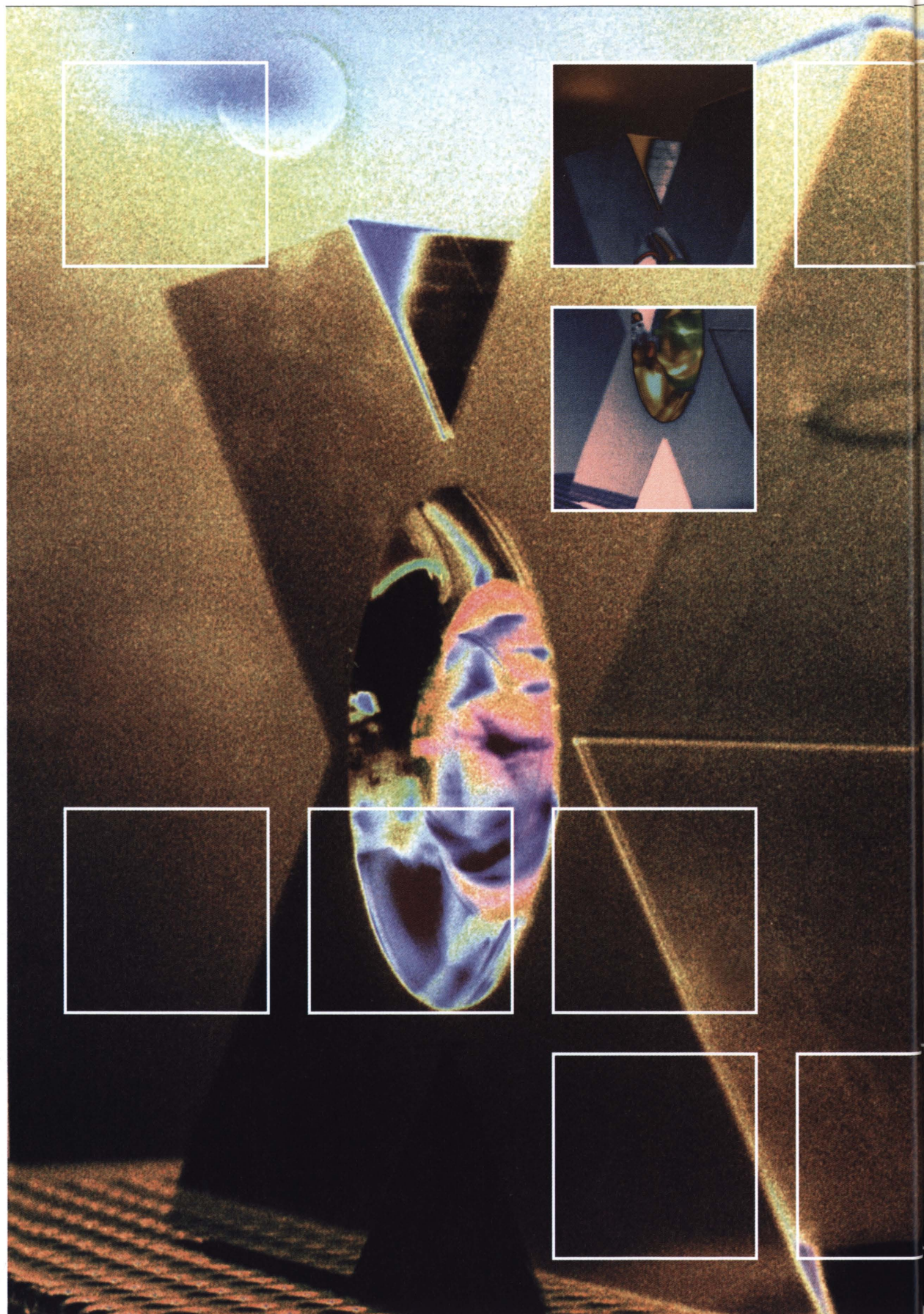
Specifications

CPU: 733MHz Intel 32bit CPU

Graphics processor: 300MHz Nvidia iGPU

Other processors: 200MHz Nvidia MCPX

Main RAM: 64Mb unified memory

Memory bandwidth: 6.4Gb/sec

Graphics RAM: none (64Mb unified RAM)

Theoretical performance: 150million polygons per second

Estimated real performance: 50million polygons per second

Graphics functions: Hardware transform and lighting, full-screen anti-aliasing, variety of 3D effects, four simultaneous textures, texture compression

Sound RAM: none (64Mb unified RAM)

Audio performance: 256 2D channels, 64 3D channels, hardware 3D effects

Storage: 5x 4.7Gb DVD, 8Gb hard drive, 8Mb memory card

Input/Output: Four game controller ports, expansion port, proprietary A/V port

Networking: 10/100Mbps ethernet broadband enabled, optional 56Kbps modem

Notes: The Nvidia iGPU frees the CPU from the bulk of the 3D processing. Sound is handled by the MCPX. The hard disk is designed primarily as a 'scratch pad' to extend main memory rather than for longterm game installation.

Manufacturer: Microsoft
Partners: Nvidia, Seagate, Western Digital
Launch date: Autumn 2001
Estimated launch price: £300
Country: US

Focus: X-Box

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Moving into the highly competitive console market has been as much an exercise in branding – and, indeed, rebranding – as in engineering for Microsoft's high priests of technology. Edge considers the story so far

The sun is presumably shining somewhere above the clouds and another murky British day is underway. It is Monday, 9am GMT, and one of **Edge**'s writers is unable to complete an article because Kevin Bachus, Microsoft's director of thirdparty games, hasn't returned a vital email. The press deadline is an hour away.

A call to the head of PR provokes a formally disappointed email to Bachus, which, incredibly, results in the answers. It's 1am Sunday night, Pacific Time, and Kevin Bachus is in the office. Working.

Leave aside those incredulity bating specs, the hard disk, the maturity of DirectX, and the bank balance of Microsoft. The reason this machine has already got so far and could go so much further is because Microsoft people don't know how to sleep.

How it works

X-Box is a machine with three brains. As in a PC, the Intel CPU is the dominant partner, co-ordinating all the other chips, handling the I/O and running the game code. Contrary to some of the marketing innuendo, even on X-Box the CPU is responsible for calculating the structure of the 3D game world as AI, physics, and the player's input act upon it. The CPU passes a description of this world to its graphics partner, the GPU, for drawing.

The GPU is as powerful as the CPU, but its abilities are more specialised. It is responsible solely for drawing 3D graphics on-screen, converting the 3D co-ordinates fed into it by the PC into a 2D 'view' visible to players. Before Nvidia's GeForce 256 chip, 3D accelerators just painted and textured polygons. With hardware transform and lighting, the accelerator also handles the transform stage – that is, converting from 3D to 2D space – and the lighting calculations. The CPU still does the initial polygonal set-up work for each frame, but the overall burden is much reduced.

Recent tweaks to DirectX 8, particularly vertex and pixel processing means the pipeline from CPU to 3D accelerator is more flexible than it was, which should alleviate fears that every game will look like Acclaim's *Forsaken*. Incidentally, it's the Nvidia hardware that deals with DVD playback, having the necessary decoding built into it. Programmers could, for instance, decode MPEGs into animated textures. The final chip, the MCPX, acts as a control centre, routing data from the hard disk, DVD, and modem around the console. It is also responsible for X-Box's extraordinary sonic capabilities.

All three chips share the console's 64Mb of unified RAM. This means developers can choose how much memory to allocate to sound, graphics, physics and the like on-the-fly, and to an extent save on shunting memory about the system. Microsoft says this is more flexible, although some critics suggest it's going to cause chips to lock over shared memory, and that it's really done for reasons of economy

Microsoft in control

Sly asides from Microsoft's competitors fall particularly wide of the mark when they suggest the company lacks experience in game hardware.

In fact, Microsoft's Sidewinder range of controllers leads the field on PC. The staple Sidewinder Game Pad and its sibling, Joystick, regularly win best-of-class awards, and the range has been extended to include steering wheels, force-feedback models, and a 'Pro' premium range.

Equally, Microsoft isn't afraid of innovation. It recently released the Sidewinder Strategic Commander, a novel device with a plethora of buttons created to break the dominance of the mouse/keyboard combo in controlling realtime RTS titles like *Red Alert 2*. (An X-Box version could also help the PC's glut of great strategy games hop to the console.) Hot on its heels comes the Game Voice Pro – a response to the growing trend of online voice capability in firstperson shooters.

Like the console itself, though, Microsoft is keeping the design of its joypads close to its chest. "Oh, yeah, the handset. We had better get started on that," **Seamus Blackley** recently joked to **Edge**. In reality, both are already waiting in the wings for a strategic unveiling.
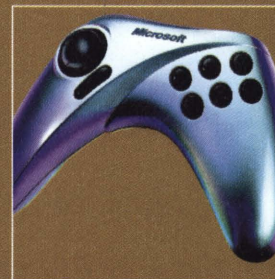
The sucker punch

When X-Box was a rumour, you couldn't find a developer with something nice to say about Microsoft. Scepticism was mirrored in consumers grown tired of the Ctrl-Alt-Del salute.

Now the opposite is true. With more than 170 developers working on games – around 20 on firstparty exclusives – Microsoft has won over a frigid audience. To varying degrees, studios in Europe, America and, crucially, Japan have embraced the machine.

Those who recalled the sketchy achievements of Microsoft's PC software appear placated. Those who pointed out Microsoft's unprecedented history of devouring or crushing other companies that dare to sell more successful software on its platform, from Lotus to Netscape, are readying potential Sony-crushing games.

Microsoft's charm offensive has just stopped short of evoking images of plucky hippies building a far-out game machine in a dusty garage. Certainly, the message has rarely been that one of the most profitable and most ruthless megacorps is turning to games to get an X-portal into the living rooms of the western world. Kevin Bachus and his colleague Ed Fries, VP of games publishing, are frighteningly effective company men, but Seamus Blackley, director of advanced technology, and Jay Allard, general manager, have more the air of two chancers who've graduated from a skate rock band. Both, in reality, are among Microsoft's brightest brains.

By creating a buzz through PR and endless meetings with developers and publishers, these men have diffused the unappealing Microsoft connotations that dogged X-Box early on. The result is a virtual machine barely visible through a cloudy smoke of hype, like the real thing enveloped on a stage by dry ice. X-Box's hardware has knocked us out before it has truly pushed a single polygon.

Out of the box

When Sony first revealed the specifications for its PlayStation2, onlookers were incredulous. But even allowing for the Moore's Law-mandated boost provided by launching X-Box a year later than PlayStation2, Microsoft's claims seem so spectacular that critics don't whether to convert or crow.

Sure, Microsoft has long been a company that hypes first and fills in the gaps later. But development sources tell **Edge** a figure of 50m fully lit and textured polygons per second is achievable on X-Box. That's almost on a par with Sony's theoretical claims for maximum throughput on PS2.

Of course, the two machines are very different, and it's arguable –
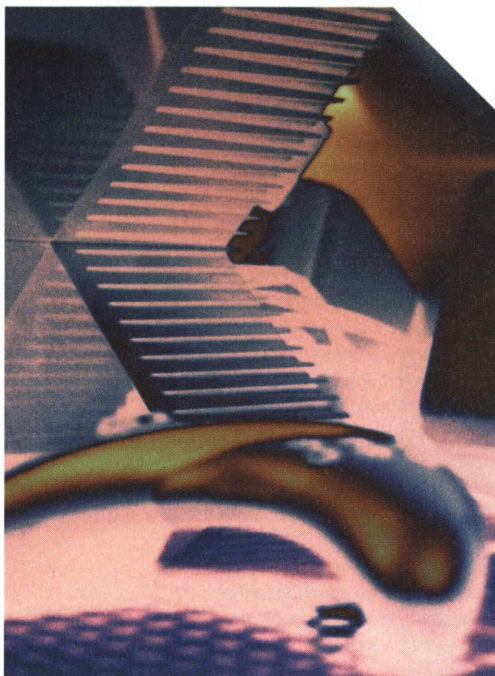
Input and Output

X-Box notably lacks connectivity options compared to Sony's PlayStation2. There are none of the plugs and ports that makes Sony's intentions so intriguing.

Having said that, Microsoft should win plaudits for building four controller ports into its machine, especially when set against Sony's miserly two. Unfortunately, despite the fact that its PC controllers are all USB, these are thought to be simple plugs that will handle devices such as steering wheels, but not much else.

Convergence is left to what is called an 'expansion port' in the official specs. There is some deliberate confusion as to what this port is – Microsoft hints that it follows the USB standard, but that the plug ends aren't themselves USB. It seems, then, that rather than create a PS2-like device ready for any digital cameras and printers, Microsoft might want to more tightly control and licence what hardware can be plugged in. Microsoft says the port can handle video, but declined to comment further.

Broadband connectivity is built-in thanks to ethernet, so when you finally get ADSL or a cable modem, hooking up your X-Box should be straightforward. Also worth noting is the support for HDTV – it won't be a factor in the UK for years, but it could catch on in the US, making screen resolutions that match the PC a reality on televisions.

Sony is banking on this – that sheer polygon handling ability won't win the war. The X-Box model is transplanted from the PCs CPU-and-3D-card combo. Where the ideal Emotion Engine program conjures its 3D from a mathematical dance on-the-fly, X-Box's technology favours the more established PC model of shuffling vast amounts of pre-prepared graphical data, even down to using the hard disk as a 'scratch pad'. X-Box's four simultaneous textures, 6.4Gb/second memory bandwidth and 64Mb of RAM are impressive – but they're also necessary to keep the beast fed.

Commentators overlooking the poised architecture of PlayStation2 are like those who compare the speeds of the 300MHz Emotion Engine with X-Box's 733MHz Intel chip and say Intel's must be inevitably better – despite the fact that they do entirely different things in each tick of the clock. The 20-year backdated architecture often looks cranky in a PC, so it's not necessarily a first choice for a new console.

That said, in the medium term X-Box's technology should provide the more impressive raw power. Ironically, in purely visual terms PlayStation2 is likely to look best against X-Box at the latter's launch, when titles like *Metal Gear Solid 2* will be released against X-Box's inevitably mediocre starting line-up. But X-Box will soon wow the eye-candy crowd, although PlayStation2 could find a second wind when the flexibility of its hardware finally proves its worth.

In tapping into X-Box's power, especially in the early days, the importance of DirectX cannot be overstated. Microsoft has effectively Beta tested the X-Box software development environment for five years now on PC. The console was – and still is – a platform in software before the hardware is even available. In terms of the API, programmers know what to expect; the close match between X-Box and PC obviates any real concerns.

A more debatable boon is the hard disk. Hats off to Microsoft for biting the bullet, giving game developers the chance to make games that use it for day one, even if only as an extension to RAM rather than for any genre-bending longterm storage. But the hope (and promise) must be that the machine really doesn't need it. If console game developers have to rely on something as inherently unstable as a hard disk, X-Box could falter.

Equally, some say that engineering a cheap knockabout hard disk for the living room will be tricky. (GameCube's carrying handle almost shouts the proud absence
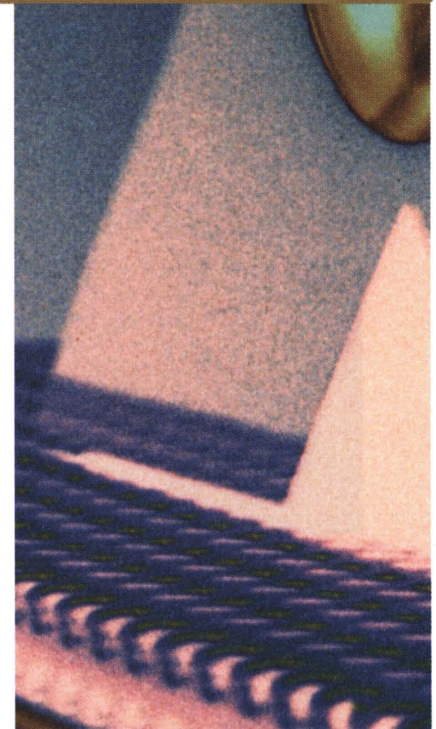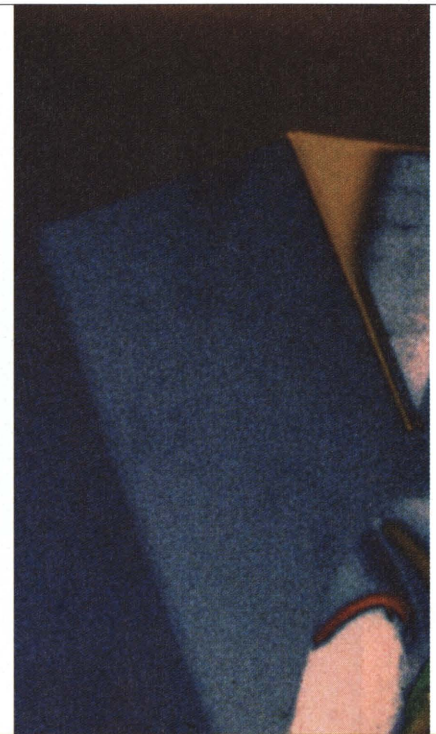
X-Box logo
Not just a pretty green cross,
but a 'fresh, exhilarating X-Box
logo' according to Microsoft.

Munch's Oddysee
Oddworld is the first studio to
defect to X-Box, taking its high-
profile *Munch's Oddysee* from
PS2 to the new console.

Halo
Microsoft's acquisition of Bungie
gives it, in *Halo*, an extremely
promising launch game
(although it is still promised
to PC and Mac, too).

Age Of Empires 2
Microsoft is taking *Age of
Empires 2* to Dreamcast, diluting
the 'exclusive' status of one of
its strongest IPs, but gaining
invaluable insight into delivering
RTS games on a console.

Soft focus

Can Microsoft's X-Box
muscle into the game
market, or has it arrived
unfashionably late?

of a delicate fixed-head disk drives).
But pundits have overstated this
issue. It's completely possible to
make robust portable drives –
there's one in every laptop.

Games, games, games
Ask Microsoft's X-Box-salaried
technopunks what their console
is for and they will say 'games,
games, games'. It's probably in
their contract. No PC compatibility
and restricted connectivity back up
their case. Yet it seems inevitable
that X-Box is part of a wider
Microsoft plan. Little hints have
slipped out, clues that back up the
big hunch generated when Microsoft
formally revealed its games console
project just as Sony launched the
machine it said would challenge
the home PC with a console in
the living room.

Ask Microsoft's vice president
of the games division **Robbie Bach**
what X-Box is for, for instance, and

on a good day he'll admit that
in addition to games: "It's also
designed to bring us another anchor
tenant in the home. You've heard
already about MSN and WebTV; X-
Box is a third opportunity to make
that happen. We really see this as
a place where we can build software
assets through game APIs that
people use in a broad platform
sense. And we see it as a place
where online gaming can really help
drive the online environment in the
home. That integrates back into the
discussion of WebTV and MSN."

At least that's what he told a
meeting of financial analysts last
summer. There are various ways of
interpreting Bach's sentiments, but
one might be: "We want to make
DirectX a standard platform for the
home as well as office, and we want
to control network access in the
home. By building a game machine
we can do that on the sly."

Does it matter? Probably not,

from a gamer's point of view.
Like Sony's more transparent
strategy, X-Box's other ambitions
require the machine to be popular
through desirable games.

There's no doubt either that
X-Box was conceived and made
first as games console. But X-Box
was given the green light not just
because the timing is right for a
Microsoft games machine – DirectX
is mature, Microsoft's games
expertise has grown, Sony seems
too powerful to some publishers –
but also because time for the PC
may be running out.

Like Sony once was, Microsoft
is, to gamers, an unknown quantity.
Edge hopes its PC-console hybrid
brings some of the PC's
inventiveness to console games
rather than its less desirable quirks.
After the cataclysms wrought by the
last new hardware entrant, who
knows what a Pandora's Box
Microsoft might be selling?

Lotus Challenge
Kuju's working on a train simulator for X-Box, as well as a version of *Lotus Challenge* (PS2 shots shown).

Metal Gear Solid on X-Box
Konami is working on various 'X' versions of its leading titles such as *Metal Gear Solid 2* – a blow for Sony, but hardly a huge advantage for Microsoft.

Raven
Microsoft will surely resurrect Raven as a face of the console – the demo girl was a hit in the flesh at E3

Tau
Kuju's *Tau* project is a technical demo designed to squeeze polygons from the nascent X-Box hardware. It hit about 10m polygons per second.

Microsoft has taken a number of apparently substantial risks in an attempt to drive X-Box into the gaming public's imagination (most notable of which is the inclusion as standard of a hard disk). However, according Seamus Blackley, the former jazz pianist currently operating as the director of the X-Box advanced technology team, everything is ready

Many game gurus have a chequered past, but few resumes include spells designing aeroplanes, or smashing atoms at the Fermi National Accelerator Laboratory in Chicago. An untypically styled Microsoft rocket scientist, **Seamus Blackley** has also worked at an LA movie studio, played Jazz piano in Boston, and paid his dues at the now criminally defunct Looking Glass Studios. "In summary, Seamus is a shifty lout who is discovered to be useless after two to three years in any profession," he jokes. Two years into his run at Microsoft, is the console he espouses as director of the X-Box
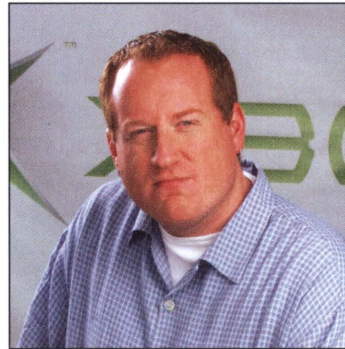
a simple-to-use reformatting method?
In the sad event that everything goes to hell and the hard drive gets roached, you can pop in the recovery DVD that comes with the system, and it will first try to fix whatever is wrong, ultimately replacing the entire contents of the drive if there is no other option. Which sucks because you lose your save games, but on the other hand is great because your box works again. But since we treat the persistent part of the HDD simply as a large memory card (not some crazy PC-like install system), and because we have an extremely robust file system, and because every X-Box title must pass a strict certification process,

director, X-Box advanced technology team

> Seamus Blackley

talking technology

advanced technology team going to stay the course?

X-Box's hard disk is clearly attractive, but it also raises new concerns for consoles. How will it be physically protected?
We are also enamoured of it, and therefore are naturally concerned with its well-being. However, it turns out that concerns about the robustness of such devices are overblown – DVD mechanical bits are actually more fragile than HDD mechanical bits. Especially considering that we are employing a kind of Soviet Army approach with the hard disk: a single platter with a big bearing and a beefy head. So, sorry to say, we will not be suspending the HDD in a gravimetric web or anything like that.

What about erroneous installations by users or thirdparty software?
Since – ahem – X-Box is not a PC, but rather a game console, games do not install. Think instead of the hard drive as an enormous, very high-performance memory card. You can have very large saved games and even downloadable content (like new characters and levels) which are saved and managed by the user in the same way that saved games currently are on memory cards.

Additionally, X-Box developers have available to them a very large, contiguous scratch area, which is basically reformatted every time the console is reset or the power is turned off.

In a worst case scenario, is there

the chances that it will get cocked up in the first place are very, very, very, low.

If X-Box is for games, why broadband and not narrowband, when the PC space has proven that narrowband works?
If the automobile is for transportation, why the internal combustion engine and not the steam engine, when the railroad has already proven that the steam engine works?

Narrowband is great. But broadband has the potential to fundamentally change the way that games are written, distributed, and played. It's a difficult challenge, but it's well worth the work.

Why does X-Box have a

proprietary A/V port?

The main reason for the existence of the custom A/V port is compatibility and flexibility – worldwide you need to be able to support SCART, NTSC composite, PAL composite, and possibly certain other goofy standards. It also makes it possible to support S-Video, SPDIF, and other high-end standards simply by selling different connectors. Not to mention HDTV, which X-Box can actually – and uniquely – render quite handily.

Why no Firewire?

We couldn't really think of an application that you could use it for that USB couldn't

game developer if it's convenient or increases performance to have local graphics or audio memory and you'll likely hear some words that your mum didn't teach you.

Local memory in console systems is mainly a cost-saving measure. It's actually a big pain to move stuff around in these systems.

In what way?

Imagine that you need to update the textures you have in VRAM: you need to quit rendering, stall other parts of the system while you copy the textures around, then set everything up again and continue

that every developer we've introduced to the memory system has come away grinning madly.

Why are you so confident that the real performance figures will be close to the estimated performance figures, when every previous hardware platform has shown a significant disparity?

Now, you need to realise that as a rule all performance numbers quoted by processor manufacturers are total marketing crap. For a thousand reasons, real games never achieve the performance even of manufacturers' performance demos, much less the theoretical limits

"Since X-Box is not a PC, games do not install. Think instead of the hard drive as an enormous, very high-performance memory card"

handle. USB is relatively cheap, easy to program, easy to manufacture, and has bandwidth sufficient even for video. We also wanted to keep things simple for the user by supporting only one expansion standard.

Why did you decide on unified RAM when the trend in both consoles and PCs has been towards allocating individual RAM batches to the various system components?

For the same reason that we chose everything else in the architecture – to increase the performance of the system for realworld games, and to make life easier for X-Box developers. The 'trend' in memory architecture on the PC is overwhelmingly motivated by compatibility issues. Ask a PC

rendering. That's a pain in the ass, and forces a lot of design and art decisions that we never wanted X-Box developers to have to make.

So we went with the unified architecture, which is superb for every reason except that it introduces the problem of contention, which is when two processors, say the CPU and the GPU, want to use the same memory at the same time. Part of this is alleviated by the fact that X-Box uses some of the fastest RAM available on Earth, 200Mhz DDR, giving a system bandwidth of 6.4Gb/s.

However, the general contention problem is handled by a custom memory controller, which is integrated physically into the graphics chip. I could go into a lot of insanely boring detail but it suffices to say
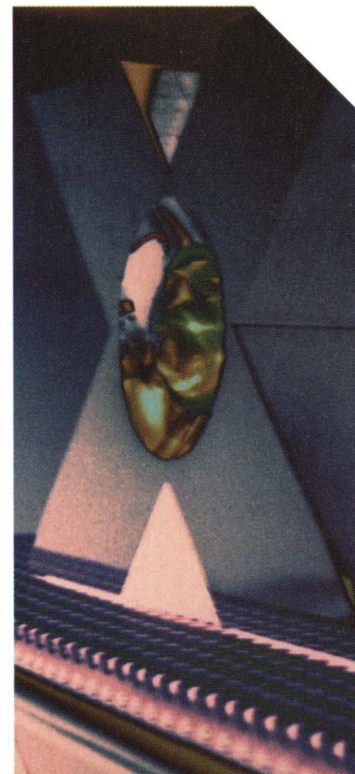
that PR departments love to quote.

That said, some architectures are much more able to approach their maximum performance. The X-Box chip, as designed by the guys at NVidia, is the result of some 20 years and ten generations of collective graphics hardware design experience. The NVidia architects have been making hardware for a long time and thus have been getting yelled at by software people for a long time – so it's not surprising to discover that it delivers a lot more of what it promises than some other designs do.

Can you give an example?
Polygon performance. Every graphics

one twentieth of that with textures and lights'. Nvidia's design goal for X-Box was to achieve maximum performance with all features turned on – lighting, textures, pixel shaders, vertex shaders, surface engine; the whole enchilada, as we love to say in the States.

The end result is that X-Box allows developers to do some really stunning full-featured rendering without substantially compromising the complexity of their scenes or dumbing down their designs. And that's the point.

Could the DirectX API actually stifle optimisation later in the console's life?

The headroom on X-Box is not in the assembly programming of the data paths to the chips, but rather in the microcoding of the chips themselves. This is obvious for the CPU, but consider that the X-Box GPU has fully microprogrammable vertex and pixel pipes, and that the APU [Audio Processing Unit] has a fully programmable DSP. When you get to this level of custom code running at every pixel on the screen and for every sound sample played, you in fact open up horizons of optimisation that no one has ever seen before.

The audio performance looks amazing – is it overkill?

design claims insanely high polygon performance, but all too often the quoted performance is for something really daft like drawing the exact same polygon over and over again millions of times. Conversely, the X-Box architecture is designed expressly to handle all the fiddly things that ruin realworld polygon performance (and that the other guys don't really talk about) like cache misses, compression, pixel rejection, etc. The numbers we quote already take into account much of the stuff that comes as an ugly surprise to developers on other systems.

But the really amazing thing about the X-Box chip is that it operates with its full feature set all the time – there's none of this 'it gets so-and-so million polys per second drawing flat shading and no lights, but only

DirectX means two really different things on the PC and on the X-Box. On the PC, DirectX enables developers to write games that run extremely well on a stupefyingly large variety of hardware configurations. On X-Box, DX provides a convenient interface that allows developers to get up and running quickly, and to spend their time working on game features instead of resolving the basic technological problems of realtime 3D.

Since X-Box is a game console, games do not absolutely need to use an API to write to the hardware, and therefore game developers can choose to write their own interfaces. The problem with this is that these days, at the 100 million polygon per second performance level, the bottlenecks just aren't the same as five years ago.

Right, the **Edge** version of X-Box looks like this: narrowband only, slow local memory, and boring old sound hardware. Brilliant!

OK, yes it is overkill and I'll tell you why – to ensure that X-Box games will always have great music and sound. Sound and music are always done last, and always have to make do with whatever system resources are left over from graphics and game mechanics. Thus game music and sound effects usually suck. And you turn the volume off because they are such crap.

So how do we solve this? We make a sound processor so powerful that it ends the resource problems. X-Box does 256 simultaneous DLS2 voices in hardware, with effects and some other cool stuff, all without taxing the CPU or GPU at all. Plus it has that programmable DSP I mentioned.

Curtis Priem
*NVidia co-founder
and chief
technology officer*

NVidia: days of living dangerously

All graphics companies live in the fast lane, but only one celebrates the ever-present danger of losing control. Just who's at the wheel at NVidia?

Jen-Hsun Huang
NVidia co-founder, president, and CEO

Chris Malachowsky
NVidia co-founder, and VP of hardware engineering

The computer industry has an almost religious reverence for its leaders. Maybe it's a reaction against the soulless mathematics of the machine's inner workings, but the few who do ride the technological rodeo to success have become gurus.

Straight-laced geeks such as Microsoft's William H Gates III and Intel's Andrew S Grove could be mistaken for techno-prophets, complete with disciples who hang on their every word. Sales pitches have become incantations to shape existence. "Where do you want to go today?" chirps Gates.

"Only the paranoid survive," grumps Grove. "Think different," smirks Apple's Steve Jobs. While NVidia has some way to go before being namechecked alongside such behemoths, the personal cachet of its president and CEO is riding high.

Still in his 30s, **Jen-Hsun Huang** was last year named high technology entrepreneur of the year by Ernst and Young, and the company he leads by example is among Deloitte Touche's 500 fastest-growing companies in Silicon Valley for the second year in succession.

The 30-day ruling

Huang's personal mantra already has the ring of greatness. "I am always 30 days from going out of business," he says.

Certainly true at certain points in NVidia's history, his pessimistic tone now seems misplaced. The company he co-founded seven years ago is currently worth $4.5bn. It expects its turnover to top $1bn in 2002, making it one of the fastest companies to break the eight-figure barrier. It is leader in the desktop 3D graphics

"Huang's stated aim is to make NVidia the most important graphic company in the world. He's right on track"

market, and aggressively targets other sectors, as proved by its partnership in Microsoft's X-Box. It's also moving into a purpose-built, half-million-square-foot facility next year. At a time when almost all its competitors have suffered major reversals of fortune, NVidia can't seem put a foot wrong – in fact, it's often NVidia which tripped its rivals up.

Huang's stated aim is to make Nvidia the most important graphic company in the world. He's right on track.

We all stand together

Alain Tiquet was NVidia's first European employee. Presently its European marketing director, when he joined 18 months ago there was a staff of 250. The figure now stands at more than 650. The share price was once $12. Now, even after a recent two-for-one split, it's $70.

"Previously I worked at Intel. The spirit at NVidia is the same," says Tiquet, by way of introduction. But while Grove's paranoia seems fearful and inward-looking, NVidia isn't looking to protect established market share. It's out to gobble up new opportunities.

Indeed, when Huang was asked by The Peddie Report to point out the characteristic that best defined his company, the answer was clear. "Intensity. No one here says they want to be among the best. We want to be the best," he said.

You get the impression that if cut, NVidians would bleed the company lime green, and this esprit de corps is sometimes startlingly demonstrated. When it launched the revolutionary GeForce 256 chip at ECTS in 1999, Ken Potashner, CEO of rival S3, attempted to gain access to NVidia's private booth. Despite his insistence, he was refused entry in no uncertain terms. The message was clear. NVidia feared no one. It wasn't interested

in even talking with its competitors.

"A lot of people approached us. I get a lot of solicitations. I have dinners a lot," said Huang in 1998. Back then, he was learning the hard way. NVidia's first part, the NV1, launched against 3Dfx's first Voodoo. It didn't support OpenGL or Direct3D and died, taking the follow-up, the stillborn NV2, with it.

"We hit the wall so hard it left a permanent stain on my body," Huang told *Business Week*. He fired 60 staff, but with those that remained NVidia tried again. The only way was up and the result was the Riva 128, followed by the TNT, the chip that put the company on the map. Now, the boot is on the other foot. Recent rumours link NVidia to a takeover of 3Dfx, although you'd be hard pressed to figure out a logical reason for the union.

Willing to win

"It is like any attitude in life," says Tiquet, of NVidia's will to win. "If you want to be first, you need to do everything to get the position. We want to win. One of the key

While the days of NVidia risking bankruptcy on a monthly basis have passed, the spirit remains

objectives of the company is the product test. We want to win them all."

As for his personal view of Huang, "The guy is amazing," Tiquet says. "One of the key points of the company is that Jen-Hsun is very open. Communication is a key asset." Recently travelling around America visiting investors, Huang emailed weekly reports to the employees explaining what was going on, and how their work affected NVidia's overall business.

"He says, 'In 30 days maybe we are

Real world statistics

Staff: more than 650
Founded: January 1993
Headquarters: 3535 Monroe Street, Santa Clara, CA 95051
Worldwide offices: Australia, France, Germany, Japan, Singapore, Taiwan, UK
Earnings, FY2000: $375million
Earnings growth, FY2000: 137 per cent
Projected earnings, FY2001: $729million
Revenue generated per employee: $1.4million
Number of operations per second the X-Box MCP chip is capable of processing: 4billion
Number of operations per second the X-Box graphics chip (iGPU) is capable of processing: 1trillion
Number of transistors in GeForce chip: 23million
Number of transistors in the X-Box graphics chip (iGPU): 65 million

One of the most anticipated games to support hardware transform and lighting is Planet Moon's *Giants: Citizen Kabuto*. It is in developing features like these that NVidia has managed to stay ahead of the pack

out of business'," relates Tiquet. "This is his famous phrase and this is the way it is for us. We do not relax. We never relax. We must keep working hard."

Pushing Moore's law

Of course, words alone have little influence on a company's performance. With NVidia, though, the words are backed up by actions. It's no secret that its design teams work to a tight six-month cycle. While Intel's Gordon Moore famously predicted the number of transistors on a chip would double every 18 months, NVidia is managing to do that in a third of the time.

While unfortunate for the hardcore PC owner who feels the need to have the latest graphics card, NVidia's philosophy has now made it pre-eminent among the OEM vendors which make up the bulk of the graphics card market. Around 130 million desktop PCs are sold per year and in its most recent quarter NVidia accounted for 48 per cent of that market.

But while its six-month cycle is common knowledge, the detail of how NVidia's designers create their marvels is not.

"Internally we have a two-year roadmap and three development teams," explains Tiquet. "It takes about 18 months to get a product out, so each team is allocated a slot and a transistor budget. They start working and when they get closer to the slot, if they cannot fit everything into the chip, it's okay. They let it go. In six months' time the

Although hardware transform and lighting is still not a standard feature for graphics cards, Shiny's recently released *Sacrifice* title supports it, as do more than 100 games currently in development

other team will have that feature. This is the way we manage to keep the pace."

Another crucial factor is the speed at which a company can turn a chip design into production silicon. NVidia's partnership with the biggest chip fabrication plant in the world, TSCM, ensures that it takes a maximum of 90 days to start volume production once NVidia releases the final design tapes. It's this flexibility and speed that enables Nvidia to maintain its frenetic timetable.

Greener fields

"If you look at NVidia, one year ago we were really focusing on the PC market, but the PC market is limited," states Tiquet. "What we want to do as well is to find new markets."

Still, it is with the PC space that NVidia has most obviously broadened its range of products. A low-power version of its GeForce 2 core has recently been released for laptops (something of a first), while the same core gets extra RAM for

The stories behind the men behind NVidia

NVidia was founded by three individuals – all of whom remain in key positions. Between them, they also control a quarter of NVidia stock

Jen-Hsun Huang, president and CEO, was originally a microprocessor designer at AMD, before moving to work at LSI Logic, where he became director of Coreware, the company's system-on-a-chip program.

Curtis R Priem, chief technology officer, created the architecture for IBM's Professional Graphics Adaptor, which was the first graphics processor designed for a PC, while working for Vermont Microsystems. He then moved to Sun Microsystems where he worked on the GX graphics product, including the first single chip GUI accelerator. The co-author of more than 80 patents, he received the William F Glaser Entrepreneur of the Year for 2000 from the Rensselaer Polytechnic Institute.

Chris Malachowsky, VP of hardware engineering, was a manufacturing design engineer at Hewlett-Packard before moving to Sun Microsystems as senior staff engineer. There he co-invented the GX graphics architecture with Curtis Priem. Malachowsky has co-authored 30-plus patents.

X factor

Many rumours persist concerning Microsoft's dealings over the guts of its console. But while the AMD versus Intel horse-trading was public, at least one online source suggested NVidia originally turned down Microsoft's offer. Not true according to Alain Tiquet. "This rumour makes out that we are very arrogant," he says. "No, from the beginning we worked very hard to get the design. We lost it maybe two times, and we managed to get it back with our winning spirit. Never at any time did we say we didn't want it."

And to the victor the spoils. One month after announcing its partnership, Microsoft revealed that it had paid Nvidia a contractual advance of $200million for its X-Box work.

Not just hardware

Proving the value of forethought, NVidia always maintains software compatibility between its different chipsets. Crucially for the consumer, this means that all NVidia-based boards use the same software drivers, streamlining tricky support issues

"Our expertise is designing the chip and the software," explains Alain Tiquet. "When we released *Detonate 3*, our latest driver, back in August we reworked it from the base, and the new driver gave between a 20 to 40 per cent speed increase compared to the old driver. Imagine that. Overnight all NVidia customers get a boost of 30 per cent by just downloading a new driver."

the professional workstation market.

But with combined annual sales total of only 33million units, these sectors don't have much growth potential. Instead NVidia is looking to expand around its X-Box work.

The specifications for its integrated Graphics Processor Unit (iGPU) make for heady reading. In a sense, though, this is run of the mill for NVidia: it's been making such performance leaps every six months for the last two years. What is different is the second X-Box chip. NVidia's Media Communications Processor (MCP), also known as the MCPX, is a crucial X-Box component. It deals with all the input and output issues from devices such as the hard drive, DVD drive, controllers, as well the 256-channel 3D audio chip and the broadband modem.

thing. Contrasting NVidia to 3Dfx he commented: "3Dfx sees 3D as a games platform. NVidia sees it as a digital medium for interactivity. If someone wants to use 3D for games, or visualising a teapot, we don't care."

He's also revealed a more esoteric side, describing X-Box's technology as being "akin to seeing through the outer edges of the universe through the eyes of Stephen Hawkins." He continued: "Most people don't really understand Professor Hawkins' explanations of black holes and theories about the creation of the universe. Mathematically, we can capture all this in 3D graphics and you can fly around the edges of the universe – the entire experience of being crushed to a little pebble of nothing as you go through a

"Most people don't really understand Professor Hawkins' explanations… we can capture all this in 3D graphics"

Huang refers to it as a 'residential gateway', in much the same way as Sony talks about PlayStation2 as the gateway to digital entertainment. "For us this is new knowhow," explains Tiquet. "It's a new chip for the marketplace, and we are going to work with manufacturers to develop a PC motherboard solution, too."

Other applications include digital set-top boxes and it has already got another console on its books, being charged with creating a graphics accelerator for the upcoming Indrema Entertainment System. This type of spin-off is what has made the X-Box contract so attractive: it is a way to create a different product for a different kind of machine. "With the X-Box, what we gain is a console," Tiquet explains. "Then we can get into other consumers, high-volume, high-performance products – any product that comes with a 3D screen."

Not simply playing games
Huang has previously said much the same

black hole is possible in 3D graphics."

This may be outlandish stuff for the gaming community to digest, but such conceptualising has always been the underlying plan for NVidia, rather than speeding up the latest version of *Quake*. Behind the hard-nosed sell of 'we could be out of business in 30 days' and the relentless six-month cycles, there has been a vision.

In some strange way, maybe it's best summed up by the fact that NVidia serves its employees free lunch and dinner. Certainly it has material benefits in that it's cited as improving staff loyalty, but compared to the inertia generated by generous share options it's probably not the main reason. It is demonstrative of the fearsome attention to detail that NVidia demonstrates in all of its innumerable business dealings.

Armies march on their stomachs, and NVidia's 3D stormtroopers are looking unstoppable.
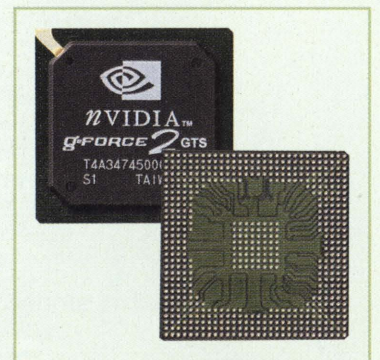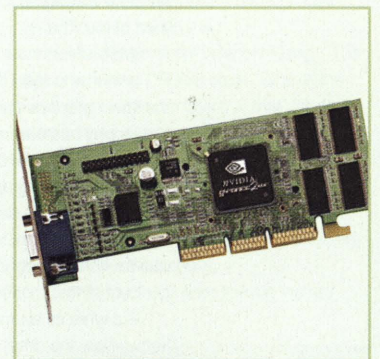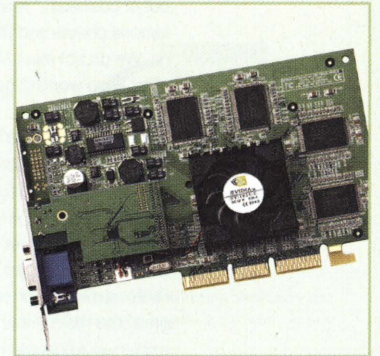
German board maker ELSA uses the GeForce2 chip for the consumer market, as shown above, as well as marketing a workstation part, Gloria III. NVidia's most powerful chipset is currently the GeForce2 GTS, but it won't be long before something more complex arrives. Outstripping Moore's Law, NVidia's six-month design cycles have produced a staggering growth in chip power

Specifications

CPU: 32bit RISC R3000 processor, 33.86MHz

Graphics processor: 53.20MHz

Other processors: Integrated sound processing
unit (SPU), digital signal processor (DSP)

Main RAM: 2Mb

Graphics RAM: 1Mb SGRAM

Theoretical performance: 360,000 polygons/sec

Estimated real performance: 360,000 polygons/sec

Sound RAM: 512Kb

Audio performance: 16bit, 24 channels, 44.1KHz

Storage and media types: 2x CD-ROM and
4Mb memory cards

Input/Output: Two game controller ports,
AV multi-out

Networking: compatibility with mobile
Internet phones

Notes: PSone accepts a separate LCD screen
with in-built stereo speakers. The screen connects
to the AV multi-out and piggybacks onto the
PSone's 9V power input. There are reports that
a Hong Kong manufacturer has launched a
thirdparty screen priced $140.
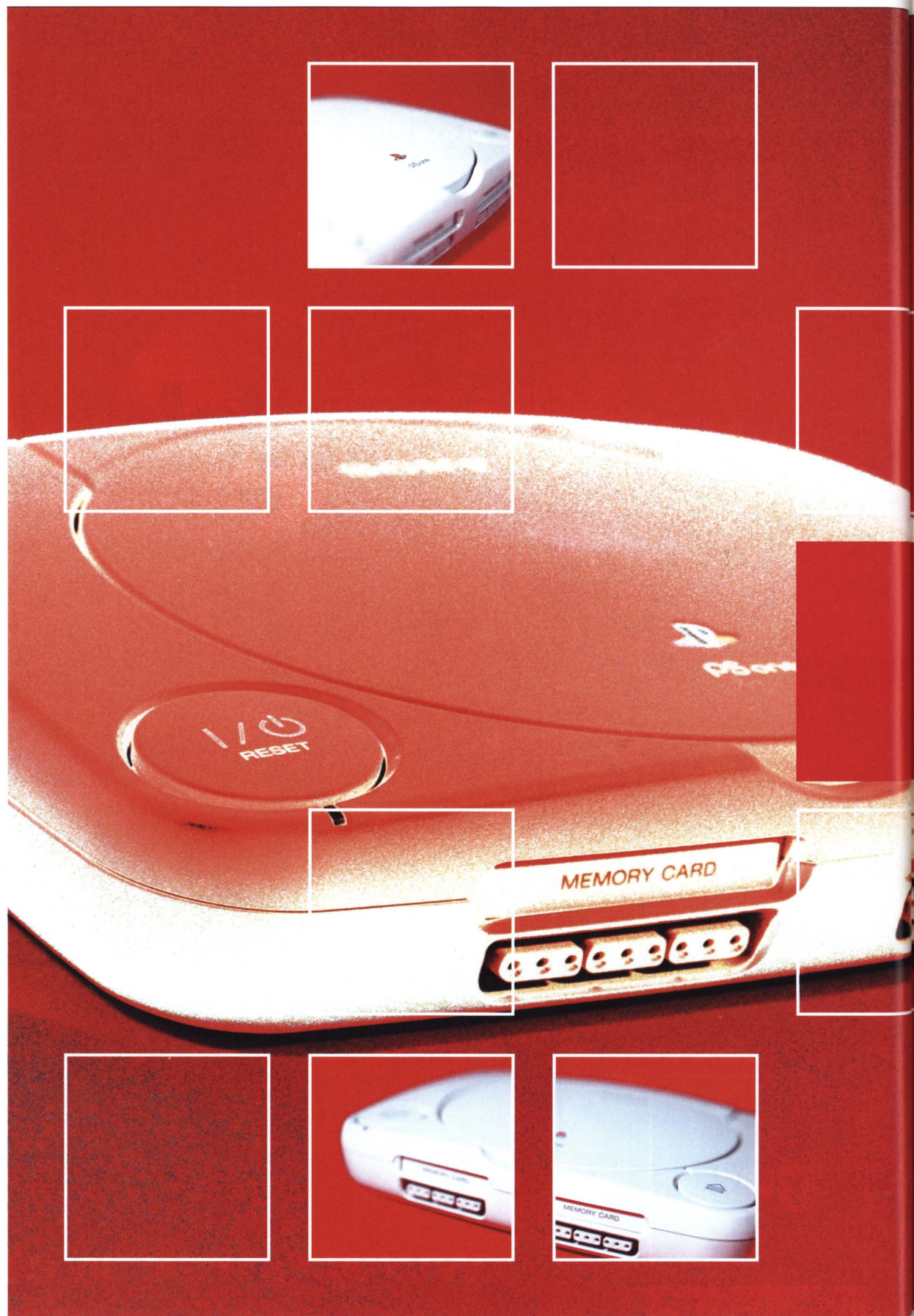
Focus: PSone

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Sony's new cute console sees the Japanese giant ring-fence the PlayStation brand
while pushing sales towards the 80 million barrier. **Edge** asks what the console has to add
to the PlayStation brand, and wonders what the marketing force driving it is focusing on

As Paul Kunkel points out in his book 'Digital Dreams: The Work Of The Sony Design Centre', it is only as the underlying technology of one of Sony's products nears obsolescence that its design reaches the point of absolute expression.

"As sophisticated products become useless marvels, design is replaced by myth-making," writes Kunkel. "Image overtakes reality."

This is an apt description of the process that has taken PlayStation to PSone. With the original PlayStation market close to saturation and the launch of its successor underway, it was always probable that Sony's designers would devise a new look for the existing technology.

Renamed PSone and repositioned as a kid-friendly, semi-portable unit, PSone clears the decks for the launch of PlayStation2 as the company's pre-eminent technology. There remains only one Sony PlayStation console on the market.

It is this philosophy of design that marks Sony out from the other console hardware vendors. While the truism that 'software sells hardware' holds, Sony's consumer electronics experience makes it more aware of the wider value of managing design.

The Saturn looked like a Mega Drive on steroids, and the N64's gentle curves whispered 'for the kids'. PlayStation, in contrast, looked the part. Its sleek, shark-like design appealed to moneyed twenty-somethings.

And just as Sony had defined portable audio as Walkman back in 1979, PlayStation's purpose was written in its name.

Inner science

But underneath that apparently unchanging battleship grey exterior, there have been many different iterations of PlayStation. The process of redesigning the machine's guts had already gone through six major stages before PSone. Starting with the 1000 series, PlayStation's internal nomenclature clicked through the 3000, 5000, 7000, 7500 series, finally ending with the 9000.

And while the exterior has remained largely unchanged, albeit with some redesigning of the output sockets, inside is a different story. No less than 17 integrated circuits (ICs) are mounted on the 1000 series motherboard – 13 on its front and four on the rear. By the 9000 series, the motherboard is half the size, with a mere 11 surface mounted ICs.

"What you see in the PSone is basically a consolidation of the 9000 series' better board layout, but there has actually been no further integration of ICs," explains

Colour-coded controllers

The full range of PlayStation peripherals will be available to the PSone convert but – perhaps confusingly for many customers – the PSone does not support PS2's fully analogue DualShock 2 pad. This is highlighted in colour, with PlayStation2's DualShocks coloured black compared to PSone's light grey.

Will colour coding be enough for a general public already struggling with the emergence of two new Sony consoles within two months? Such problems demonstrate the scale of Sony's problems. For example, what are retailers to do with a stockroom of original dark grey DualShocks?

+ People still want PlayStations
+ Cute design
+ Priced for impulse buyers
+ LCD is a neat concept
+ Japanese kids will love i-Mode link

∧

It's not broken...

The old dog has a couple of new tricks, but how many more lives?

1995 PlayStation 1000 series
Sony's original 32bit machine, which has sold more than 76 million units, had little idea it would slim down to become a PSone
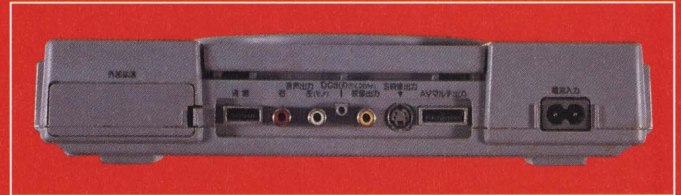
So why did they fix it?

∨

- Retail confusion
- How much software support?
- PS2 lifecycle requires PSone to die
- Portable PSone is a risky concept
- PS2 is backward compatible

Mike Nabarro, Sony Computer Entertainment Europe's director of technical services. "What you've got with the PSone board is a shortening but deepening of the 9000 board, put it into a smaller, neater, sexier package."

Sony style

If the technology isn't a radical departure, repackaging it as PSone underlines how PlayStation's success has left Sony with something of a hangover. Managing the migration of a product from cutting-edge technology to a cheap box given away free with washing machines is never trivial.

PSone's size, broad curves and lighter tone are all designed to help that process – PSone is High Street Chic, the diffusion line of PlayStation. More practically, the redesign also means that Sony could drop the price point further if it desires, further differentiating its two

consoles. "Manufacturing the PSone board is probably four to five times cheaper than manufacturing the series 1000," says Nabarro.

In addition, even the 9000 series required five screws to be removed to get the cover off and then the removal of another four or five screws to get the components out. PSone, on the other hand, has six screws holding everything together. Once removed, the CD drive, the two metal RF shields, and the motherboard are released.

"Sony has got a very aggressive recycling policy, and the faster you can disassemble a product, the cheaper it is to recycle," explains Nabarro. "When PlayStations come back to us that are beyond repair, we don't throw them in the bin. They are all properly disassembled – all the plastic components are separated out, and the metal and ABS plastic is recycled. There is a cost associated with that."

Wireless with a power lead

So, the end of the line for worn-out PlayStations, but not the conclusion of the PSone story. The jokers in the pack are the optional LCD screen that clips onto console's back and the connectivity hinted at by support for a mobile phone adaptor. Little information is currently available about either of these two features. The screen is expected to go on sale in Europe during 2001, but unless the price point of a bundled screen and PSone package is under £150, it's hard to see such limited portability making financial sense as a massmarket product. The lack of a battery pack and domination of Game Boy are just two daunting obstacles.

Similarly, while the popularity of i-Mode mobile Internet phones with Japanese teenagers could prove to be a killer app for domestic sales, the patchy penetration of WAP in Europe and the States seems to

1997 PlayStation 7000 series

Internal redesign has been a feature of the PlayStation's lifecycle. The only external change however, was the removal of the three composite video outputs and the RF input from the back of the console, as can be seen in this 7000 series model.
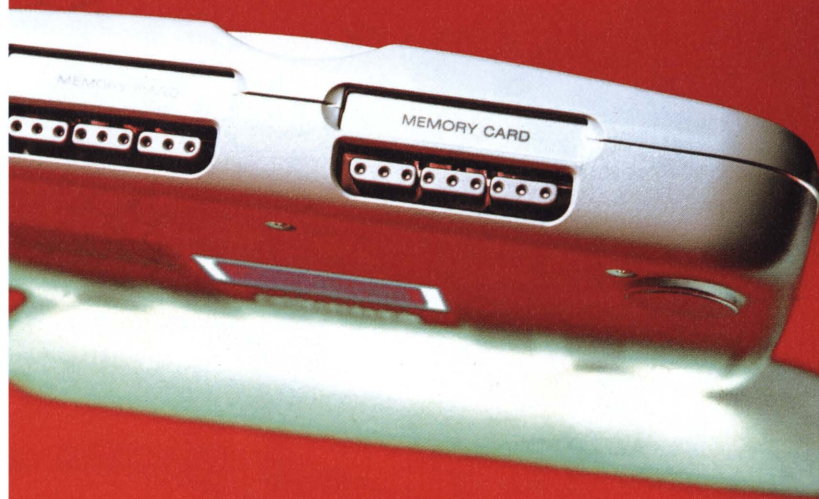
How it works

It is interesting to note that compared to the 1000 series PlayStation, the integration of PlayStation chips to create PSone's motherboard occurs mainly on the CD side of the machine. The exception is the CPU's allocation of 2Mb of DRAM. Originally located in four 500Kb blocks, advances in memory technology have shrunk it into a single similarly sized 2Mb block. Other than that, the CPU and GPU and their associated RAM allocations are the same in PSone as every other PlayStation.

Integration has condensed the digital signal processor (DSP), digital servo controller, CD-ROM decoder and sound processor unit. Common in devices with a CD-ROM drive, such as Walkman, the functionality of these individual four ICs are now carried out by a single digital signal processor. Integrating these chips and the reworking of the circuit layouts shrunk the motherboard to make PSone possible.

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make this feature irrelevant away from Sony's homeland.

Money for nothing?

Sony is probably making more money per PSone unit sold than when it launched PlayStation at £300. And it will certainly be making more money from PSone hardware sales than PlayStation2. Indeed, the concept of PSone really only makes sense if Sony expects to sell a lot of them. It's already shifted more than 1.5m, which suggests total sales could breach five million. That means five million additional customers to be fed into the PlayStation2 market in a couple of year's time.

The question mark hanging over this plan is the continuing support of publishers. Even with Sony's revised licensing agreements, there are few PSone blockbusters are lined up for 2001. Redesigns aside, nobody teaches an old console new tricks like game programmers.

Soft focus

Final Fantasy IX

It's back to fantasy basics for the last PlayStation incarnation of the long-running series that brought RPGs to the masses.

Tomb Raider Chronicles

Lara's final outing on the console that secured the majority of her 23million sales will vie for the Christmas top spot with *FIFA 2001*.

Alone In The Dark: The New Nightmare

Proving it is possible to further push the hardware, Darkworks' chiller looks as good as anything that Capcom has achieved in the field of survival horror.

The World Is Not Enough

EA takes cross-platform development to the max with four separate versions of its Bond-based shooter, but will PSone see a sequel?

c-12

If Sony wants long-term support for PSone, it may have to rely on in-house titles such as Sony Cambridge's *Syphon Filter*-inspired *c-12*.

Mobile mix up: inputs and outputs

The mobile phone connector featured prominently in the original press shots was pitched as a key boost for PSone. Unfortunately, outside of Sony Japan, perhaps, no one has any real idea what it will be used for.

The technology seems geared towards Sony's domestic market, where NTT DoCoMo's i-Mode mobile Internet standard is a social phenomenon amongs teenagers. Outside Japan, it isn't clear how Sony will support all the different WAP handsets available worldwide. Will it issue compatible connectors for all handsets, or stick with giants such as Nokia and Motorola?

It is also far from certain what advantages a phone would bring to PSone games. Some sort of connected *Pokémon Stadium* experience might suggest itself, but considering the scant processing power and slow connection speed of the phones, the connectivity looks in danger of proving a gimmick.

Force Feedback Wheel

Force Feedback 2 Joystick

Game Pad Pro

the untouchables
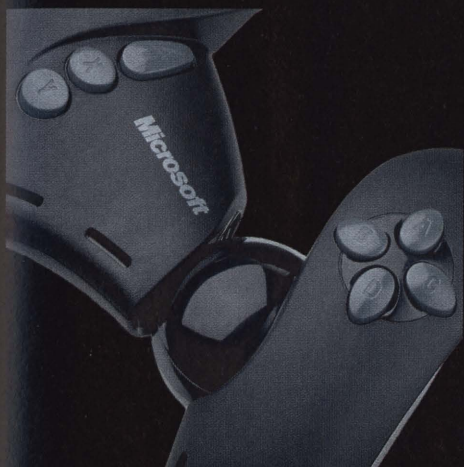
Dual Strike

Strategic Commander

Game Voice

MICROSOFT

SideWinder

Get in on the action and hang on tight as SideWinder takes you ahead of the game with innovative devices and advanced technology for greater precision and control. Get a grip and immerse yourself with Force Feedback. React with lightning speed reflexes. Command and control your forces. Plot your gaming tactics with your team. Speak your mind. Give them hell. **Your opponents don't stand a chance!**

www.sidewinderhardware.co.uk **Microsoft**
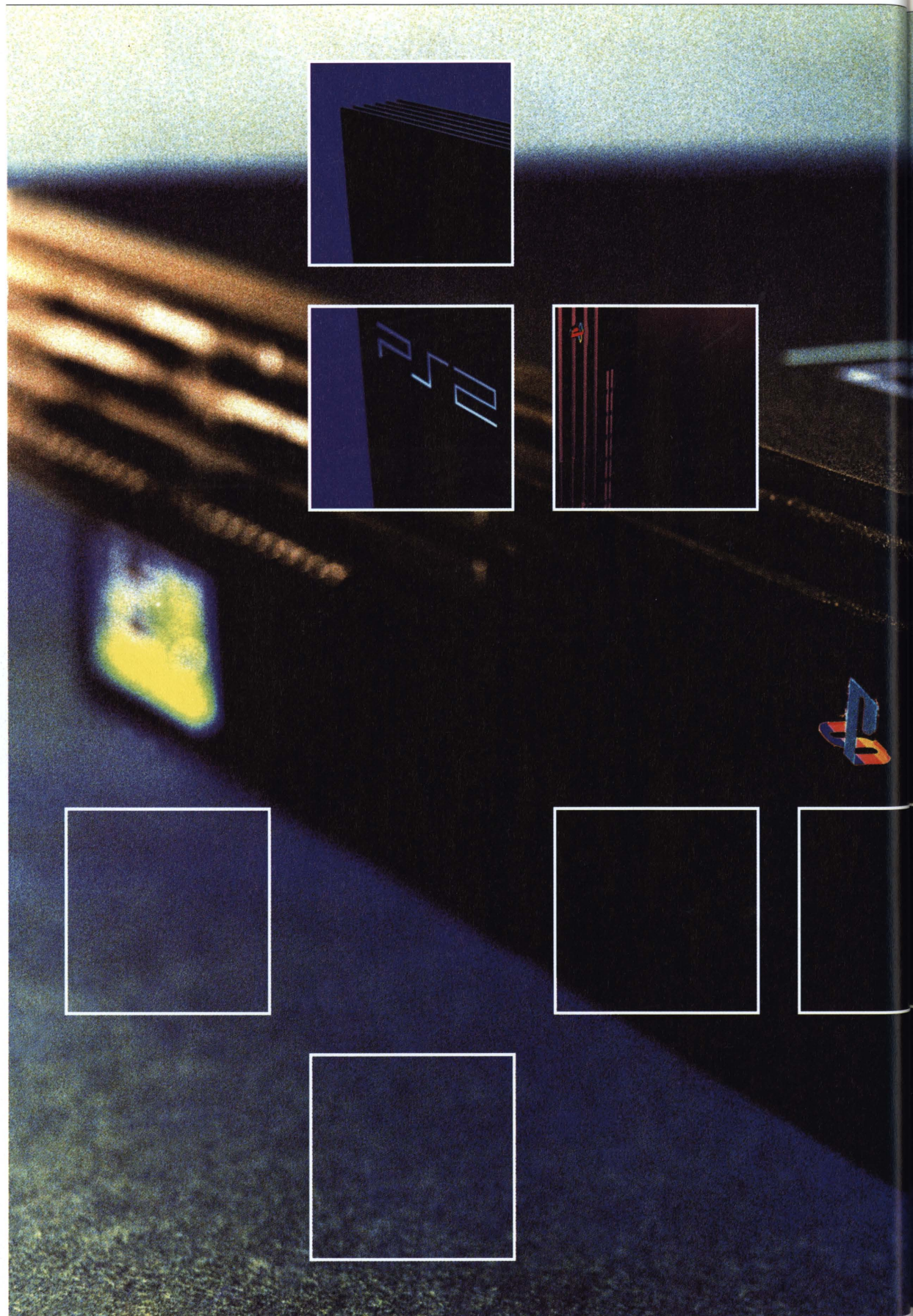
Specifications

CPU: Emotion Engine, 128bit, 294.912Mhz

Graphics processor: Graphics Synthesizer, 147.456Mhz

Other processors: Input Output Processor (IOP), Signal Processing Unit (SPU)

Main RAM: 32Mb RAM

Memory bandwidth: 3.2Gb/sec

Graphics RAM: 4Mb embedded on GS

Theoretical performance: 66m polygons/second

Estimated real performance: 20m polygons/second

Graphics functions: Built in trilinear mipmapping, single pass antialiasing, zero cost alpha blending / texture modulation / per pixel fogging. Full screen and multipass anti-aliasing supported via sample code. T&L engine is completely programmable – programmers are encouraged to directly address the hardware rather than a software abstraction.

Sound RAM: 2Mb embedded on SPU

Audio performance: 48 channels, 0-48Khz, Dolby Digital 5.1

Storage: 4x4.7Gb DVD, 8Mb memory cards, optional hard disk (capacity unknown), potential for i-Link and USB storage devices

Input/Output: Two game controller ports, two USB ports, i-Link, AC-in, AV Multi-out, Digital Out

Networking: Slot for optional broadband modem, optional USB model from thirdparties

Notes: European and US models are built with a mixture of 0.25 and 0.18micron technology, and also differ from Japanese models by having embedded sound RAM and a built-in slot for hard drive/broadband instead of a PCMCIA slot.

Manufacturer: Sony
Partners: Toshiba, MIPS
Launch date: March 2000 (Japan),
October/November 2000 (US/UK)
Launch price: £300 (UK)
Country: Japan

Focus: PlayStation2

>

Sony's next generation console is the one that the massmarket has
been waiting for, fuelling the belief that the company will maintain its
market supremacy. However, it doesn't look like being plain sailing

G reat civilisations flounder, it is said, when they no longer encounter more advanced ones. The declines of the Greek and Roman empires – and even the navel-gazing Chinese civilisation – were precipitated at the very moment that their supremacy was achieved.

Historically, it has been much the same story for TV-based console manufacturers. From Atari to Sega, via Nintendo, dominant console makers have never yet managed to hold on to the position of top dog when shifting from one generation of machines to the next. (If Nintendo's handheld trinity of Game Boy, Game Boy Pocket, and Game Boy Colour is an arguable exception, surely it won't remain one forever.)

Local dynasties have sometimes been achieved, and vast profits surely made but, globally, upstarts have inexorably

PlayStation2 memory cards have eight times the capacity of those that were used for the PSone

1988 SNES

Sony originally entered into partnership with Nintendo to make a CD-ROM-based system called PlayStation that also played SNES cartridges. It wanted to explore the emerging multimedia market, and believed its ownership of movie and music studios would give it extra leverage (rather like its broadband network argument today). But Nintendo became jittery and pulled out in 1991.

1995 PlayStation

Sony reveals its typographically truncated PlayStation to considerable industry scepticism. But the 32bit hardware excels at 3D graphics, and Sony encourages and helps developers explore this new route for console gaming – titles like *Wipeout* subsequently squash Sega's tricky-to-program Saturn. The N64, another 3D workhorse, arrives late and, despite brilliant software, it can never catch up with Sony's console, which goes on to sell 76million units.

2000 PSone

Improvements in silicon manufacturing enable Sony to shrink the PlayStation hardware to create PSone (known internally at Sony as 'P-Sony'). Despite its ambiguous positioning, which involves intimations of portability such as a clip-on LCD screen and mobile phone support, yet no battery slot, it is expected to sell well, with many people upgrading just for up-to-date styling.

How it works

The Emotion Engine, a single chip designed by Toshiba, is the tortured genius at the centre of PlayStation2. Its important components are an industry-standard MIPS III based CPU working in tandem with two vector unit coprocessors (all cast on the same silicon die). Other processors include the Graphics Synthesiser (GS), the I/O processor (IOP), and the Signal Processing Unit (SPU).

Typically, the CPU works with one vector unit to calculate the environmental and physical changes in the game world (produced by player input, the AI and physics). The second vector unit produces display lists (sequences of rendering commands) that are sent to the Graphics Synthesiser, a separate chip responsible for drawing, lighting and texturing scenes onscreen. Developers can choose to use the architecture slightly differently if they desire.

Such a gross simplification can't explain how intricately the MIPS core and the VUs cooperate, aided and abetted by various memory caches, direct memory buses and further processors. This refinement enables one chip to elegantly cope with the masses of data required to render 3D scenes. It also demands that developers must master a particularly testing form of machine code for optimal performance.

Aside from creating 3D graphics, the Emotion Engine takes input from the IOP, which might include joypad input or data from the USB or i-Link ports. The IOP also handles PlayStation 1 emulation. Sound and music is the concern of the SPU – essentially two PlayStation 1 chips added together.

emerged to steal the very highest honours and define a gaming generation. Producing an encore to the revolutionary PlayStation was never going to be easy.

Not only was history set against Sony, the sheer success of its debut machine would make any heart flutter. Could an installed base of some 76m machines really be achieved again by a sequel that would first ship in just the hundreds of thousands? Mathematical forecasts say yes, but the mind boggles regardless.

Yet Sony is one of the most effectively ambitious companies in the world, and its TV, video, and audio manufacturing track record suggests that dominance can be sustained over decades. Sony has so far avoided the fate of Levi's, remaining an aspirational brand for owners young and old alike. Why should the space under our televisions be so different?

PlayStation 1.5

The solution to retaining leadership and beating the expectations raised by PlayStation was predictably a bold one – although it might not look like that today.

Rather than wait for an outsider to redefine the meaning of the game console, Sony has sought to do so itself. Having sold the PlayStation as a revolutionary gaming device – riding to glory with consumer marketing chutzpah, developer worship, and eye-popping 3D graphics – the company has thrown away the rulebook for PlayStation2.

For all the moody PlayStation2 marketing set to emerge over the next few months, the appeal of games – and of the console – is this time being taken for granted.

All the hype has been generated externally. Besides the initial choreographed, euphoric press launch, Sony Computer Entertainment itself has been

remarkably restrained.

For this reason alone, the machine smells odd to some hardcore gamers. Sony isn't really bothering to seduce them first, a breach of etiquette that doesn't quite compute. Moreover, while the hardware is certainly powerful (unimaginably so before Microsoft unveiled X-Box) some look at titles like *Tekken Tag Tournament* and see 'PlayStation 1.5'.

That perhaps isn't Sony's fault so much as a sign that the game hardware market is finally maturing. Rather than strategically reject this notion (as Microsoft has), Sony has chosen to embrace it.

And rather than taking gaming into new dimensions, the real surprise of PlayStation2 is how squarely it puts convergence back on to the agenda. Boasting a cluster of ports you'd more expect to see on a graphic designer's Macintosh workstation, PlayStation2 is a fully
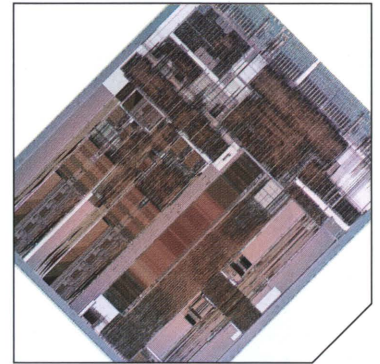
Sony executives scoured manufacturing plants in south east Asia through the latter months of 2000 in an effort to boost the production of its bespoke chips such as the Emotion Engine

fledged multi-talented digital appliance. There's no real suggestion that the USB ports or the i-Link connectivity are there to make games any better – they are meant for different things altogether.

Ditto the DVD drive. Few developers are running up against the limits of CD-ROM (thankfully, many would say). On a RAM-lite machine like PlayStation2, which favours the realtime generation of graphics over streamed-in material from a disc, the case for DVD is particularly slim. The DVD drive is there solely for movie watching.

But it's the broadband strategy that will really put a rocket up the accepted uses for a 'game console'. Substituting a standard modem, (which has already proven itself a boon in PC gaming) for broadband connectivity that is still at least a year away emphasises just how far into the future Sony is looking.

Whoever first associated the term 'Trojan Horse' with PlayStation2 cottoned on to this. Despite superficial appearances, this is meant to be much more than a game machine. Equally, it's a console with more than one life.

Whether or not you term the black box on sale this Christmas PlayStation2, the later addition of a broadband modem will enable Sony to up the effective generation count without the hassle of launching a PlayStation3.

The X-factor

That's the plan, however brilliant or flawed. But even in this radical strategy, the games must come first.

Looking at the unspectacular early offerings on PlayStation2, some wonder if Sony has put the cart before the horse. If the games don't appeal to more people on PlayStation2 more (for whatever reason) than on rival consoles, Sony will lose the lead.

Things would look very different if Microsoft – the historically predictable upstart – hadn't stepped into the fray. The fact that brilliant and surprisingly attractive games have appeared on Dreamcast only further proves that Sega as a company just wasn't up to selling machines as effectively as Sony. As for Nintendo, few would back it to achieve dominance, however superior its own games. Nintendo says that GameCube will be easy to program and attractive to thirdparties but its track record in these areas invites scepticism.

Microsoft is using proven PC technology – both hardware and software – to make its console. It is coming from the PC world, where a freewheeling mentality has produced the most vibrant software market on any computer platform. And, as its recent humbling in the US monopoly courts proved, Microsoft only knows how to win.
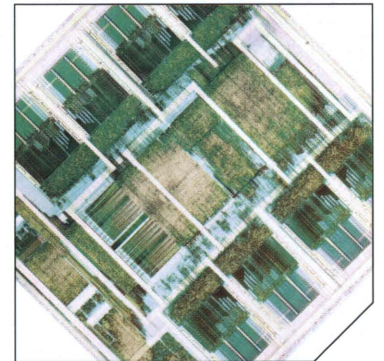
PS2's Graphics Synthesiser consists of a massively parallel rendering engine with a 2,560bit wide data bus. Some 20 times the size of the equivalent bus in PC-based accelerators, it highlights the radical rethink in 3D processing made incarnate on PS2

ControlStations

PlayStation 2's joypad, the Dual Shock 2, is an updated version of the Dual Shock joypad that was first released on PlayStation in the late '90s. The decision to stick with the Dual Shock design has caused some controversy, with those who argue that while Nintendo first brought analogue control to the masses, Sony has perfected it, being barracked by those who say that a new console with old controllers is an anticlimax.

There is one key difference. The iconic 'shape' buttons are now analogue, offering 256 degrees of sensitivity. Little software has exploited this feature so far, and using the joypad it's difficult to believe such fine-tuning is really there,

but, theoretically, it will enable designers to combine actions such as crouch, walk and run on one button. A driving game might match the sensitive steering possible via the joypad's two analogue joysticks with more accurate pedal simulation.

Sony's decision to include only two game controller ports is more universally acknowledged as annoying in the extreme, especially as PlayStation owners will also need to buy new multitaps for the new console. Conspiracy theorists suggest this further demonstrates Sony isn't bothered about gamers – cost-cutting is the more prosaic explanation.

Is the raw power of PlayStation2 a force that can be mastered?
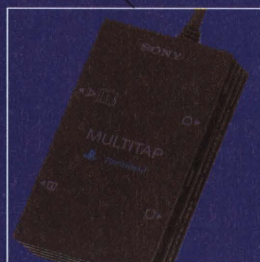
Sony 1 Microsoft 1

Assessing PlayStation2 the game platform in the shadow cast by X-Box throws up some doubts.

Let's leave aside Microsoft's still unproven claims and concentrate on what is known about PlayStation2. Most developers find the Emotion Engine CPU hard to program, period. Its esoteric delights just don't seem to be designed to make developing great games easy, however innovative the technology.

Suspicions that Sony may not have optimised its console for easy game development grow as the Emotion Engine finds other uses as parallel processing workhorses in GScube and even network routers.

The PlayStation2 hardware is undeniably a powerful graphics generation device. Straight comparisons with PC architecture are meaningless – the two technologies are entirely different. But that's also a problem

for developers, who have never seen anything quite like it before.

Sony's theoretically devastating 3D gaming platform has developers struggle to keep up with its demands. Middleware, which was meant to make it easier, hasn't shaken off the stigma associated with all off-the-shelf games technologies, with some justification. X-Box might offer a cruder way of getting polygons onscreen, but thanks to DirectX most developers already understand the basics of how it works, and that the console is still more than a year away, rather than nearly a year old.

Perhaps Sony has more faith in game programmers than Microsoft. Maybe the 'synthesis model' that favours conjuring up games in realtime inside the machine really will lead to better games in time. Whatever the case, before Microsoft, Sony engineers could have assumed the

difficulties wouldn't matter, because everyone would take their titles to PlayStation2. Oddworld's defection to X-Box proves otherwise, and the *Oddysee* of Abe and Munch's recent outing could yet prove an exodus if other developers follow suit.

Despite these question marks, PlayStation2 remains a hard machine to bet against. It will almost certainly overtake Dreamcast's global sales within just a couple of months of its launch, and it will have a huge lead on Microsoft when X-Box it arrives at the end of next year. But its developer support teams in Japan, the UK and America must redouble their efforts to help studios get the best out of this quixotic console. PlayStation2 must field games that attract gamers if it's to effectively build up a sizeable installed base.

A Trojan Horse left outside the city gates won't win any wars, let alone rewrite history.
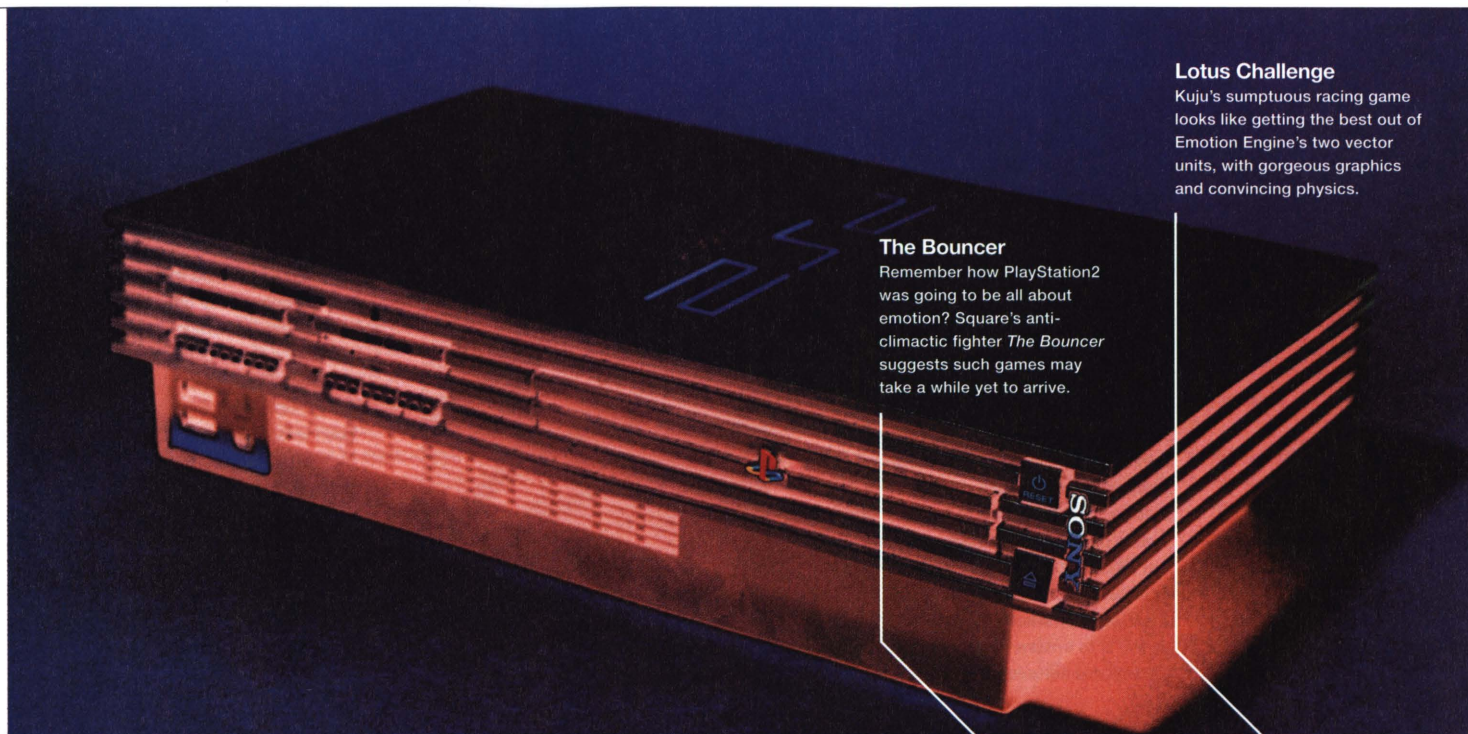
Lotus Challenge
Kuju's sumptuous racing game looks like getting the best out of Emotion Engine's two vector units, with gorgeous graphics and convincing physics.

The Bouncer
Remember how PlayStation2 was going to be all about emotion? Square's anti-climactic fighter *The Bouncer* suggests such games may take a while yet to arrive.

Soft focus

Metal Gear Solid 2
Konami's *Metal Gear Solid 2* needs no introduction. This game must give Sony nightmares. It proves what PlayStation2 can do – and what most developers can't.

TimeSplitters
Free Radical Design's *TimeSplitters* is the PlayStation2's most enjoyable multiplayer offering so far.
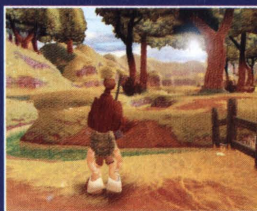
Herdy Gerdy
Can British codeshops rise to the challenge of PlayStation2? Can Core Design move on from Lara Croft? *Herdy Gerdy* has a lot to live up to.
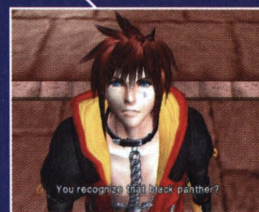
Work and play: input and output

The interfacing capabilities of PlayStation2 are unprecedented. Even leaving aside the upcoming broadband modem, the machine comes with a tangle of I/O options.

There are two USB ports, bringing PlayStation2 the ubiquitous PC standard for relatively fast connections to up to 127 devices such as printers and scanners. Then there's i-Link (also known as Firewire), another industry standard that supports connection to devices such as digital cameras at speeds of 400Mbps. Digital output means you can play PlayStation2 games through a Dolby Surround Sound home cinema system or make perfect music recordings from PlayStation2 on to MiniDisc.

So, will you be able to take pictures with a digital camera, edit them on your PlayStation2 and output them to laser printer? Yes, and sooner than you think. Hundreds of existing PC USB and Firewire devices means the hardware is all but ready – Sony and other developers must now create the software.

Broadband modem connectivity – which will come coupled the hard disc upgrade – is the most mysterious and potentially important piece of the puzzle. Sony has been buying up Internet and media companies for months, and the company has told the financial markets that it is in the process of transforming itself from a manufacturer into a network content provider. But how it will do this – and where PlayStation2 finally fits in – remains to be seen.

Sony believes that it is in possession of the technology that will redefine computer entertainment. According to in-house cheerleader Phil Harrison, PS2 and its forthcoming broadband adaptor and hard drive will smooth the path to world domination. **Edge** talks to the man tasked with moving electronic entertainment into a new era

Prior to becoming Sony Electronic Publishing's first European employee, **Phil Harrison** was head of product development at Mindscape. For the majority of his nine years with Sony, Harrison has been the company's public face among the development community. He launched its European thirdparty and software development division, before moving to Sony America as vice president, thirdparty relations and R&D – a post he held for four years. Now back in Europe as senior vice president, commerce and development, his job is to ensure PlayStation2 takes electronic entertainment to a new era.

in which suggested that developers need a completely different mindset to develop PlayStation2 games?
Yes, I think that is often but not exclusively the case. There are products now that are being publicly demonstrated that have been written using new development methodologies: *DropShip*, Evolution's rally game [*World Rally Championship*], *The Getaway*. These are products that are indicative of future direction, albeit they are only scratching the surface at this time.

PlayStation2 technology is bigger than just the games machine. How does GScube fit in to the overall picture?

senior VP commerce
and development
Sony

Phil Harrison

talking technology

Is the videogame market big enough for three consoles to be profitable or is it still a console war?
You have to draw a distinction between profitable and successful. Nintendo, although they are the loser in the public race, continue to be a profitable company. The overall market will continue to grow. I think that PlayStation had proved that one console can be successful in three markets – Japan, US, Europe – which is a first. Obviously, we continue to lead the market, we will continue to lead the market with PlayStation2, and it's just a question of how the rest gets divided up.

Do you think PlayStation2 will outsell PlayStation?
Yes, I do. Without a doubt.

How do you feel developers are dealing with PlayStation2's architecture?
Some developers have ascended the learning curve quicker and further than others. But there's no question that the vast majority are making great progress. Witness the volume of non-Japanese product at launch in the US and Europe.

How much is this due to middleware?
Certainly there are some middleware solutions being deployed, either internally developed or licensed in. But I think you will see the middleware solutions really impacting less experienced developers coming into the market later.

Previously you have talked about the synthesis model of software creation,

GScube uses the advances made in the design of PS2 and takes it a stage further. It's not intended to give any indication of our future strategy for home consoles. It is an opportunity for us to leverage our technology in other markets and learn from that. The GScube chipset is one of the most advanced bits of silicon engineering on the planet, and that has a trickle-down effect on our consumer business.

Sony is also licensing the technology to thirdparty hardware vendors: how is that progressing?
The chances of another product competing directly with PlayStation2 in the computer entertainment system is unlikely. I think, however, that you will see the PlayStation2 chipset used in other devices, primarily set-

top boxes and next-generation digital TV.

Is PS2 primarily a game machine?
The fundamental architecture of
PlayStation2 is designed first and
foremost for the high-speed processing
of 3D computer graphics, physics, and
simulation, and its application is obviously
games. However, the addition of DVD
movie capability, USB ports, i-Link ports
and, crucially, the broadband adaptor
means that the machine is going to be
made future-proof. Computer
entertainment will become the future use
of the device and it's up to us to define
what the computer entertainment is.

content that you are able to play, the
business model in which you obtain it,
the experience you get as a result. The
whole thing is going to get shifted.

**What is the schedule for PlayStation2's
broadband components?**
The broadband adaptor is contained
within the hard drive, and that will be
available from the middle of next year.

**How will you make it an attractive
proposition for users?**
We will come back and spend a lot more
time discussing this in the future. We've
got some applications, but it's about the

content, and it's about the community,
and it's about the experience you get
from the community and the content.
It is not just the Internet.

**What are you looking forward
to in your new job?**
What I'm looking forward to is when we
start changing the dynamics of software
publishing a little bit. When we start coming
out with new kinds of games, episodically,
and we start to augment them with
broadband content and the communities
you can create around it and extending the
commercial and creative life of a product
beyond its three weeks of shelf life.

"We lead the market, we will continue to
lead the market with PS2, and it's just a
question of how the rest gets divided up"

**Historically, hardware add-ons have
not been successful. How do you
expect to overcome this?**
I think you have to look at some obvious
failures. Let's take Sega CD as an example.
What Sega CD did was to change the
delivery mechanism of software without
changing the fundamental experience the
consumer got. So you were asked to pay
as much again for the add-on as you paid
for the hardware, and you had to buy
software that was generally more expensive
than the cartridge products. And the
games that you got were either rubbish
or they were cartridge games with CD
soundtracks and video intros. With the
PlayStation2 broadband adaptor and
hard drive, it is going to completely reinvent
the way people play games – the kind of

Focus: Dreamcast

Sega's console dream looks doomed to disintegrate with the advent of PlayStation2 and the imminent arrivals of X-Box and GameCube, but developers and hardcore gamers have been unstinting in their praise of recent titles. So, what went wrong, and where now for Sega?
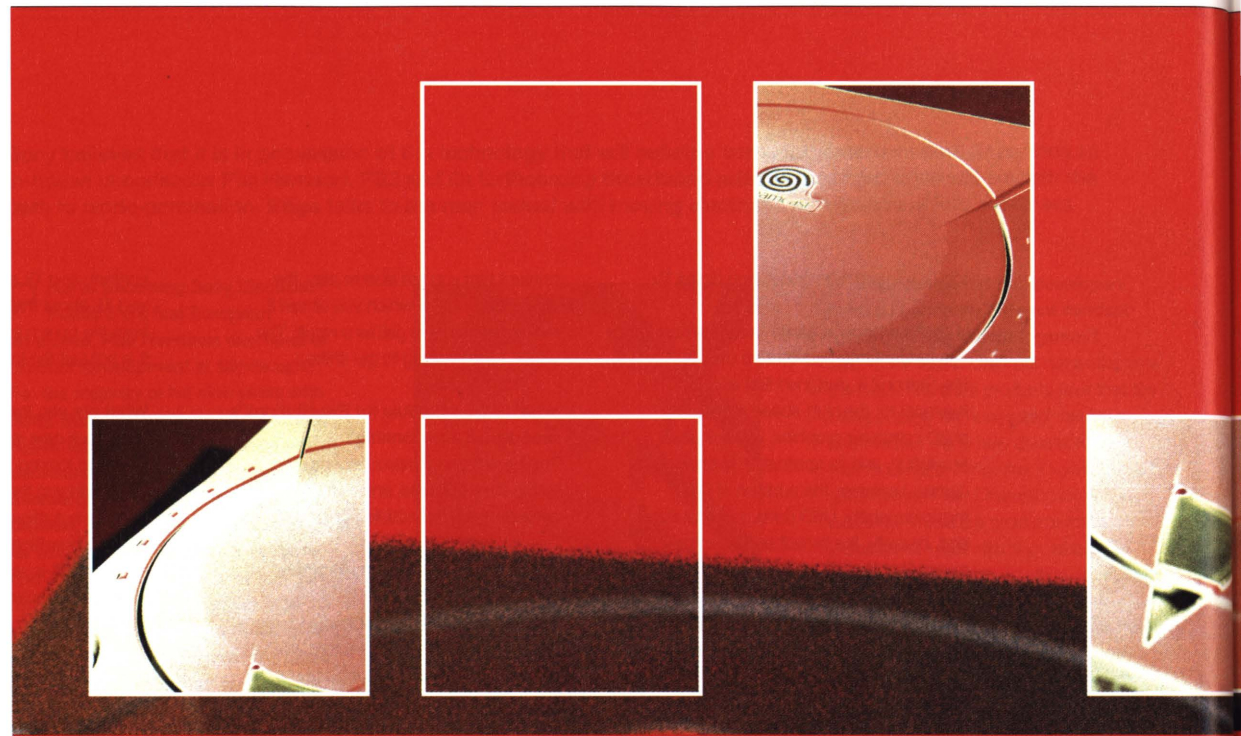
Specifications

CPU: Hitachi SH-4 128bit 200Mhz

Graphics processor: NEC/VideoLogic PowerVR CLX1 0.25-micron technology 150Mhz

Main RAM: 16Mb

Memory bandwidth: 3.2Gb/sec

Graphics RAM: 8Mb

Theoretical performance: 3million polygons per second

Estimated real performance: 1.5million polygons per second

Graphics functions: Tile-based rendering system, Z-buffer, anti-aliasing, 640x480 resolution, on-board 5x texture compression

Sound RAM: 2Mb dedicated RAM, support for samples up to 64Kb

Sound CPU: Yamaha system featuring AIM7 CPU, 64-channel output, surround effects, DSP effects

Storage: Proprietary 12x 1Gb GD-ROM. 128Kb Visual Memory System cards featuring 48x32 pixel monochrome LCD, D-pad and four buttons

Input/Output: Four joypad ports, two expansion slots per joypad, A/V main out, serial I/O

Networking: Ships with either 33.6Kbps or 56.6Kbps modem according to territory. This is removable to allow upgrade to either Ethernet or cable network adaptors (only confirmed in Japan)

Notes: Dreamcast's texture handling is very good. Large 1024x1024 16bit maps can be stored in VRAM, which through on-board compression can theoretically handle 40Mb of data. Comparing *Soul Calibur*'s crisp locales to those of PS2's *Tekken Tag Tournament* gives a favourable indicator

Manufacturer: Sega
Partners: Hitachi, Imagination Technologies
(previously VideoLogic),
Microsoft, NEC, Yamaha
Launch date: November 1998
Launch price: ¥29,900 (Japan) £200 (UK)
Country: Japan

1985 Master System

Sega's 8bit riposte to the NES
was comparatively more powerful,
but too late arriving to win the day.

With the possible exception of Atari's freefall into oblivion, Sega's tumble from the number one spot it held with the Mega Drive/Genesis is the most infamous in videogaming history.

The trio of fumbles made by the company during the mid '90s – Mega CD, 32X and Saturn – is the only way to begin the story of Dreamcast. The technological, financial and ideological impact of those failures was crucial in defining both Sega's company culture and the hardware design of its next machine. The huge borrowings which were essential to fund Dreamcast development hang as dark clouds over Sega's future; early in 2000 the company split its software divisions into distinct companies in order to assure their survival.

Only two years after Dreamcast's Japanese debut, few in the industry expect the console to celebrate a happy third anniversary. Despite having six months of quality in-house releases ready for the machine, Sega's Japanese leaders seem to have already admitted defeat – much to the chagrin of those who run their subsidiaries in the west.

The company has now stated it will be shifting its emphasis towards being a content provider in portable and online environments. Undoubtedly Sega has already begun to consider transferring its key IPs to other home gaming platforms, too. Yet at its May '98 unveiling Dreamcast was received with a huge amount of goodwill from the industry and media, while the dedication of Sega's fanbase is second to . none. So what has gone wrong?

Troubled from launch

The short answer is PlayStation2, which has been the most widely and furiously anticipated hardware launch since Nintendo released the Super Famicom (aka SNES). That alone has taken much of the wind out of Dreamcast's sails. However, it only goes part of the way to explain the lacklustre sales of the console, which has only seen something like acceptable retail performance in the US.

Clearly, Japanese gamers are highly sensitive to content, and the decision by Konami and Square to focus their creative efforts on PS2 was a body blow to Dreamcast. Sega has been very strong in delivering games that its fans adore, but that mindset is not necessarily one that is relevant in the post-PlayStation world. It will be extremely interesting to see how titles such as *Crazy Taxi* fare on other platforms, when competing in an open market.

In the west, Dreamcast's fate has been sealed mainly through a

A cast of thousands

For a console that has barely broken the five million sales mark worldwide, Dreamcast has interfaced with a remarkable number of peripherals. Partially a legacy of Sega's continuing coin-op business, and partially an adjunct to the console's online functions, it would take a committed gamer to purchase the full range.

So far a steering wheel, arcade joystick, fishing controller, maraca controller, lightgun, vibra pack, keyboard, and mouse have appeared – not to mention the four joypads that titles such as *Virtua Tennis* demand.

Although Dreamcast's controller is universally maligned – with particular bile targeted towards the weak construction

of the twin shoulder triggers – it presents an interesting concept in the form of the Visual Memory System. These enhanced memory cards feature a small LCD screen that is visible from within the joypad where they connect to the console.

Support for the memory card's added features has been lacking, with only *Power Stone* and *Sonic Adventure* making use of the VMU as a standalone device. However, that may well be due to the card's 128Kb storage (considering PS2 memory cards sport 8Mb) and 48x32 pixel screen resolution. Nintendo's take on the concept – using Game Boy Advance as a controller for GameCube – is likely to receive somewhat better support.

+ Online functionality here and now
+ Several must-have, exclusive titles
+ Developer-friendly system
+ Will remain the lowest-priced next-generation console for some time

∧

Works like a dream

Where now for Sega's great white hope, as its roster of 2001 titles thins by the day?

1990 Mega Drive (Japan and Europe) **Genesis** (US)
The great 16bit battle; Sonic the hedgehog (1991) outpacing Mario in the style war; SNES the technical superior.

1993 Mega CD
CD-ROM was the great unknown, and Sega took the leap with this expensive, underpowered Mega Drive add-on.

1994 32X
With 3D flavour of the month, the 32X brought added horsepower to the ageing Mega Drive. But unfortunately few games

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Great white hope

∨

- Little publisher support
- Technically weak compared to GC and X-Box
- Narrowband network offers questionable performance for online gameplay
- New Sega business model downplays Dreamcast
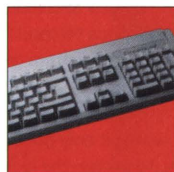
Sega certainly hasn't stinted in providing peripherals for Dreamcast. The microphone (above) joined the more staple keyboard and mouse

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wholly unenthusiastic level of support from publishers. Speak to any developer and they relate the same tale – of a machine that has many appealing technical features, from online functionality to a clean and accessible hardware design, but also one that it is now near-impossible to secure publisher funding for.

For Sega of America this must be a galling outlook; it has worked hard to build an audience for the console through aggressively targeting hardcore gamers with its marketing. SoA has also ensured that core titles, such as its fabulously detailed and online-playable *NFL2K1* American football game, are more exciting than anything the opposition can field on any platform.

Dreamcast's European presence has been a different tale. From the very outset, when alleged network difficulties lead to an 11th-hour delay of the console's launch by

three weeks (so last-minute that even the *Official Dreamcast Magazine* went to press with the wrong date), it seemed that Sega of Europe (SoE) had taken its eye off the ball. Under the leadership of its football addict, former music industry supremo JF Cecillion, the European operation committed huge chunks of its marketing finances to football sponsorship deals. Meanwhile the decision was taken not to focus marketing efforts on hardcore gamers, because it was assumed that they would buy Dreamcast whatever.

Pointedly, they did not, while seemingly obvious priorities, such as a killer football title to accompany the marketing spend, failed to materialise. This year SoE spent many thousands of pounds on a beach football competition as summer promotion – three weeks prior to the superb *Virtua Tennis*'s virtually unadvertised release.

Beginning of the end

Sega of Europe, like its parent, is running short of time and money. Sega Enterprises, now simply 'Sega', posted a ¥20bn (£100m) loss for 1999-2000, yet ambitiously forecast profits for the following year would exceed ¥22 bn. Dreamcast will not be the source of that income, that much is clear; the console will not survive PS2's onslaught – not to mention the time when GameCube and X-Box join the fray.

A cynic might argue that, in retrospect **E**60's hopeful 'Sega is dead, long live Dreamcast' coverline was missing a question mark. **Edge** hopes, however, that Sega's stated future as a provider of online and multiplatform content means that the company will weather the storm.

Above all else, Sega titles such as *Jet Set Radio*, *Shenmue*, and *Phantasy Star Online* prove that the videogame world would be a far greyer place without it.

How it works

Sega, like others in the hardware business, has been accused of being 'creative' in its claim that Dreamcast's Hitachi SH-4 is an 128bit design.

While far from Atari's Jaguar claims (by which it added four 16bit chips together to make, er, 64bits), some have said that the SH-4 is a 32bit design, albeit of the powerful RISC type. The claim to 128bit status is made on the basis that the SH-4 can handle four simultaneous packets of 32bit data for operations such as matrix multiplication.

At Sega's request, Hitachi added a selection of special functions to its version of the SH-4, including one to accelerate inverse square root calculations, and others for sin and cosin. Another of Dreamcast's strong points is its twin 'store queue' facility, allowing programmers to stack up all the information for one vertex while another set is being sent to the PowerVR chip. This allows faster data stream between CPU and GPU.

The visual divide between Dreamcast and its next-gen rivals is most marked when it comes to lighting, a consequence of Sega's machine totally lacking hardware lighting routines. Support is only included for vertex lighting, rather than prettier lightmaps, due to the way in which the console draws the display in one burst, making the swapping of textures only possible between what is already held in VRAM.

1994 Neptune
The unborn child of 32X and Mega Drive, combining the functions of both in a single box. Unmissed.

1994 Saturn
Designed as a 2D powerhouse in a 3D world, Saturn was a technical nightmare for developers. PlayStation, however, was not…

1997 NEC/Videologic
NEC/Videologic fights off 3Dfx in a battle for the Saturn sequel's GPU contract. The battle is rumoured to have split Sega Enterprises in Japan and Sega US, although both sides got the right technology in the end.

Soft focus

Quake III Arena
Quake III Arena sees console gaming's first real steps into functioning in an online world

Phantasy Star Online
Sega has high hopes for *Phantasy Star Online*. Sony and Microsoft will doubtless watch with keen interest

Connecting with Dreamcast

Dreamcast was conceived as the core of a connected lifestyle. At the very heart of its design was the inclusion of a modem as standard (33.6Kpbs in Japan and Europe, 56Kpbs in America). As Nintendo did with its faltering 64DD storage system for the N64, so Sega held ambitions for Dreamcast being the core of a networked, creative system.

The console's standard modem gives Sega unprecedented level of access to its users, and a platform which, theoretically, is able to play host to cutting-edge game content. Predictably, it has taken time for that to come to fruition.

The VM units are portable gaming devices in their own right. Joypads have two slots – one for memory cards, the other for devices such as microphones. Finally, the console has a serial port on its rear for connecting to proposed peripherals, including a 100Mb Zip drive and a DVD player.

Sega's Dreamcast is showing its true colours this Christmas, fielding essential titles that are as technically stunning as they are enjoyable – a feat some critics thought unlikely back at the console's launch in 1998. **Edge** asks the man who oversaw its development how he sees the platform developing, and whether it has lived up to his expectations

Hideki Sato is a Sega man par excellence. Joining the company straight from college, he has filled a variety of roles during his 30-year career. Currently senior managing director of consumer business and intellectual property, in a previous function he oversaw the development of Sega's comeback console, Dreamcast. **Edge** caught up with Sato-san for a retrospective look at his creation.

Titles like *Jet Grind Radio* and *Quake III Arena* are notching new performance benchmarks for Dreamcast. How much more is there to come?

Dreamcast. We are extremely satisfied with this positive result. However, we still work hard to achieve our ultimate goal of further expanding the number of online subscribers. With strong network titles like *Daytona USA* coming out in the very near future, we are confident that our network strategies will be put into high gear.

At one stage you considered giving Dreamcast a DVD drive instead of its GD-ROM. In hindsight, do you feel you took the right decision?
What you need to understand is that the technology was not the issue; the issue was development cost and environment.

senior MD
Sega >

Hideki Sato

talking technology

Yes, we are seeing the real thing coming now. Since it usually takes two to three years for programmers to get used to a new platform, we are looking forward to great titles that will stretch Dreamcast capabilities to the fullest in the near future. Our learning curve is less steep compared with other platforms, but still I don't believe that anybody has had the best performance out of it yet.

Which game do you feel has best demonstrated the potential of Dreamcast?
While there are many titles with extraordinary image and sound qualities such as *Metropolis Street Racer*, *Jet Set Radio*, and *Shenmue*, the unique characteristic of the console is its network

function. In order to show the full potential of the console, it is indispensable to utilise its network capabilities; in this respect, we are yet to see a truly network-oriented game for Dreamcast.

Our first full-blown online game, *Phantasy Star Online*, will be launched shortly, and will undoubtedly be the pioneer of networked console RPGs. It will provide players with a taste of the future.

Are you pleased by how widely the Dreamcast modem is being used?
Approximately 30 to 40 per cent of Dreamcast owners are connected to the Internet at present. We have seen this amazing trend, which shows a clear sign that many of our customers have a great interest in networking – the main feature of

We strongly believe that consumers who want to watch DVDs will go out and buy a standalone player for that purpose. We doubt the necessity of having that function in a games console at all. PS2 is said to be used more for its DVD functions rather than its original gaming functions; in effect, it has lost its significance of being a game console. That is the risk we fear.

Compared to the budget for PlayStation2's development, you wrought a minor miracle with the budget allocated for Dreamcast. How?
Sega has contributed significantly to the history of computer games, and has accumulated many talented developers and knowhow for game development. Those resources, which cannot be bought

with money, are packed into the Dreamcast console. Further, Sega has optimised the architecture based on past experiences and concentrated on a strong partnership with a semiconductor manufacturer.

Dreamcast has been graced with a remarkable number of peripherals. Is this a future trend in gaming or just something that suits Sega's arcade game conversions?
We try to provide unique game styles for each individual game genre. Peripherals sometimes help players at home to experience the realistic sensations of playing in an arcade, and sometimes

Since high-capacity semiconductor memory is very expensive, a Zip drive is still comparatively realistic at present. If and when the cost of high-capacity memory decreases and games that require such large memory appear on the market, we might consider the need to handle large-capacity storage as well.

Which aspect of the Dreamcast design do you now feel most proud of?
We are extremely proud that Dreamcast's technology and performance is by no means inferior to PS2, which was launched well over a year later. Dreamcast is a product that has a truly impressive

cost-to-performance ratio.

If you were to create a successor to Dreamcast, what hardware features would you include?
Necessary hardware features vary depending on the kinds of services you intend to provide. In that respect, we might consider a large storage memory to be one of the most necessary functions for us to add to a new console. However, since the current Dreamcast has the scalability to support any technical innovations, we see no need – and have no actual plans in the near future – to develop a successor.

"Great titles will stretch Dreamcast to the fullest in the near future. Our learning curve is less steep compared with other platforms"

provide a whole new experience or new game style. We will continue to provide new game styles and experiences for Dreamcast in the future.

Despite seeming quite a neat idea back in May '98, the VMU has not been well supported by developers. Could it have been made more appealing?
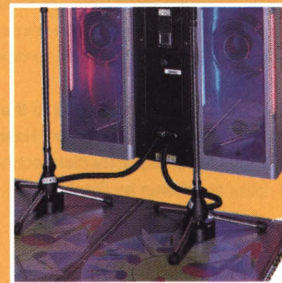We still believe that the VMU is a very good idea. It may be taking more time to come up with some great applications, but it is another aspect to the unique technology that differentiates our console from others.

What has happened to the planned Dreamcast Zip drive? Hasn't that kind of low-capacity disk technology been overtaken by Flash RAM?

10 PENCE 1-PLAY
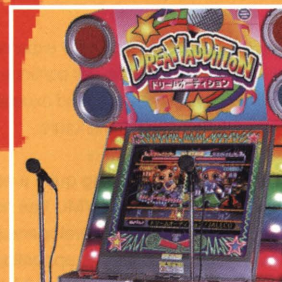
Arcade evolution

Forget hi-tech, hi-spec computer architecture. Today's arcade industry is in love with mechanics. Edge looks inside the cabinet and discovers how the interface became everything

Sega's recently unveiled Naomi 2 board is a step forward, but interfaces, not image-processing tech, now lead the way in the arcade

The arcade industry is in trouble. You know this because the powers that be have stopped spin doctoring the figures and started facing up to the future – whatever it might hold.

At the recent JAMMA show in Tokyo, the organisation's president, Yoshihito Kikahara, told attendees they were living through the worst period in his 35 years in the business. Competition from consoles and from the burgeoning word of mobile-phone gaming has sent arcade revenues crashing. According to JAMMA, over 4,500 Japanese arcade locations closed down in 1999, and the profits for arcade operators are dropping too, by a steady one to two per cent every year.

So what must manufacturers like Sega, Konami and Namco do to compete with the post-PlayStation explosion? The answer lies not in the technology arms race of the '90s but in a totally unexpected area – at least for the contemporary videogame industry. It lies in creativity.

Home from home

So far, there have been two key initiatives that have attempted to drag the arcade industry out of recession. One is the 'if you can't beat 'em…' solution which looks to low-end-architecture-based console technology – Sega's ST-V and Naomi boards and Namco's Systems 11 and 12 being the most recent examples.

There have been successes here. Naomi, using the Dreamcast Hitachi SH4 CPU and Power VR2 graphics set-up, has made a major impact in the European market. As **Guy Woodward**, editor of coin-op trade journal *AB Europe*, explains: "It's so adaptable and operator-friendly. The games are pretty cheap, easy to produce, and consequently quite varied. The sports games have been a notable success".

However, there have been problems. Arcade visitors are beginning to notice that the games they're paying one pound a go for in arcades are exactly the same as the ones they can buy for home consoles. The conversion of *Virtua Tennis* from Naomi to Dreamcast, for example, is virtually flawless – the only visual hit the Dreamcast version suffers is that during play the audience are sprites rather than the arcade's 3D models.

The other concern is that any problems with home console technology naturally translate across to any arcade hardware based upon it. The Saturn-based ST-V board was as 3D-unwieldy as its home companion, while Namco's new System 246 board – essentially a PlayStation2 – has failed to excite thirdparty coin-op developers due to the difficulty of programming for it. Sounds familiar?

Going too far in the other direction, though, has caused problems of its own. Arcade history is littered with the skeletons of high-end architecture that proved too demanding and too expensive

Catching coins with the Net?

Arcade manufacturers haven't exactly embraced the Internet, but things are changing

Konami recently set up a special online tournament mode that offers prizes to gamers who submit top scores earned on arcade games. More impressively, Sega Japan will construct several of its new Net@ centres next year. These feature 20 or so networked terminals allowing visitors to play games, watch movies and send email.

If the arcade industry continues to decline, the Internet escape route could well be the one that manufacturers follow.

As *AB Europe*'s Guy Woodward says, "Quite a few developers are looking at putting Internet kiosks in pubs and arcades. In Japan, the likes of Capcom are aiming at the i-Mode (WAP) phone consumers, who will be able to download content straight to their phone. In Europe, and the UK in particular, it's more a case of companies developing multi-application terminals capable of housing several games, which can be downloaded remotely."

However, **Edge** wonders how long these companies can keep spreading themselves so thinly over several markets. Sega has arcade technology manufacturing, console manufacturing, software development and Internet cafés – but the company is expected to post a group net loss of ¥22.1bn for the last fiscal year.

Surely at least one of those concerns will have to be dropped, and with the mobile phone and Internet sections booming, it's not hard to guess where the cuts will be made.
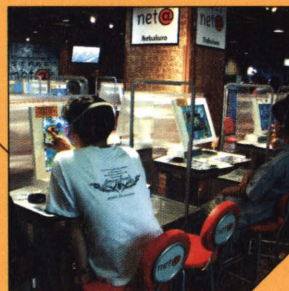
1996 Time Crisis (Namco)
It was by no means the first lightgun game, but *Time Crisis*, with its slick design and increased gameplay depth, reignited the genre.
Led to: *Silent Scope*, *Virtua Cop*, *House of the Dead*

1997 BeatMania (Konami)
Provided a simple turntable and mixer interface, allowing players to mix and scratch along to various dance choons. Singlehandedly caused the coin-op music boom.
Led to: *Dance Dance Revolution*, *Crackin' DJ*, *Dream Audition*, *Samba de Amigo*

How did it come to this?

Edge looks back on the most important – and influential – machines in the coin-op installation arms race to date

1996 Alpine Racer (Namco)
Basic skiing game which employed a two-ski-pole interface allowing players to employ 'real-life' skills to control the onscreen character.
Led to: *Top Skater*, *Alpine Surfer*, *Ski Champ*, *Sega Water Ski*

to manufacture and develop for.

The latest victim is Sega's hugely powerful 'Hikaru' – the final mutation of the Model 3 board. Used most recently to power *Star Wars: Episode 1* and the forthcoming sim *NASCAR*, its expensive proprietary technology (which includes a dual-CPU set-up) and complex potential has seen it exploited by only the most talented of Sega's in-house teams.

The board's successor – unveiled at the recent JAMMA – is Naomi 2, which again uses the Dreamcast SH4/PowerVR 2 but adds a huge 32Mb of video RAM allowing for the manipulation of around ten million polygons per second (including effects).

As with the original Naomi, it is easy to developer for, and relatively inexpensive for arcade operators to buy (it even comes with option of CD-ROM instead of the usual ROM storage, with CD-ROM being cheaper but slower). It also packs a post-Dreamcast visual kick that will differentiate the standard

from its inspiration. Look out for *Virtua Fighter X* and *Virtua Striker 3* next year.

Beat this
More importantly, though, hardware manufacturers are finding that gameplay innovation is proving more important than simply making the appearance of the same old games better every six months.

Take the music game phenomenon. Revenue from titles such as *BeatMania* and *Dance Dance Revolution* topped ¥16billion last year, making them easily the most popular genre in arcades. Yet the computer technology behind these coin-ops is almost pathetically low-end. Onscreen visuals are limited to animated 2D cartoon scenes – hardly rocket-science stuff.

What attracts younger arcade-goers is music. Unlike blasting aliens, it's a part of their real lives. Gamers can come and play together as groups and show off – and girls like it as much as boys.

The huge success of this genre has prompted manufacturers to make cheap but interesting arcade hardware in order to explore new ideas. Konami's most recent games include *Take Your Best Shot*, in which a simple camera device enables players to photograph digital girls, and *Shinjuku Keisatsukan*, which sees the onscreen character respond to the movements of the player thanks to a simple motion tracker. The computer architecture behind these games is irrelevant – it's the interfaces bringing in the punters.

"Novelty cabinets have become increasingly popular amongst players because they provide an experience which just can't be emulated at home with a joypad or keyboard," explains **Andrew Muir** at Konami Europe. "Interactive, physical experiences are what is keeping the arcade alive".

Which doesn't just have to mean offbeat ideas such as *Take Your Best Shot*.

The mechanical advantage

1994 Daytona USA (Sega)
The most influential racing game of all time. The linked-cabinet feature and excellent interface design have inspired every coin-op racer since.
Led to: *Ridge Racer, Scud Race, Sega Rally, Sega Touring Cars*

1996 Neo Print (SNK)
A simple photobooth which allowed users to modify the images and then print them onto stickers. Prompted a worldwide craze.
Led to: *Chaku Melo* (Capcom's tune download coin-op for mobile-phone users)

Robot wars with a difference, now appearing in an arcade near you

Namco's *Kart Duel* features a hydraulic kart interface which turns in relation to the steering. Konami's *Fighting Mania* has pads which gamers strike when directed to by the onscreen action. Both are proving highly successful in Europe.

Yes, the novelty cabinet is in, and it may just save the arcade industry.

But these behemoths don't come entirely problem free. Although novelty games don't rely on advanced and expensive hi-end architecture like Super System 23 or Model 3.5, they're not exactly cheap.

"Physically interactive games can be equally costly to produce, as time must be dedicated to the interface for purposes of ergonomics," explains Konami's Andrew Muir. "Arcade cabinets can go though several stages of rebuild before we even come close to the finished article. It's a bit like having to redesign the joypad every time we produce a title'.

There are also legal concerns. In Europe any arcade videogame which includes a mechanical interface must satisfy strict EC safety regulations. The original Japanese cabinets can't be used, because they don't comply. "Games for Europe have to be bigger and more robust than games for the Japanese market," says Namco Europe's managing director. Mike

Nevin. "European players are physically bigger, and there is not as much respect for property in Europe as there is in Japan".

Transportation also becomes a problem with the larger novelty units. Namco builds its European machines in France, Italy and Greece as well as the UK, and Konami has its factories in France, Italy and Wales. But getting the units to the rest of Europe (as well as storage at key points on the journey from manufacturer to arcade operator) is often twice as expensive as with standard arcade cabinets.

In the arcade business, it seems, there are no cheap options. No wonder the days of 10p-a-throw coin-ops are long gone.

Sports games employing interfaces designed to mimic the real-life experience are also proving massively popular. **Mike Nevin**, managing director at Namco Europe, thinks this is down to three factors. "These games have a classic appeal and are not fashion-based. Secondly, they are significantly different from what is available in the consumer market. And thirdly, they are not intimidating. As a consequence they appeal to a wider market".

It's true. Casual gamers are much happier spending five minutes messing about on *Top Skater* (which features a real skateboard to stand on and a sport they understand) then they are taking three months to get to grips with the daunting six-button control system employed by the latest incarnation of *Street Fighter III*.

Moore's law floored

With installation-based games, the emphasis is also focusing on the interface,

not the silicon. One of Namco's latest racers is *Kart Duel*. It features a realistic hydraulic kart whose movement corresponds to the onscreen action. The fact that such hydraulic technology has been in the arcade for decades doesn't seem to worry the punters.

"*Kart Duel* is the perfect example of a successful game produced to hit a key pricepoint employing technology which is not state of the art," says Nevin. "The mechanical side of the game is best described as basic engineering. It has been used many times and is a proven, reliable system."

As for the onscreen quality, "*Kart Duel* players will pay for the experience and not the hi-tech graphical content," insists Nevin. In other words, what is the point in providing expensive, state-of-the-art visuals when people simply want to sit in the damn kart?

Indeed, Namco's faith in the importance

of ideas over technology is so great that the architecture behind *Kart Duel*, which also happens to be the company's newest technology beside System 246, is the System 10 board – a less powerful version of the five-year-old System 11. It is, for all intents and purposes, a PlayStation1.

The arcade industry is retracing its steps, technology is going backwards, and Gordon Moore would have a heart attack.

Where will this lead? No one yet knows. And that, in many respects, is the best part. Not so long ago, the best gamers could look forward to in an arcade environment was a beat 'em up with more realistic animation, or a driving game with better handling. Now coin-op fans are shaking maracas, playing guitars, singing, racing horses, taking photos, and capturing wild animals.

Right now, the sensible money is in concepts, not technology. Enjoy it, because it almost never happens.

Upload: ubiquitous gaming

Time
was when a videogame console was either a
Nintendo or a Sega, and most gamers were too young to have
heard of Atari or too old to imagine they'd ever buy a console from Sony.
That's all changed, of course. Sony's demographic plundering has opened up
vast hinterlands of untapped consumers. A videogame console under a thirty-something's TV
isn't an ironic statement but a vital part of modern life.

Gaming will continue to spread out to reach audiences unthinkable today. And just as the people who find
themselves playing games has widened, so the games have become more footloose.

The poster game for this movement is Lionhead's *Black & White*, which looks like appearing wherever games are
played. Lionhead has even opened a separate company to manage its proliferation, with PC, Dreamcast, PlayStation2,
X-Box and even a WAP release already confirmed. Lionhead believes the core gameplay will work on any of these formats,
and it sees no reason to favour one format over another. Perhaps Peter Molyneux can have a unique confidence in his game, but
for other developers and publishers, the plethora of consoles either available now or on their way makes life more complex.

Certainly there are many benefits to crossplatform development. It can maximise the returns not only from a great game or
character but also from the actual work that goes into making a version of the game. X-Box and PlayStation2 may work very
differently, but it's still possible to use essentially the same 3D models in games made for both. Hence so many of the titles due in
the next 18 months being set to support both machines. With Dreamcast, X-Box and PC the case is even more compelling.

But such promiscuous development rarely results in the very best games. Can Lionhead really believe that its games will be as good
on every platform as if they had been designed for one platform alone? The technical feasibility of a version is one thing, but it's quite
another to optimise the game for the mindset of the audience, the threat of the competition, the nuances of the game controllers, or the
intricacies of the hardware. The wealth of classic games that have appeared on just one platform suggests as much, although that so
many of their publishers (Nintendo, Sega, Sony) are also format holders confuses the picture.

Boon or bust, the picture's getting cloudier. Sega has joined Sony and Nintendo in revealing it is to license out its Dreamcast
technology to go into other appliances in search of new sales. Those widening markets are too appealing to ignore.

Does a GameCube, a PlayStation2 or a Dreamcast become something else when it's hidden inside a chrome box and sold as a
Web TV or a DVD jukebox? Definitely. Consoles are already as disparate in their marketing and market and their
hardware. Such differences affect the type of games produced and their success in the shops. Consider the difference
between Nintendo's perceived status as a kids brand against Sony's clubby twenty-something partyheads, and the
software that has resulted.

To extend this, a GameCube sold as a Panasonic DVD player to an ageing couple (where added
entertainment from Nintendo comes as a bullet point beneath the choice of blue or black casing) can
be considered a different platform to a GameCube sold on *Pokémon*.

As gaming spreads to everyone and everything, publishers will need to judge their
potential audiences even more judiciously. It's one thing to master the
Emotion Engine. It's quite another to spark emotions in
a 45- year-old gaming virgin.
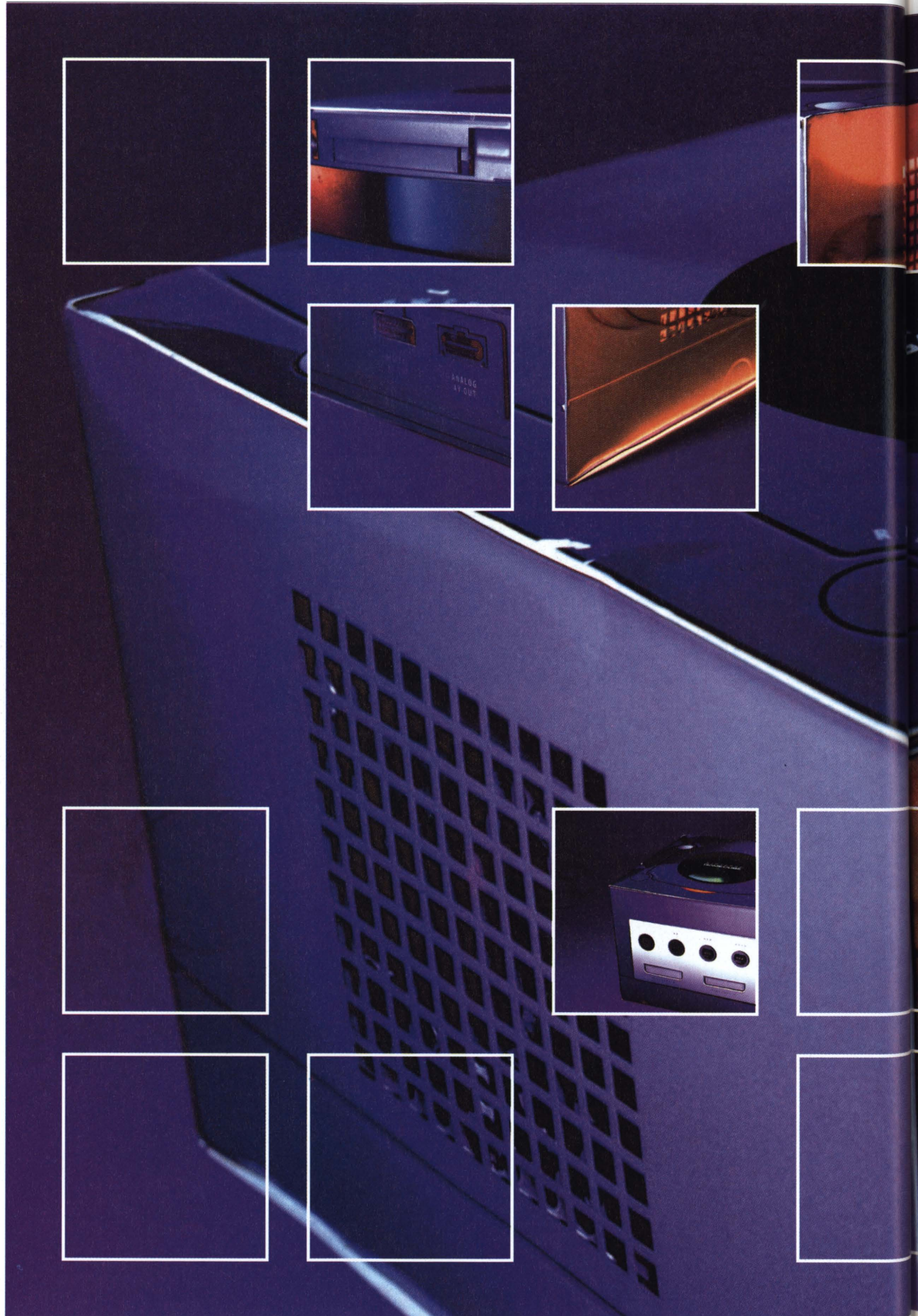
Specifications

CPU: IBM PowerPC: Gekko, 128bit, 405MHz

Graphics processor: Flipper 128bit, 202.5MHz

Main RAM: 24Mb

Graphics RAM: 16Mb

Memory bandwidth: 3.2Gb/sec

Theoretical performance: 12m polygons/second

Estimated real performance: 6-12m polygons/second

Graphics functions: fog, subpixel anti-aliasing, HW light x8, alpha blending, virtual texture design, multi-texture mapping/bump/environment mapping, MIPMAP, bilinear filtering, realtime texture decompression (S3TC), 24bit colour

Sound RAM: 8Kb instruction RAM + 4Kb ROM, custom 16bit DSP

Audio performance: 64 channels, 48KHz

Storage and media type: 1.5Gb GameCube disk drive, 4Mb Digicard flash memory, 64Mb SD-Digicard adaptor

Input/Output: Four controller ports, two Digicard slots, one Analog AV output, one Digital AV output, high-speed parallel port

Networking: 56K modem and broadband ports

Notes: Not the most powerful machine to come, but several developers think it's genuinely easy to work on. Nintendo has focused heavily on graphics functions to allow a seemingly surprise-free operating system. But only as long as you only want to develop games – the system obviously offers little flexibility when placed next to its adversaries.

Manufacturer: Nintendo
Partners: IBM, ATI, Matsushita
Launch date: July 2001 (Japan)
Estimated launch price: ¥24,800 (£160)
Country: Japan

Focus: GameCube

>

In the N64, Nintendo failed somewhat spectacularly to match the dominance
of the SNES, its world-conquering 16bit sibling. Now playing catch-up – albeit
with a multibillion dollar war chest – Nintendo is set to launch GameCube

It's Thursday, August 24, 2000. Outside the temperature is a seasonal 34°C that, when combined with the ludicrously high humidity levels, makes the slightest venture outdoors unbearable. Inside, however, the air conditioning is working well within safety limits to keep the 1,000-odd people cool. And dry.

On the other side of the thermo-regulatory glass panels, Tokyo is enjoying the worst Japan's summer can cook up. In here, however, Nintendo is preparing to unveil a new console. One the company hopes will return it to its more characteristic position at the top of the console food chain. But let's backtrack a little. This didn't just happen overnight.

The ultra console

The Nintendo 64 was made available to Japanese gamers in June 1996, a full year and a half

The Wavebird controller

Long the leader when it comes to control peripherals, Nintendo hasn't disappointed when it comes to designing the GameCube controller.

The standard model includes seven buttons (eight if you count Start/Pause), a now-standard analogue control stick, a D-pad and an analogue camera stick, replacing the C buttons found on the N64 controller. The two trigger buttons are also now analogue, and the Z trigger has moved above the R shoulder button. The configuration of A, B, X, and Y has also altered, so that A becomes the most obvious button, taking centre stage with the other three placed as satellites around it. Rumble functions are also incorporated.

Interestingly, for certain titles the Game Boy Advance can also be used as a GameCube controller, a sort of über-VMU. It will give players their own private detailed colour view – particularly useful if you don't want your next tactical move to be displayed on the main screen for your opponent(s) to see. The potential here is obvious. Expect Nintendo to come up with some extremely ingenious uses for it.

With the exception of Wavebird, a wireless version of the joypad that will operate up to a distance of ten metres, no other gaming peripherals have been announced. Expect the obligatory thirdparty steering wheels, of course, though the SD-Digicard adaptor could see Nintendo coming up with some GC-specific, digitally friendly gadgets to enhance the gameplaying experience.

Inputs and outputs

The quartet of controller ports that everyone but Sony now deems essential line up along the console's face, sharing two Digicard slots between them. Round the back, beneath the handle, a digital and analogue AV outputs sit side by side, with the power input slightly disturbing the otherwise clean, clear lines.

The SD-type Flash memory card (up to 64Mb) should go some way to make up for the GameCube's lack of hard drive. Meanwhile, the machine's underbelly hides a high-speed parallel port as well as two high-speed serial ports, one of which is dedicated to modem or broadband connections (both will be available separately, naturally).

Nintendo is being rather reticent when it comes to these connections, currently stating that it isn't looking to follow Sony (that is the 'play the game, download the music, buy the T-shirt online' model). The manufacturer argues convincingly that its focus is on games, so any broadband connectivity must emphasise gaming potential. Currently this equates to online multiplaying, data exchange, and/or games downloading, for which narrowband is acceptable.

Cost – both financially and performance-wise – is one of the reasons why you won't find USB connections on the GameCube, says Nintendo. As far as a game machine is concerned, the videogame giant sees no advantage in including it in its hardware.

after Sony released its 32bit gamble on to an anticipant world.

As with all new Nintendo hardware, it was met with record-breaking enthusiasm, but this wasn't to last. Nintendo's 'quality not quantity' promise, which on paper seemed so attractive, in practise amounted to little of either.

Landmark, genre-defining titles emerged from Nintendo, of course, but far too infrequently for Japan's gamers who eventually abandoned NCL's cartridge-based beast in favour of 32bit competitors. Nowadays, you only need wait a couple of months before being able to pick up even the finer N64 titles for little more than a fiver from any one of Akihabara's dwindling videogame stores.

Cross the Pacific and the N64 story is somewhat different. In the US, Nintendo has been running a consistent number two to Sony's virtual monopoly on the console market since the machine's launch in September 1996. True, the gap is large but the N64 is very much alive and about to enjoy another healthy Christmas period.

Europe, on the other hand, suffered an absurd (yet typical of Nintendo) wait until April 1997 before gamers had a chance to play letterboxed, 17 per cent slower PAL interpretations of NTSC software. The conversion process improved (no doubt it helped that some of the best N64 games were actually produced in the UK by Rare) but the flow of releases remained pathetic – and still included far too many examples of substandard electronic entertainment. But by then SCEE ruled Europe with a 32bit lifestyle accessory that ruled the airwaves and entered the pop cultural lexicon. Nintendo couldn't make up the ground, *GoldenEye* or no *GoldenEye*.

The slippery dolphin

Financially, things never looked shaky for Nintendo. They wouldn't – not when the company's line-up also features *Pokémon* and a revived Game Boy. But as Sega, Sony, and now Microsoft have moved in on the 128bit market, Nintendo has surely vowed not to get it wrong again.

The day before the June 1999 E3 show opened its countless doors, NoA invited selected members of the videogames press to assemble inside a theatre in downtown LA. After the inevitable delay, then-NoA president Howard Lincoln appeared on-stage to announce the company's next-gen contender.

Codenamed the Dolphin, details were characteristically thin on the ground: an IBM 'Gekko' CPU running at 400MHz, a custom ArtX-designed 200MHz graphics chip, an unspecified quantity of DRAM for memory with a 3.2Gb/sec transfer rate and a Matsushita-designed

System LSI "Flipper"
(システム・エル・エス・アイ "フリッパー")

A-Memory
(エイ・メモリー)

MPU Gekko
(エム・ピー・ユー "ゲッコー")

Main Memory
(メイン・メモリー)
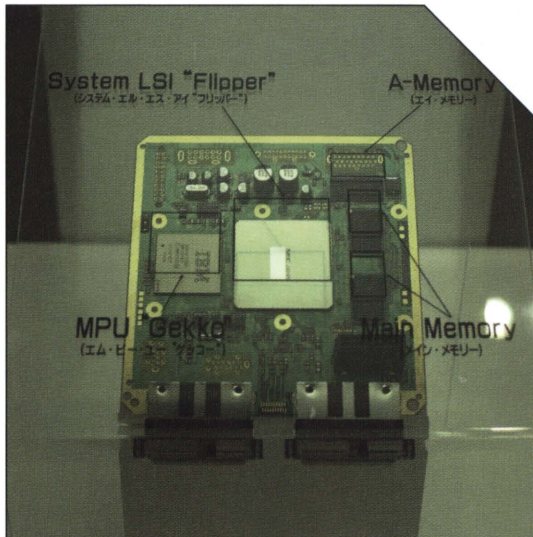
How it works

The GameCube's architecture is interesting – although difficult to determine precisely, given the unwillingness of developers to talk about it. However, those who have ventured an opinion agree that the system's strength lies in its memory structure and the way this can be internally manipulated.

The memory is 1T-RAM (one transistor RAM) and although it's dynamic, it acts like static memory with all its attendant speed advantages. Significantly, this means that it performs at one cycle access. Usually, while cache memory runs at one cycle, a console's main memory runs in multiple cycles and hence is slower. This is why developers try to maximise the use of cache memory – it's much faster. But on GameCube, all the memory runs on one cycle access and thus doesn't need to be cached. That's a big advantage.

The graphics chip itself only has a very small amount of memory built in, so that when it's rendering a frame it has to transfer that frame from the graphics chip into the main memory before it can be displayed. But because the main memory is so fast, there's little disadvantage in storing textures and models on there rather than on the graphics chip.

However, while both the X-Box and PS2 have programmable geometry allowing developers to get the hardware to perform clever tricks in order to obtain satisfactory results, coders can't really change the way the GameCube handles 3D graphics. Nintendo and its partners have decided on the optimum way of doing 3D graphics, and has decided to enshrine this in the hardware.

It's not yet clear whether Nintendo's way is the right way. If it is, developers will benefit from finely tuned hardware that is straightforward to exploit. But if not, then the fact that the GameCube isn't very flexible in terms of programming could prove a brake on creative development.

An ancient family

Before *Mario*, before *Zelda*, before *Pokémon*, and before global videogame sales of one billion, Nintendo began its life in 1889 as a Kyoto-based playing cards manufacturer. The GameCube is simply the latest videogame-playing box to emerge from the company with an illustrious gaming heritage and a unique 111-year grounding in entertainment.

proprietary DVD storage medium. Only fools took talk of a global launch in late 2000 seriously. And then, in typical NCL style, silence.

Until, to return to the beginning, 3pm on Thursday, August 24, when Nintendo formally reveals GameCube, the 128bit next-generation console. The audience barely has time to gasp at the quintet of differently coloured units that appear on stage before footage of forthcoming GameCube titles overloads the senses. *Wave Race*, *Zelda*, *Metroid*, *Luigi*, *Star Wars*, *Perfect Dark*, and, of course, *Pokémon* whip the audience – largely consisting of US journalists – into a frenzy. End of story?

Not yet. Shigeru Miyamoto, the planet's most admired videogame creative, then emerges to talk the audience through the joypad. Frustratingly, while he lists the various buttons available and discusses the operating range of the

wireless 'Wavebird' model, he gives nothing away. Gameplay implications are left to the imagination of the attendees and, crucially, to those of the competition.

And interestingly, no one mentions specifications. As a way of demonstrating the machine's grunt, Miyamoto-san ends up with 128 Mario models made up of 700 polygons each running around the screen, toying with graphical effects (toon shading, motion blur, transparency), and changing the terrain topography in realtime. It's a convincing argument that is quickly followed by the announcement that nothing else will be revealed until next year's E3, in May. The only ones panicking haven't noticed that a full rundown of the machine's specs is listed in one of the many press releases distributed before the event.

Cubicle politics

The most striking aspect of

GameCube, other than the obvious fact that it isn't a cube, is its unambiguous demeanour. There is nothing about it that would lead you to believe it isn't a videogame console. Even at its most basic design, GameCube shouts 'games', and nothing else.

It's a similar story once you remove the casing. Created with ease of development in mind, this doesn't boast the most powerful statistics of the 128bit class. But it has been carefully crafted to make the technical aspects of building a game as invisible as possible, hence leaving developers with more time to concentrate on the actual gameplay elements of their projects. Well, that's what the press release says, anyway. But most of the developers **Edge** has talked to since agree that, on blueprint at least, things look remarkably well thought out.

This is crucial. Nintendo has admitted it has learned from the N64

1978 Coin-ops
Created and started selling coin-operated videogames like *Radar Scope* using microcomputers

1977 Mitsubishi Electric
A co-operation with Mitsubishi Electric sees home-use videogame development

1973 Clay pigeon shooting
Develops laser clay pigeon shooting system to muscle in on the ten-pin bowling market

1980 Game & Watch
The hugely popular Game & Watch series invades the market some 91 years after the company's debut.

1981 Donkey Kong
Donkey Kong is released and becomes the best-selling individual coin-op on the arcade circuit

1983 Famicom
The Famicom arrives in Japan and engulfs the US two years later in the guise of the NES

1989 Game Boy
Game Boy, to date the world's best-selling console, emerges in original chunky monochromatic form

1990 Super Famicom
Super Famicom continues where the Famicom left off, not only boasting massive global success, but also some of the greatest titles to have been committed to silicon

1996 N64
The N64 launches in Japan on June 23 and sells over 500,000 units in one day. On September 29, the same system rolls out of US stores and infiltrates 350,000 homes in 72 hours

episode. Creating a machine that is difficult to get performance from is of little use if only two or three developers in the world manage to make it sing and dance. More importantly, not readily sharing development libraries with your thirdparty associates is not an especially productive plan. It may make you look technically superior to them, but that's not particularly helpful if everyone is buying PlayStation games instead.

Rather than keeping all of its cards to its chest, Nintendo is promising a change in the way it deals with its thirdparty developers. Given the machine's architectural structure, the technical aspects should induce less headaches, though Nintendo seems keen to hand pick a number of competent codeshops and offer whatever assistance it can to ensure the end product is up to scratch. Nintendo believes it is pointless to

list hundreds of supportive companies when only a few produce anything of value. Software superiority is paramount.

The 'quality over quantity' argument remains, then, but a more amenable development environment should, in theory, see a significant change in the way GameCube titles turn out compared to the N64's predicament. Couple that with a very aggressive price point and things are looking rosier for NCL.

But good games and affordable consoles are only part of the story nowadays. Nintendo is also fighting a marketing war, and it's one that Sony is remarkably well drilled in. Proportionally, Nintendo may make the better games but its machines lack the appeal that Sony managed to attach to the PlayStation. The PlayStation2 may look like a Bang & Olufsen reject, but its soberness, combined with DVD playback and brand awareness, make it a more
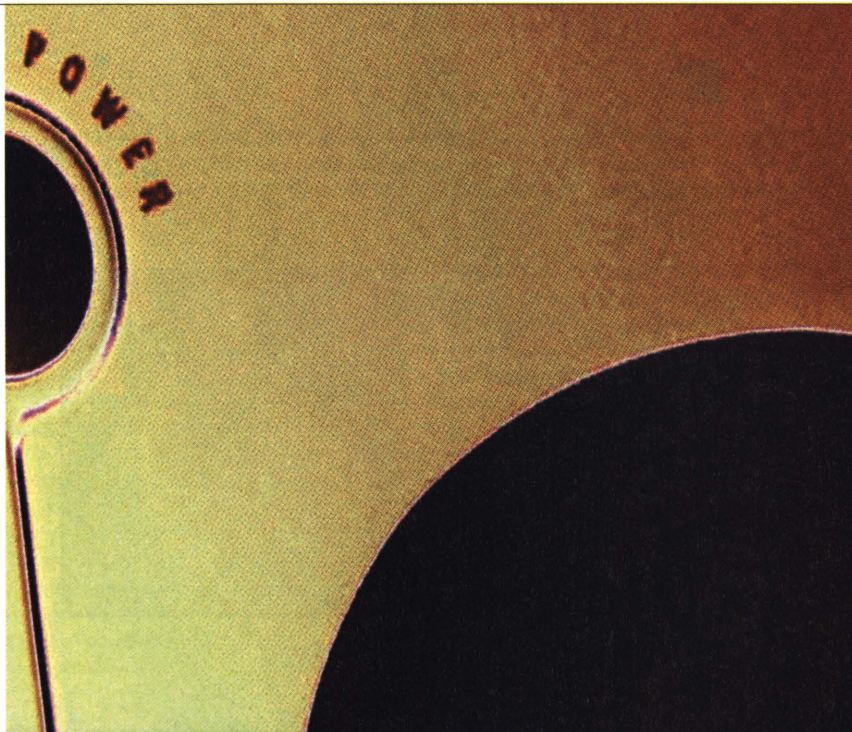
1998 Game Boy Color

Game Boy Color is introduced and *Pokémon* is unleashed on an apprently cash-rich world. *The Legend of Zelda: Ocarina Of Time* is released on N64 and destroys US pre-sell records for a videogame

+ Shigeru Miyamoto
+ A strong portfolio of game licences
+ Unique talent at Nintendo and Rare
+ Experience and hindsight, as NCL has been a market leader
+ Reported ease of programming
+ Aggressive price point
+ Interfacing with Game Boy Advance
+ A games machine, if not a multimedia station

∧

The sun rises in the east

It's a fine-looking machine, but will it catch the eye of the older market which could help it achieve number one status?

But it sets in the west

∨

- The brand image is geared towards kids, especially in Japan
- Quality not quantity debate has previously failed with N64
- Storage system remains proprietary
- The massmarket may see lack of DVD drive as a limit
- May well arrive too late in Europe
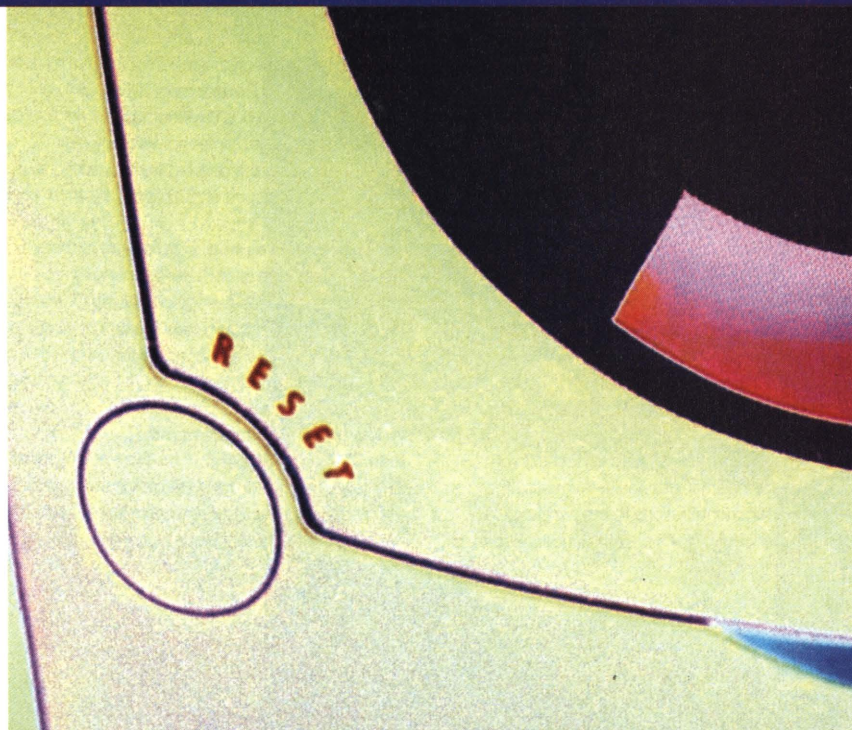
socially acceptable acquisition for Joe Average.

'Yes, it's a games machine, but it can also do other things,' he could argue to any house guests. In this image-conscious world, a console that blends itself with the rest of a consumer's hi-fi set-up will propel you into markets that other colour-friendly brands can't reach.

GameCube may suffer the kiddy label that has been traditionally – if erroneously – bestowed on Nintendo machines, making it massmarket-unfriendly. But hardcore gamers and children will embrace Nintendo's new plastic box of tricks. Not even Japan's summer humidity will keep them away from Akihabara's streets when GameCube launches with five titles next July. With the right approach, others may well follow.

Nintendo has the right games and the right machine. But if it wants to be number one again, it needs the right image.

Having suffered at the hands of PlayStation before being beaten to the 128bit punch by both Sega and Sony, Nintendo is finally ready to enter the next-generation console fray. But given the company's slow start, and shaky N64 support policies, **Edge** asks Nintendo of America VP Jim Merrick why thirdparty developers should be interested

A grounding in 3D graphics acquired during a 12 year sabbatical from the videogame industry (during which time he worked in the CAD/CAM software business) saw **Jim Merrick** arrive at Nintendo of America six years ago to manage its technical developer support. **Edge** caught NoA's VP of engineering in a talkative mood...

Why will developers support GameCube?

In short, because of the superior design of our system and ease of use for developers. Our system has been designed from the ground up solely as a videogame console –

cost saving for publishers. Since we have the advantage of not being a DVD player, we took the opportunity to capitalise on the attributes of DVD while creating a new media format that is better suited to gaming.

What are the benefits of having so many built-in graphical capabilities?

We are deliberately leaving the 'technical arms race'. Yes, NGC will be extremely powerful. We've got the acronym soup our competitors like to talk about and some they don't even know about yet. But that's missing the point. The true advantage in NGC is not the individual

> **Jim Merrick**

VP of engineering
Nintendo of America

talking technology

Nintendo GameCube is more than the sum of its very powerful individual components. GameCube is better designed than anything else in the marketplace, and its components work together at faster speeds and with more efficiency, yielding far better results in a shorter period of time. Those results specifically maximise play.

What are you doing to ensure thirdparty support?

The level of game development for NGC is significantly beyond that for Nintendo 64 at a corresponding point in time – dozens of different development entities in the western hemisphere are in possession of Nintendo GameCube tools. We realise the important contributions to be made by independent developers, and understand

that they will play a pivotal role in our system's success. Development is well underway at numerous development locations worldwide. Nintendo will continue to refine and enhance development tools throughout the lifespan of the product.

Why the shift away from solid state?

While the cartridge offers a number of technical advantages over disc-based media, the cost of silicon chips makes the economics no longer practical for today's sophisticated games.

Why a proprietary medium rather than DVD compatibility?

Basically to combat piracy. Because our media contains a strong anti-piracy deterrence, there is in effect a built-in

components, but how those components are engineered to work together.

How can I prove this? With a ducky in a sink? Butterflies in the garden? Unfortunately these types of 'technology demos' have little or nothing to do with the system's capabilities as a videogame system – to understand that, you need to see and play a game.

Was there ever any thought regarding USB or other advanced link-ups?

Sure. Nintendo has always included ways to interface to accessories on all of our systems. GameCube features two high-speed serial ports on the bottom (one is dedicated to network or modem connections) and one high-speed parallel port. But these serial ports

are not USB. Why not? Because we are not a PC, USB offers no advantage to us. There are very real financial and performance costs with USB that we don't think gameplayers want to pay for.

How did you develop GameCube's new joypad?
The Gamecube controller was designed in large part by Mr Miyamoto, and who better to design the primary human interface between the player and the game? Miyamoto had to resolve two basic desires: the desire of the game designer to have as many functions as possible to facilitate unique forms of gameplay; and

broadband/modem connections underneath the console?
In Japan, as outlined at Spaceworld, a Game Boy Advance accessory can connect players to an external network primarily for the purposes of enhancing their gameplay experience. Currently, the majority of people connecting online in Japan do so wirelessly; in America, by PC. We don't believe that any game system will replace those devices that consumers already use. So again, the focus and dedication of our online strategy is to improve the gameplay experience.

Is there any chance of 64DD-style

writeable media appearing?
You will note that Nintendo GameCube supports the SD-type flash memory cards, which are available in a variety of sizes ranging up to 64Mb. That will address many of the features a hard disk might provide in other systems.

Finally, what is the handle hiding? It suggests portability, so can we assume owners can visit their friends with their GameCubes to link two or more machines together?
The handle simply makes it easier to move from room to room. It's no more complicated than that.

"The level of game development for GameCube is significantly beyond that for Nintendo 64 at a corresponding point in time"

the desire of the consumer to have a transparently simple controller, one in which you never have to think about buttons or controls.

The GameCube controller addresses these by grouping major controls in two 'systems' positioned around each of the player's thumbs, and by further designing the size of the controls according to their priority or frequency of use. Additionally, consideration must be given to the wide range of player hand sizes, extreme robustness, weight, and so on, so it has been an involved process.

At Spaceworld Nintendo clearly stated it wasn't interested in replicating Sony's PS2 broadband approach. So what are you planning to do with the
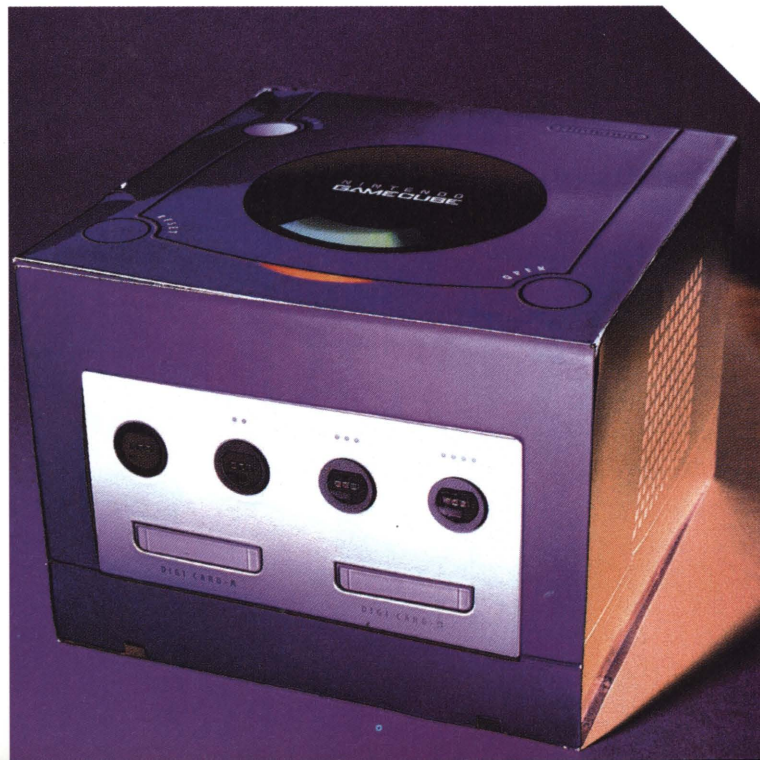
The ten best-selling

Machine name: Master System
Manufacturer: Sega
Year released: 1986
Peak year: 1990
Estimated number sold: 10million
How it succeeded: Arcade ports made up
the majority of the Master System's top software.
Despite being technically superior to the NES the
Master System was a secondary console, particularly
as developers had to sign an exclusive deal if they
chose to make games for the rival Nintendo system.
The innovative 3D glasses released for the Master
System can be counted as a plus or a minus,
although only by historians – few consumers actually
bought the things.
Key games: *Wonder Boy III*, *Alex Kidd in Miracle
World*, *Phantasy Star*, *R-Type*, *Fantasy Zone*
Why it died: Although it was supported in
Europe into the '90s, Sega's release of the
Mega Drive meant that the company's global
focus switched away from the Master System.
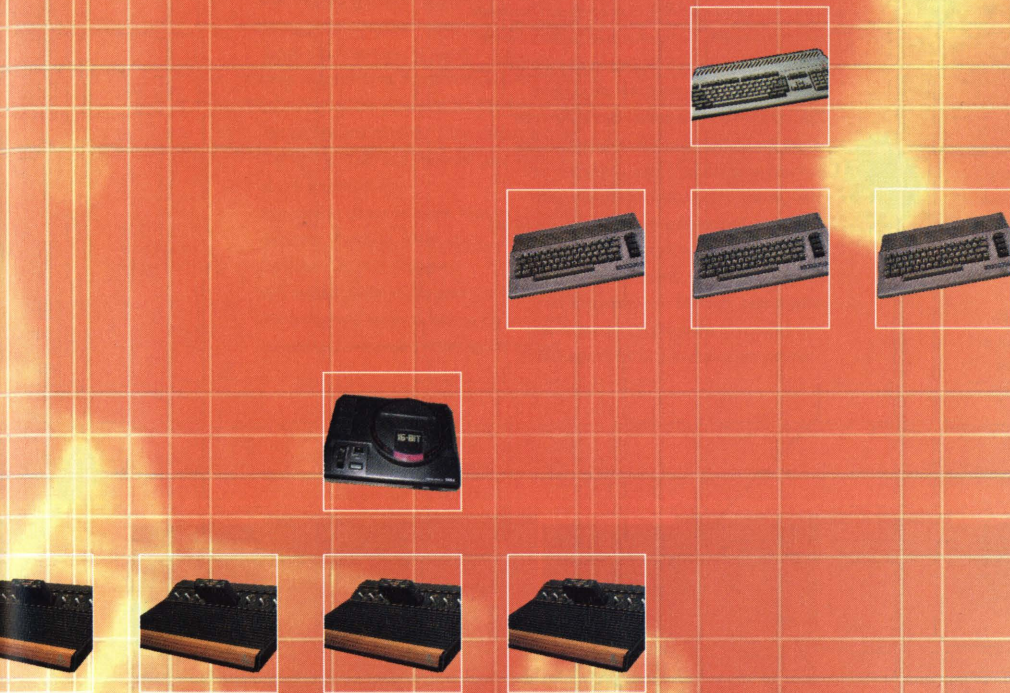
ten

consoles in the world, ever…

Like a phoenix, the videogame industry dies in order to make progress. Even as a new box packed with the latest technology is released, its successor sits on the drawing board in an R&D lab somewhere in the world.

But while the industry's cyclical nature generates a string of obsolete machines every five years, it also makes for an amazing history. Machines that hit the big time spectacularly jostle alongside wannabes that never stood a chance. And although there are few surprises in the top ten game consoles of all time, there are lessons for the current contenders to learn. Pricing, marketing and availability have played a part, but for all winning formats, the quality of games was the crucial element in their success.

It all started 30 years ago with the Magnavox Odyssey. Since then hundreds of gameplaying devices have emerged, but only a select handful have been truly successful. Over the following pages Edge presents the most popular examples
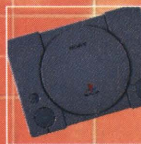
Tops of the flops

Launching game consoles looks far easier than it is – suburban attics are dotted with the failed children of those who underestimated the challenge. The '80s saw most companies ape Atari's worst side, rather than its success. The Vectrex, for example, was more a standalone toy than a game console. Something of a hardware cul-de-sac, it was still a highlight of the innovation demonstrated in the early '80s.

Basic business concepts had still not been learnt by the end of the decade. The world's first 16bit computer, Sinclair's QL was aimed at business users, while Amstrad's supremely ugly GX4000 was always a generation adrift of its competition. Another interesting UK attempt was the Konix console. Never actually released, its distinctive controller was based around a steering wheel.

The mid-'90s saw a rash of new machines. A lack of software finished off Atari's last-gasp effort, the Jaguar, while the Amiga CD32 – in reality an A1200 with CD drive – was pretty much obsolete before launch. 3DO's attempt to create an open standard for consoles looked a winner, until the PlayStation and Saturn were revealed. More ignominious still was the Virtual Boy. It's hard to fathom why it ever left the R&D lab and remains Nintendo's only major failure.

The biggest problem with the majority of handheld devices has been battery life – as notably demonstrated by the PC Engine GT and Atari Lynx. Sega's best attempt at a competitor to Game Boy came in the shape of the Master System-inspired Game Gear. It was a valiant attempt, but a lack of software support killed it.

Machine name: C64
Manufacturer: Commodore
Year released: 1982
Peak year: 1985
Estimated number sold: 15million
How it succeeded: The follow up to the VIC-20 (itself the first PC to reach one million sales in the US) the C64 boasted 64K of memory and hardware sprite processing. Somewhat overshadowed in the UK by the Spectrum, the C64 proved the more popular machine on the global stage, doing particularly well in the States. By the mid-'80s it had the best range of software, and lived on through an amazing 11-year production run.
Key games: *The Sentinel, Mercenary, Little Computer People, International Karate, Paradroid, Uridium, Way Of The Exploding Fist, Wizball, International Soccer, Beach Head, DropZone*
Why it died: The C64 was finished off by a combination of emerging PC standards and Commodore's switching to the Amiga format.

nine

eight

seven

Machine name: Amiga
Manufacturer: Commodore
Year released: 1988
Peak year: 1991
Estimated number sold: 13million
How it succeeded: Famously funded by three rich Florida doctors in its early stages, the Amiga eventually found a home with the then giant Commodore corporation. Initially launched against the Atari ST, the Amiga was a massive success, especially across Europe, helped by a great range of software from the likes of codeshops such as Bullfrog and Psygnosis.
Key games: *Syndicate, Lemmings, Populous 2, Sensible Soccer, Speedball 2, Dungeon Master, Stunt Car Racer, Formula 1 Grand Prix*
Why it died: It may have been a great success but Commodore launched too many different machines, with ill-judged ventures such as the CD32 and A1200 series playing a part in its bankruptcy in 1994.

Machine name: Mega Drive
Manufacturer: Sega
Year released: 1988
Peak year: 1992
Estimated number sold: 23million
How it succeeded: Technically advanced, the Mega Drive for once really did bring 'near-perfect arcade conversions' into the home. While it was never a big success in Japan, it really took off in Europe and the States thanks to excellent marketing campaigns. The other major popularity booster was a certain speedy blue hedgehog. Gaming's first real pop icon, Sonic became Sega's mascot.
Key games: *Sonic The Hedgehog, Ecco The Dolphin, Super Shinobi, Golden Axe, Herzog Zwei, Space Harrier, Strider, John Madden's Football*
Why it died: Mega CD and 32X. These hardware add-ons were a disaster. Expensive and woefully undersupported, they saw Sega shoot itself in the foot – twice.

Machine name: Atari VCS
Manufacturer: Atari
Year released: 1978
Peak year: 1982
Estimated number sold: 26million
How it succeeded: Back when arcade machines were becoming a social phenomenon, Atari's cartridge-based system was just one among a crowd of competitors. Its rise to true stardom came with the home conversion of *Space Invaders*, backed up by the marketing clout of Warner (which had bought Atari in 1976). Other classic software such as *Pac-Man* and *Defender* gave the VCS its pre-eminent status.
Key games: *Space Invaders*, *Missile Command*, *Asteroids*, *Pac-Man*, *Pitfall!*, *Joust*, *Galaxian*, *Defender*, *Dig-Dug*, *Frogger*
Why it died: At the VCS's peak it generated around half of Warners' revenue, leaving the company dangerously over-reliant on an ageing system.

Machine name: SNES
Manufacturer: Nintendo
Year released: 1990
Peak year: 1993
Estimated number sold: 49million
Why it succeeded: Although not even a true 16bit console, the twin 8bit processors of the Super Nintendo Entertainment System (SNES) gave superior performance over its main competitor, Sega's Mega Drive. Software, once again, was the main reason for its success, with Nintendo continuing to expand its already impressive catalogue of game franchises.
Key games: *Super Mario World*, *Street Fighter II*, *Final Fantasy III*, *Super Bomberman*, *Super Mario Kart*, *Secret Of Mana*, *Super Metroid*, *F-Zero*
Why it died: By the mid-'90s cartridge-based consoles were under pressure from a combination of the PC and the general adoption of CD-ROMs as the standard storage medium. The launch of 32bit consoles saw 16bit hardware sales nosedive.

six

five

four

Machine name: N64
Manufacturer: Nintendo
Year released: 1996
Peak year: 1999
Estimated number sold: 28million
Why it succeeded: While it's considered a failure in the face of Sony's triumph, the N64 has sold enough to reach the top five on the strength of the Nintendo brand and the quality of its software. But what the size of its installed base does underline is the incredible paucity of thirdparty titles for the system. It should have been a goldmine, but Nintendo's adherence to expensive cartridge technology made it a difficult machine to profitably exploit. That the N64 sold as many units as it did is proof of the truism that software sells hardware.
Key games: *Super Mario 64*, *Legend of Zelda: Ocarina Of Time*, *GoldenEye*, *1080° Snowboarding*, *Wave Race 64*, *PilotWings 64*, *Perfect Dark*
Why it died: Starved of software for most of its life, the N64 survives on the crumbs of *Pokémon* tie-ins. Redesigning the console's façade with Pikachu and PokéBall has prolonged its lifespan.

The top ten chart

Units sold (millions)

125
100
75
50
25
0

- Sega Master System
- Commodore Amiga
- Commodore 64
- Sega Mega Drive
- Atari VCS
- Nintendo 64
- Super Nintendo
- NES
- Sony PlayStation
- Nintendo Game Boy
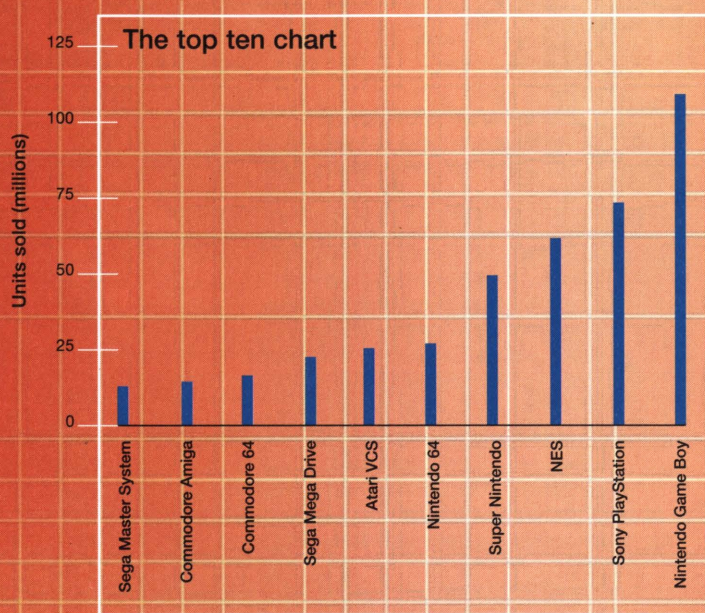
Machine name: PlayStation
Manufacturer: Sony
Year released: 1994
Peak year: 1998
Estimated number sold: 74million
Why it succeeded: The first test of Sony's CD-based box was a launch against the Sega Saturn. PlayStation was cheaper and proved easier to develop for. Sony's lack of in-house talent made it is more open to thirdparty developers and publishers, which helped it see off strong competition from N64. Sony's marketing savvy underlined the public perception of PlayStation as the console of a generation.
Key games: *Wipeout*, *Tomb Raider*, *Gran Turismo*, *Final Fantasy VII*, *Tekken*, *Resident Evil*, *Driver*, *Metal Gear Solid*, *Crash Bandicoot*
Why it died: The first case of the euthanasia in the games industry saw the venerable PlayStation bumped off for the PSone. Like a Frankensteinian experiment, its brain lives on in its successor.

three

two

one

Lies and statistics

As proved by the research for this feature, there are lies, damned lies, statistics, and installed figures. Excellent figures exist for successful hardware, with companies falling over themselves to press release their latest million-odd sales. More problematic are formats that were seen to be failures and those that were licensed to different global manufacturers.

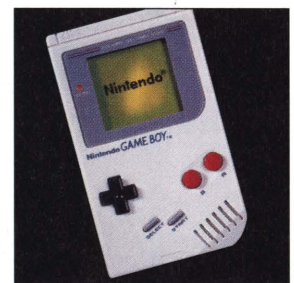A good example was the Sinclair ZX Spectrum, which sold around five million in the UK, but was also made as far away as Brazil and Russia. In these situations, educated guesses from informed sources was the best information on offer, and on that basis Sir Clive's baby didn't make it.

The other major source of information here came from the issues of highly paid electronic entertainment analysts. Complete with nice graphics and purposeful-looking tables, these proved to be generally useless – surely a worrying situation for the industry.

Machine name: NES
Manufacturer: Nintendo
Year released: 1984
Peak year: 1989
Estimated number sold: 62million
Why it succeeded: Having developed a string of successful arcade games, Nintendo's Entertainment System was its first foray into home machines. Japanese sales proved to be strong, so following the collapse of Atari, Nintendo decided to launch the system in the US. Initially sales were steady rather than spectacular, with retailers sceptical of the prospects for another game system. However, as its popularity grew, Nintendo's strict licensing rules meant that the market never became over saturated as in the days of the Atari VCS and ensured the NES's longevity.
Key games: *Super Mario Bros (series)*, *Excite Bike*, *Legend Of Zelda*, *Metroid*, *Final Fantasy (series)*, *Punch Out*, *Contra*, *RC Pro-AM*, *Duck Hunt*
Why it died: An evergreen system in the world of consoles, the NES was manufactured until 1995. It was run into ground by the SNES, although its successor never reached the same level of ubiquity.

Machine name: Game Boy/Game Boy Color
Manufacturer: Nintendo
Year released: 1988/1998
Peak year: 1999
Estimated number sold: 110million
Why it succeeded: With only a monochrome screen, one of Game Boy's main advantages was its battery life using only two AA batteries. The conversion of Nintendo's back catalogue was another plus, although its first killer app was a Russian game, *Tetris*. Ten years on, the release of the backwardly compatible Game Boy Color updated the format without alienating its fanbase. That it managed 18million sales in 1999 can only be accredited to the *Pokémon* phenomenon.
Key games: *Tetris*, *Pokémon*, *Super Mario Land (series)*, *Legend Of Zelda: Link's Awakening*
Why it died: The announcement of Game Boy Advance has already led to diminished development support for Game Boy, although considering the size of its still-growing installed base, it would be foolish for publishers to end Game Boy development just yet. It's still a highly profitable business, especially for Nintendo.

illustration: **Richard May**

SO ACTION

Console: Atari Video Computer System
Computer: Apple I
Handheld: Simon
Genre: Shoot 'em up
Chip: Z80
Memory: 4K ROM
Graphics: Phosphor
Sound: Programmed
Media: Built-in ROM
Game: *Pong*
Character: Space Invader
Man: Nolan Bushnell
Country: USA
Magazine: *Popular Electronics*

Specifications

CPU: Intel Pentium III 1000Mhz

Graphics processor: ELSA Gladiac Ultra with NVidia GeForce2 Ultra (250Mhz)

Main RAM: 128Mb RAM

Memory bandwidth: 100MHz based SDRAM units hit about 800Mb/s

Graphics RAM: 64Mb on graphics card

Theoretical performance: A Pentium PC with a Hercules 3D Prophet II GTS 3D card (based on the GeForce2 chip) is said to hit 31 million polygons/second with a fill rate of one billion pixels-per-second

Estimated real performance: A 500 Mhz PC with 128Mb RAM and the above card hits 60fps playing *Quake III*

Graphics functions: A mass of lighting and filtering effects typically handled by chip – more recently hardware geometry processing. MPEG2 decoding for DVD playback and TV output common

Sound RAM: A Creative Labs Sound Blaster Live! Platinum card, inserted in a PCI slot, has 32Mb of sound RAM

Audio Performance: The aforementioned card offers 48 MIDI channels and 1,024-voice polyphony sampling at up to 48KHz, plus effects such as Dolby Digital

Storage and media type: Floppy drive (1.4Mb) and a hard drive (10Gb typical), plus a CD reader (48x speed, 650Mb) or DVD player (12x speed, 4.7Gb single sided). Additionally Zip and Jaz discs (100Mb and 2Gb) and 'super-disks' (120Mb) are common

Input/Output: Typically keyboard, mouse, VGA output to monitor, speakers, two COM/Serial ports, two USB ports, parallel/printer ports, game controller

Networking: 56Kbps dial-up modems now standard. PCs can also connect remotely via ASDL or ISDN, as well as through line-bonded dial-up (like Home Highway). Local area networking through ethernet cards. Some PCs can also communicate through infrared ports or radio-wave transmitters

Notes: Unlike gaming consoles, 'PC' is a catch-all title to refer to a diverse array of machines. A PC game that runs straight out of the box with no tweaking is a rare and beautiful thing
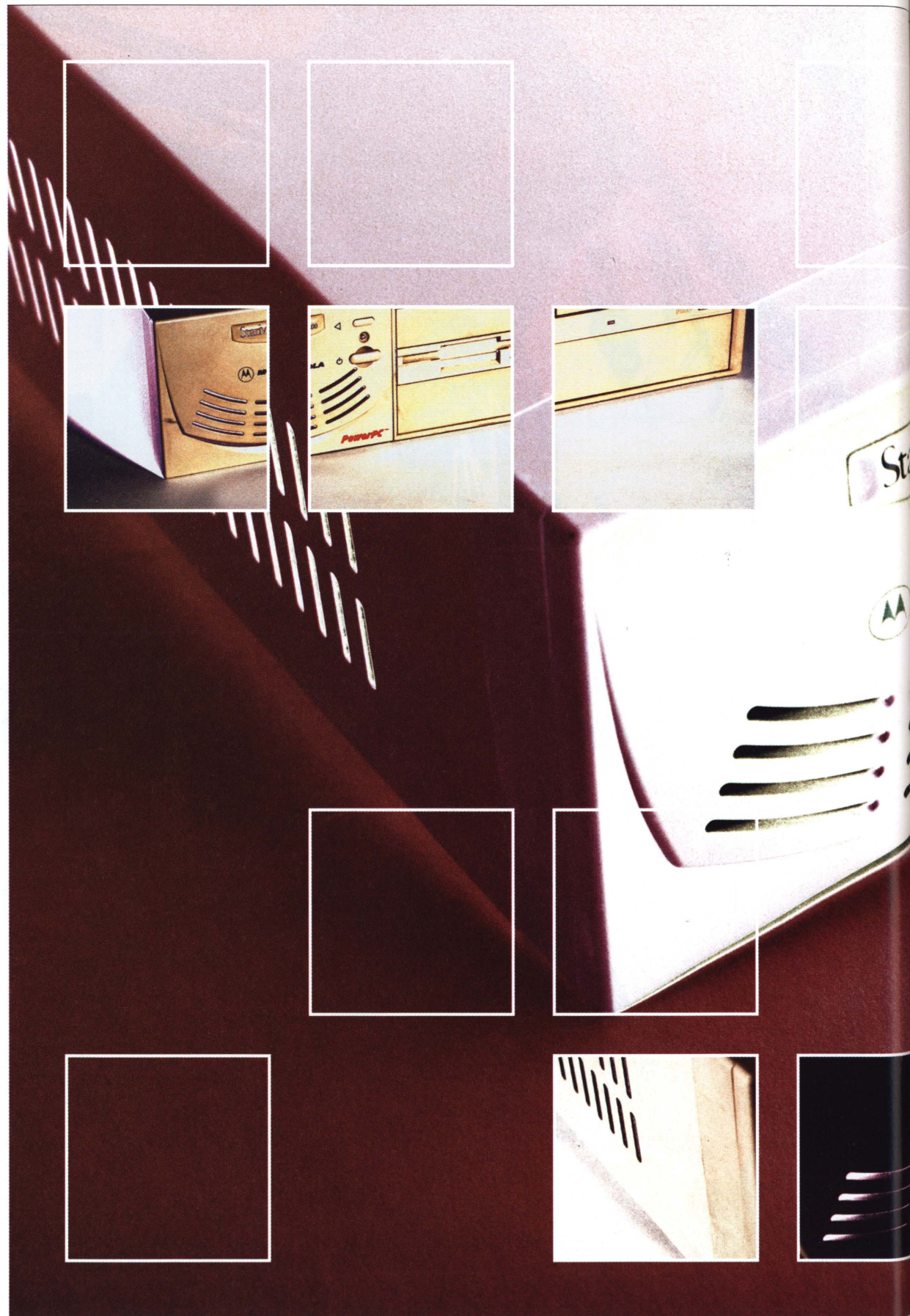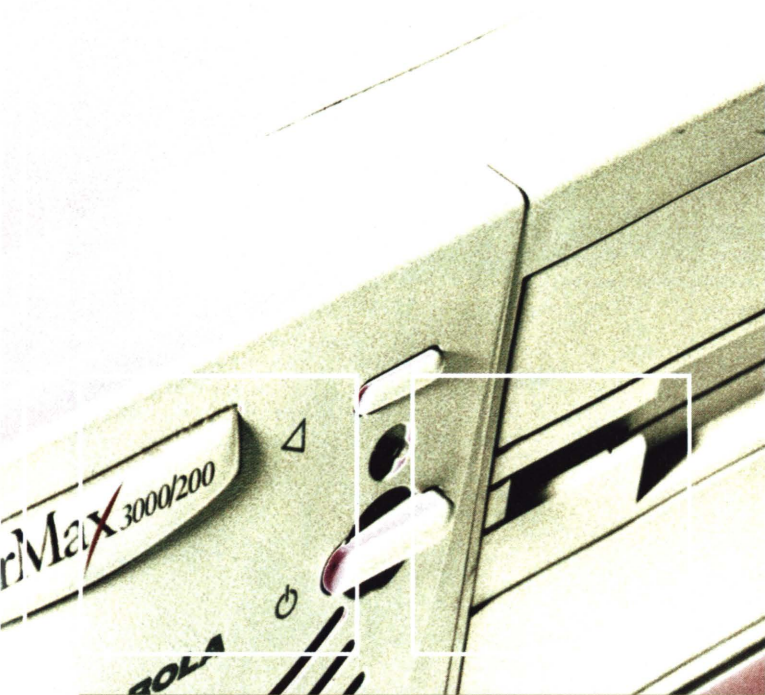
Focus: PC

Worshipped and reviled in equal measure – often by the same person in the
course of installing a game – a PC costs five times more than a PS2, and yet
still enjoys the reputation of being the world's most enduring gaming platform

N ext year, the microprocessor celebrates its 30th birthday. The invention of the computer-on-a-chip by Intel in 1971 knocked over the first of a chain of digital dominoes that is still toppling.

Estimating how many personal computers are in existence today is almost impossible, particularly as 'PC' is such a generic term. It refers to a multi-purpose microcomputer compatible with a certain set of loose architectural standards, but really there is no such thing as 'The PC'.

The original source of this confusion is Albuquerque, New Mexico, where a small pocket calculator outfit called MITS employed Intel's 8080 chip as the basis of its hobbyist make-your-own-computer kit. Called the Altair 8800, the machine had no keyboard, just a set of switches enabling you to assign instructions thanks to the CP/M operating

system (OS) bought-in by MITS from Digital Research.

A messy birth

On top of the Altair 8800's operating system, users could run a version of BASIC, including one designed by two teenage fans, Paul Allen and Bill Gates. They'd seen the MITS machine on the cover of *Popular Electronics* magazine and fallen in love. In 1975, having dropped out of college, they co-founded Microsoft.

Although MITS fell apart shortly afterwards, dozens of firms began manufacturing business computers that could run CP/M or BASIC, some of which could share components and software. Others targeted the home market with less complex rival technologies.

However, the behemoth mainframe maker IBM had noted the market for affordable desktop

1981 Personal Computer

IBM launched the Personal Computer revolution using thirdparty components and a bought-in operating system. Its 8088 processor runs at less than 5MHz.

1983 Apple Lisa

Apple released the expensive Lisa in 1983, boasting a GUI. To fight off Apple, IBM introduced the XT computer with a 10Mb hard drive, 128K RAM and three expansion slots. Microsoft formally announced Windows as the GUI for PCs. A busy year, then.

1995 Windows 95

The number of companies making PCs had exploded and Intel's Pentium had reached speeds of 60Mhz. Microsoft released *Windows 95*, an attractive 32bit operating system intended as a stable platform for all software, including games.
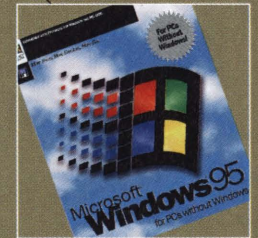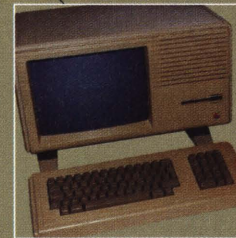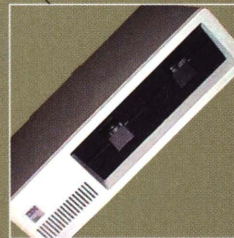
Plug-in-and-play power

The standard PC controllers are the keyboard and the mouse. Ergonomic keyboards and optical mice are increasingly commonplace. Innovations like force feedback mice exist, but have yet to make an impact.

Early games were often text-based and took full advantage of the keyboard as an input mechanism. Having such a large number of shortcut keys remains an advantage, and many strategy games would be much less sophisticated without them. The mouse seems custom-built for navigating 3D worlds. Both controllers dictate that PCs are rarely found on living room floors.

Additional peripherals in the form of joysticks – analogue, digital, force feedback – steering wheels and pedals, flight yolks and steering columns are an option for hardcore simulator fans.

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computers. On August 18 1981 it poked its nose into the crowded microcomputer scene with the IBM Personal Computer. Critically, IBM didn't bother to create its own processor, operating system and internal parts, and so didn't get patents on its system architecture, the way other manufacturers had done. Instead, it copied the MITS Altair model and bought in components from third parties. Intel's 8088 processor sat inside and Microsoft's newly minted DOS operating system sat on top.

Any program that would run on IBM's machine would run on any computer made using compatible components, regardless of manufacturer. In 1982 the first true 'clone' appeared from Columbia Data Systems. Dell and Compaq soon followed. Firms could make an IBM-style Personal Computer, incorporating their own choice of keyboard, mouse, monitor, sound

system or hard drive. Smart users kept their PCs up to date by installing newer pieces for it when required. The PC phenomenon had begun.

Coming of age

That IBM PC blueprint lives on 20 years later. It has adapted to accept more advanced constituents – like 3D cards or CD drives – with the result that the most ubiquitous games machine on Earth is, in fact, millions of different but familiar machines.

"The PC's upgradability is both the platform's greatest strength and its greatest weakness," argues **Mike Gamble**, European manager of Microsoft's Windows thirdparty gaming group. "The ability to add hardware on-the-fly has allowed innovation, although this has sometimes happened at the expense of the consumer's ease of use." There's no denying that, as gamers

go, from the start PC users had to be more patient, wealthy, and technically minded than their console-owning friends.

"No two PCs are the same and this, from a developer's point of view, together with the historically high cost, is the PC's defining aspect," agrees Kuju's technical director, **Julian Davis**. "When we're developing for the PC we pick a range of platforms to target. The high end of that range is a guess at where the hardware will be at the end of the project, but the wide variance in technology leaves little opportunity for refinement or massive efficiency."

Come together

In the early days the PC was a workhorse, but it soon became a hobby horse, and then a games machine, with conversions of Atari ST and Amiga games proving popular. Original software like
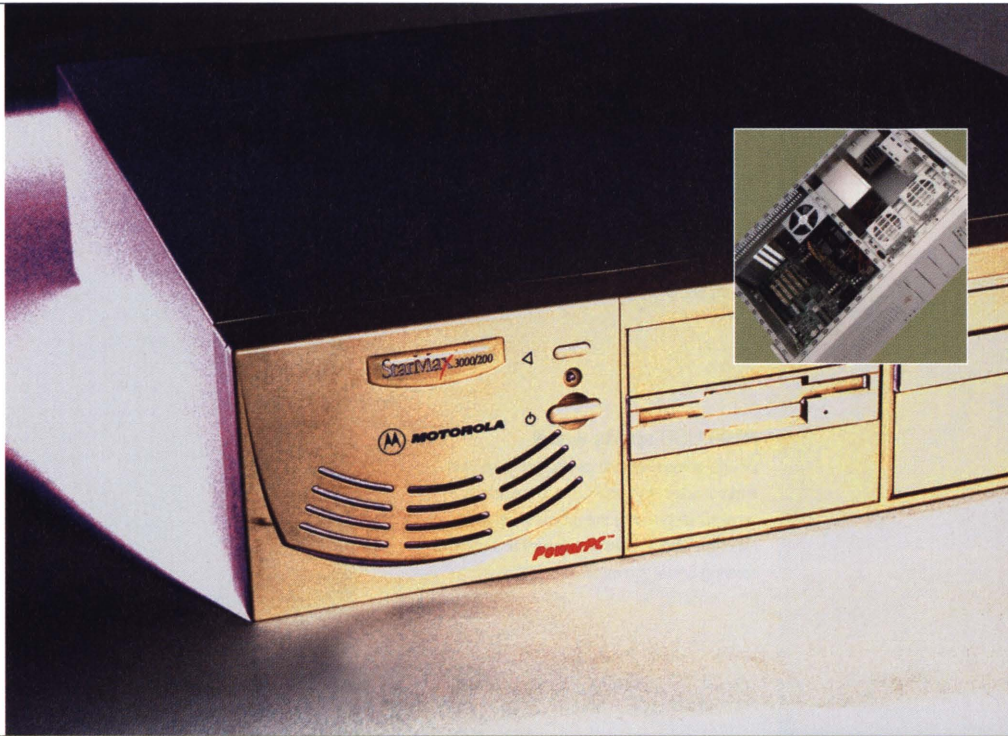
How it works

All PCs have a BIOS firmware chip that sits on the motherboard, starts it up, does a quick once-over, checks for input devices, and loads the Windows operating system (OS). The OS sits between the applications you run and the hardware, employing drivers to handle communication between components.

During each operating cycle the processor is fetching data from RAM to act on, with faster CPUs having a large cache to store regularly employed instructions, typically 512K, with perhaps another 32K 'Level 2' cache on the chip itself. Every time data is written to RAM it is also written to the cache in case it is needed in a hurry. To further accelerate floating-point mathematics, all modern chipsets have built-in maths co-processors.

Since 1995, video-cards are also on the system bus, installed on the PCI slots off the peripheral bus or plugged into a dedicated AGP slot on the motherboard. A 3D card offloads a varying degree of the visual processing duties from the CPU. A pass-through cable takes calculations from the motherboard into the 3D card, which then outputs to the monitor from its own port.

The CPU also streams music and sound from the CD or hard-drive. This is routinely sent to the sound card, which handles music and effect channels without much further CPU involvement.

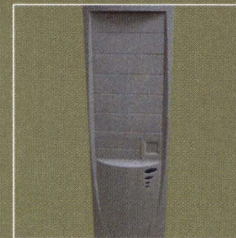Civilization and Sim City were big hits, and Dune II elevated the PC to its position as strategy king. In Dallas, id Software created the 3D titles Wolfenstein 3D and (in 1994) Doom.

The mouse and keyboard interface was well suited for tactical wargames and fluid action adventures. But for the PC to match the emerging consoles, two things had to happen: a better OS and faster 3D graphics.

In 1994 Microsoft announced a 32bit OS, Windows 95, and the graphics company 3Dfx was founded. Windows proved a better platform for running games, while 3Dfx enabled the basic PC to be upgraded with an additional chipset solely designed to manipulate 3D graphics.

"When 3Dfx announced the Voodoo Graphics chip at Comdex, the consoles on the market were predominantly the Sega Mega Drive and the SNES," recalls **Adam Foat**, product specialist at 3Dfx. "These consoles were at the cutting edge until the Voodoo Graphics chip – it was a breakthrough which put the PC at the top of the market. Before Voodoo, there were the S3 chipsets, but these could only achieve basic 3D graphics. We changed the way the world looked at computer games."

One of the key accompaniments to the 3Dfx chipset was Glide, a proprietary API for getting the most out of 3Dfx's accelerator cards. Microsoft realised that if Windows was to be a viable gaming platform, configuring and running games had to be much simpler, both for developers and for gamers.

"What is now known as DirectX was originally the brainchild of Alex St John who built the Game SDK for Windows 95," says Gamble. That SDK became DirectX, an API that freed developers from the burden of coding for proprietary chipsets from rival manufacturers.

"DirectX provides the ability to treat the PC as a single platform," says Davis. "Effectively, all games developers are now leveraging Microsoft's compatibility testing and software development skills. Direct3D also provides a direction for PC platform development. Hardware manufacturers must get their features adopted into DirectX, which reduces variation and focuses innovation."

Live forever

Microsoft looks ever stronger in the games market. Besides ramping up its games output, it's begun shaping the way entertainment technology moves. Windows CE sits inside Sega's Dreamcast, which also uses PowerVR technology – a rival of 3Dfx – for its 3D. And Microsoft's DirectX will drive the company's own X-Box

The PC

The flexibility of the PC has enabled the platform to expand off the desktop, replacing mini and mainframe computers file servers and the like, and finding a new role for computers as portable workstations.

Saitek Cyborg 3D Gold USB joystick
Only flight sims, a PC staple, really make
full use of joysticks. They are modelled
on pseudo-military aircraft controllers.

R100 USB sports wheel
Driving games are one genre that span PCs
and consoles, but on PC the emphasis is
on simulation – note the recent success of
Hasbro's *GP3* – making a decent analogue
steering wheel is a must.

+ Unrivalled graphics
and sound
+ PC diversity means
choice and innovation
+ Almost infinite expansion
possibilities
+ Backwards compatible
to the 1980s
+ Versatile and multipurpose
+ Unbeatable for strategy
and action games

∧
PC thinking

Is the PC a cutting-edge,
infinitely evolving game
platform, or a jumped-up
accounts machine that
costs too much and
crashes too often?
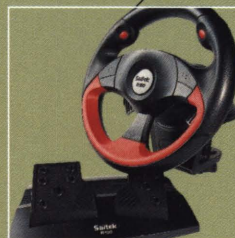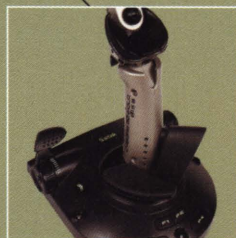
A mixed-legacy system

∨

- Expensive to buy and
to upgrade
- Lack of pick-up-
and-play games
- Could lose momentum
to X-Box
- Inconsistent, often
glitchy software
- Some technical knowledge
still required
- Can't sit on the
living room floor

Sidewinder Game Voice
The PC is uniquely placed to accept voice input,
and Microsoft's newest gadget is designed to let
you give the computer commands and speak
directly with other gamers over the Internet.

console in 2001. Yet as a games
machine, the PC is still often
perceived to occupy a niche.
As the Internet becomes available
through new consoles, does the
expensive PC still have a unique
place in the gaming scene?

"It's probably unfair to compare
the price of a PC with a console,"
argues Foat. "Instead, you should
compare a console with the price
of the graphics card, because that's
what enables the PC to play games.
When you compare the quality of the
3D graphics between a console and
a PC, the PC wins hands down. A
console's performance is fairly close
to a PC when it's released, but within
a couple of months, the best PC's
performance can literally be
twice that of the console."

Gamble agrees: "Despite what
some doom-mongers might think,
the *Windows* platform has a rosy
future as a games machine. It has
already seen off a variety of 'closed

box' game systems, and there
are areas – online gaming for
one – where *Windows* remains
the only viable platform."

Davis agrees, but he predicts
a change in the way the PC is
marketed to gamers – a reaction
to a long history of change and
uncertainty, spurred by the success
of next-generation consoles: "We
may start to see PCs packaged
in the same way as X-Box, for
instance, a small unit, no
extensibility, fixed spec
for a while and so forth.

"You can imagine Dell and
Gateway getting together and
defining a really tight spec for
a PC games/Internet system,
and then pushing that."

A trend towards consolidation,
then, seems to be on everyone's
radar, but as history shows, the
PC has thrived precisely because
nobody has been able to keep
it completely under control.

Neverwinter Nights
Massive hard-drive space and
Internet connectivity have made
the PC into a roleplaying staple.
AD&D-based games like
Neverwinter Nights grow ever
more complex and rewarding.

Halo
Halo offers combat in glorious
Technicolor – Microsoft liked the
look of it so much, it bought the
company. Now slated as an
X-Box launch game, too.

Black & White
Make people believe in you, and
create a world that depends on
your personality. Peter Molyneux's
Black & White will appear on
128bit consoles, too.

Soft focus
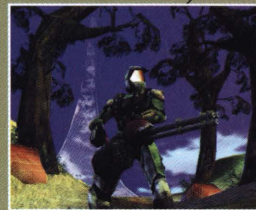
Wolfenstein
Id's first 3D adventure gets
a millennial overhaul as *Return
To Castle Wolfenstein*, and
looks stunning. The state
of the art when it comes
to firstperson shooters.

Train Simulator
The PC has always been home
of the simulator, and next year
Microsoft and Kuju extend this
paradigm to virtual train sets.
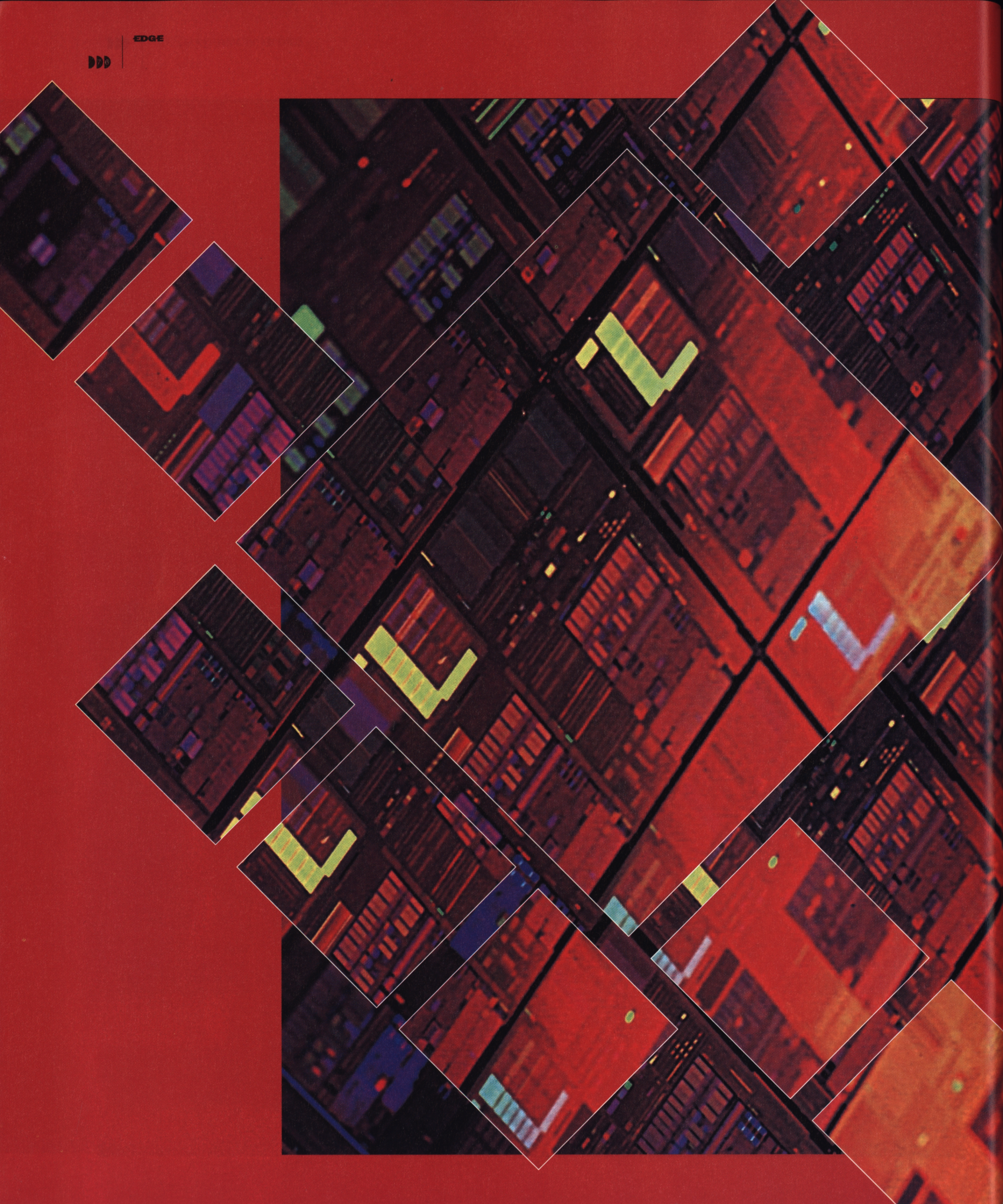
Inside Intel

While they form the most important part of any game box, microprocessors remain a blind spot for many users. **Edge** pulls back the curtain by visiting chipshops and talking to the men behind gaming's building blocks

At the heart of every game machine lies one or more microprocessors. These fingernail-sized jigsaws of silicon are the smallest and most complex human constructions in existence, and the last 50 years of human advancement has been achieved largely thanks to their invention.

Manufacturing such a chip is a lengthy and complex process. Cleanliness is paramount at a chip fabrication plant, since even the smallest particle of dust can ruin a chip. Manufacturing plants are vast (typically as large as several football fields) and filtration equipment occupies much of the space.

The air in a clean room continuously flows downward and out through holes in the floor and is completely recirculated ten times each minute. The pressure in the room is maintained at a slightly greater level than outside, which prevents dirty air from entering. The chip giant Intel's microprocessors are manufactured in Class1 clean rooms, where not more than one particle of 0.2 microns in diameter is permitted per cubic foot of air. That's the relative equivalent of one garden pea in a three-cubic-mile area.

Humans pose the biggest threat to chips. They scatter hair, skin flakes, sweat, perfume, make-up, and clothing lint everywhere they go, hence the infamous 'bunny suits' made famous in the Intel ads – the manufacturing clothing which isolates technicians from the products they make. Everyone working in the clean room wears a white suit

Moore's law

Gordon Moore still works as chairman emeritus of the Board for Intel

Gordon Moore, one of the founders of Intel, was writing a speech in 1965 when he noticed a trend in memory chip performance. Each new chip had around twice the capacity of its predecessor and was released within 18-24 months of the previous chip.

Due to continuing advances in chip manufacturing, Moore's observation has held for 35 years. Known as Moore's Law, it is used by chip designers to forecast future performance.

Intel's original microprocessor, the 4004, was released in 1971 and consisted of 2,300 transistors. In comparison, the 866MHz Pentium III Xeon released this year has around 28million transistors, an increase of around 12,000 times over 29 years. Incidentally, addenda have been proposed to Moore's Law. One, Rock's Law, says that they cost of equipment to build semiconductors will double every four years.

So, even if they can keep packing on the transistors, costs will eventually prove prohibitive.

comprised of boots, hoods, masks, gloves, and breathing apparatus which filters particles from the breath.

The $6billion plan

It is no help that people are such a liability – the fab plants require a lot of manpower, as **Maria Power**, an engineer at Intel's Dublin-based plant, explains: "We have 4,400 employees who work permanently at the factory. This is average for Intel."

The cost to set up and run a factory is considerable – "$2billion in total, the equipment costing $1.4billion," says Power. "The building itself should be viable for about 20 years, but equipment is off the leading edge in one to two years, with a total useable life of five years."

With equipment depreciating almost as soon as it's installed, it's no wonder that Intel plans to invest $6billion in its plants this year alone. With running costs also soaring into the millions, chip manufacturers have to ensure production exactly matches demand, or else suffer huge losses.

Another expense is the research and design of new chips. "Each design takes several years," explains **Jens Drews** from Intel's great rival AMD. "Even as you bring one new chip generation to market, you already have teams working on the generation after."

Much of this research focuses on making the chips smaller and smaller. Tighter circuits increase performance for the decidedly low-tech reason that electrical signals have shorter distances to travel. The result is a saving in the CPU processing time, and thus increased performance.

Miniaturisation enables chip designers to pack more transistors into a single chip, increasing performance and allowing for features such as embedded data caches that speed up memory access. Smaller chips also produce less heat and consume less power, which means processors can be made for mobile devices. Finally, more chips can be produced from each batch of silicon wafer, which makes smaller chips cheaper to manufacture.

Environmental concerns

Technological advances on this scale do not come cheap. Indeed, the microprocessor industry is perhaps the most capital-intensive business on Earth. When Intel was founded, individual pieces of manufacturing equipment cost around $12,000. By 1992, the cost had exceeded $1million. Some specialist tools now comfortably sit with the $3million range. To make matters worse, within three years, three quarters of the equipment is obsolete.

These economic constraints are more likely to slow the pace of microprocessor advance than the technology itself. Although the boom-bust cycles of the '80s have not been repeated in quite the same way, financial risks remain huge. The cost of design is doubling with every new generation of microprocessor, and revenue growth has barely kept up with the cost of capital investment across the industry – currently standing at an annual $50bn.

The toxic chemicals and ultra-pure water needed for chip manufacture also pose a potential environmental threat, although the chip manufacturers claim to address this. "Design for the environment is an integral part of the semiconductor process," says Power.

"Humans pose the biggest threat to chips. They scatter hair, skin flakes, and sweat… hence the infamous 'bunny suits'"

"We have constantly been able to demonstrate that at each new technology generation we use more environmentally friendly chemicals per unit of production."

At it like bunnies

Despite the financial headaches, Power says working in a chip plant is an interesting job: "It is stressful at times, but also rewarding for the same reason.

"As a first job it is amazing to learn, see, and experience so much – I'm not sure other companies could offer the same opportunities."

Apparently the pay isn't bad either. "It ramps up quickly after you start here as a recent college graduate," says Power. "After a few years it tails off, but the benefits of stock option programs kick in and become very valuable at that stage."

Any young **Edge** readers interested in working at a plant should begin studying. "The qualification level determines the type of job available," she says. "There are a wide range of courses that fall into this bracket, from engineering, to electronics, to chemistry, to physics". Over at AMD, Drews says the company looks for people that have "a sound technical or engineering education and who are motivated, communicative, focused."

But what potential employees really want to know is: will they get to dance in the bunny suits?

Quantum leap

Engineering chips at the atomic frontier

Microprocessor design is already focused on the world of the very small, and this trend will have to continue to build faster processors. Eventually, logic gates will be so small as to use just a few atoms. At this level, it is quantum mechanics that determine how atoms react – a very different science to the 'classical' rules of conventional logic gates. If computers are to become yet smaller, a transition to quantum technology is inevitable.

According to quantum physics, a subatomic particle exhibits a statistical probability that it exists in a particular place and time. There's no way of knowing whether it's there or not until you observe it, at which point all the probabilities collapse down into a definite state.

If you make a register (essentially a single computer memory cell) from atoms in an undetermined state, it represents not just a single number, but all possible numbers in a given range. When an operation is performed on this quantum register, the operation is thus performed on all of the numbers at once.

Despite sounding highly weird, these operations are also highly efficient. They will eventually enable computers to solve problems previously considered too large, such as cracking massively encrypted code, indexing very large databases and, just maybe, getting certain PC games to run at reasonable frame rates.

Turning sand into CPUs

There are more than 200 steps in making a processor, and the entire process takes several months

Chips are created from silicon, which is a natural semiconductor. This means it will either insulate or conduct electricity depending on how it is treated. This enables the construction of transistors – essentially tiny electrical switches.

The silicon is first chemically processed into nearly 100 per cent pure cylinders and then sliced into thin, polished wafers. Hundreds of chips are produced simultaneously on each wafer.

A layer of silicon dioxide is grown on the wafer, and then coated with a substance called photoresist, which becomes soluble when exposed to ultraviolet light. In a process called photolithography, ultraviolet light is passed through a specially patterned mask on to the silicon wafer. The mask protects specific parts of the wafer from the light, turning the exposed areas into a gooey substance.

A solvent dissolves this exposed layer of photoresist, and the silicon dioxide revealed is then etched away with chemicals. The remaining photoresist is then removed. This process leaves ridges of silicon dioxide on the silicon wafer base. Exposed areas of the silicon wafer are 'doped' – bombarded with chemical impurities that alter the way electricity is conducted by the silicon – and the layering and masking is repeated. Windows are created, and filling them with atoms of metal creates connections between the layers. Another masking and etching stage leaves the strips of metal that make the electrical connections.

Around 20 layers make up each chip, with the exact number dependent on the design. To protect the completed chip from damage, it is inserted into a protective package featuring pins enabling it to connect to other devices. Each packaged microprocessor is then tested before being ready for use.
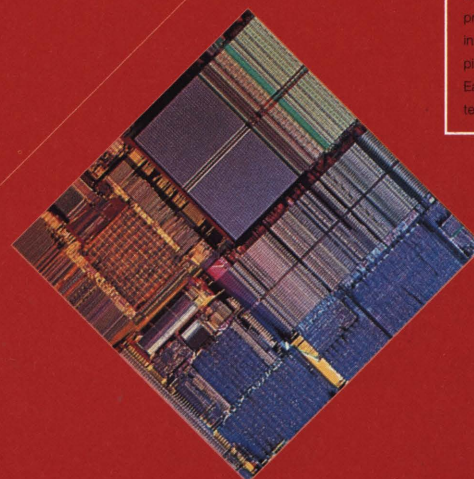
Upload: Bits in pieces

or any but students of electronic engineering, the only way to judge a gaming system is by the entertainment it produces. Not even by the games. To give an obvious example, *Zelda* on Game Boy Color is graphically lamentable compared to *Zelda* on the N64, but that's an easy sacrifice for portability.

To a certain breed of Maplin's catalogue fetishist, that's a disagreeable conclusion. The fact that a supposedly superior machine might fail because its licensing terms meant publishers didn't support it, or because its marketing meant gamers wouldn't buy it, that's an

anathema. These devotees believe in provable technical superiority, and their battles continue even after the machines – and the games – have been consigned to nostalgia by the mainstream.

These were the people who argued over the Atari and the Amiga by singing the praises of the former's fractionally faster CPU or the latter's graphics coprocessor – not over the games (or what they might spend their change on if they bought a ST). A similar faction eschewed PlayStation and waited for the N64 not for Miyamoto's sublime offerings but because 64bit was, in their eyes,

exactly twice as good as 32bit.

The trouble with such acolytes of silicon is that they fail to grasp the technology they seek to evaluate. And if their arguments were futile back in the 16bit days, in the era of PlayStation2 they're ludicrous.

Many of the world's most skilful programmers only began to venture conclusions about Sony's console after six months of experimentation. Isn't it ludicrous then that someone whose entire experience of programming a computer amounts to selecting a new *Tekken* fighter via a Dual Shock pad will simply notice

that Intel's CPU is faster, at 733MHz compared to PS2's 300MHz, and pronounce the former 'the winner'?

The entire philosophies of the systems are different. The PlayStation2's architecture is a radical one built to enable the swift transfer of data about the machine and its rapid manipulation, but offering little in the way of local storage. It follows a model that academics have mooted as ideal for multimedia processing, since most of the work to be done involves a few instructions enacted millions of times on lots of data.

Furthermore, PlayStation2's CPU is

truly 128bit, meaning it can store and act on data that is 128bits wide. In contrast, Intel has yet to even release its 64bit Itanium processor. The Intel chip in X-Box will be 32bit – although certain critical operations are performed on 128bit data. In the mathematics of our *Tekken* technician, the 128bit PS2 is actually 'four times as powerful' as the 32bit Intel CPU, even if it's 'half as fast'. So shall we split the difference and say Emotion Engine is twice as powerful? **Edge** hesitates to even make such a suggestion in jest.

Videogame hardware is a particularly challenging subset of computer science, where the smallest architectural

differences can profoundly alter the results: better or worse games. How well programmers exploit the hardware, considering its esoteric design (PlayStation2), ill-considered implementation (Saturn), or inconsistently supportive format holder (Nintendo 64) further prejudices the outcome.

To be fair, with partisan industry evangelists who should (and do) know better singing the praises of their products in the most flattering and misleading ways imaginable, its easy to forget that all platforms have strengths and weaknesses. While it's natural to be excited on the cusp of the new generation, wise gamers make their judgements when they are so besotted with the games on their machine that they have forgotten the technical arguments altogether.

illustration: **Richard May**

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Console: Nintendo Entertainment System
Computer: ZX Spectrum
Handheld: Game & Watch
Genre: Platform
Chip: 68000
Graphics: Sprites
Sound: Waveform
Memory: 64K RAM
Media: Cartridge
Game: *Elite*
Character: Mario
Man: Sir Clive Sinclair
Country: UK
Magazine: *Zzap!*

>

SQUARE EYES

Photography: **Martin Thompson**
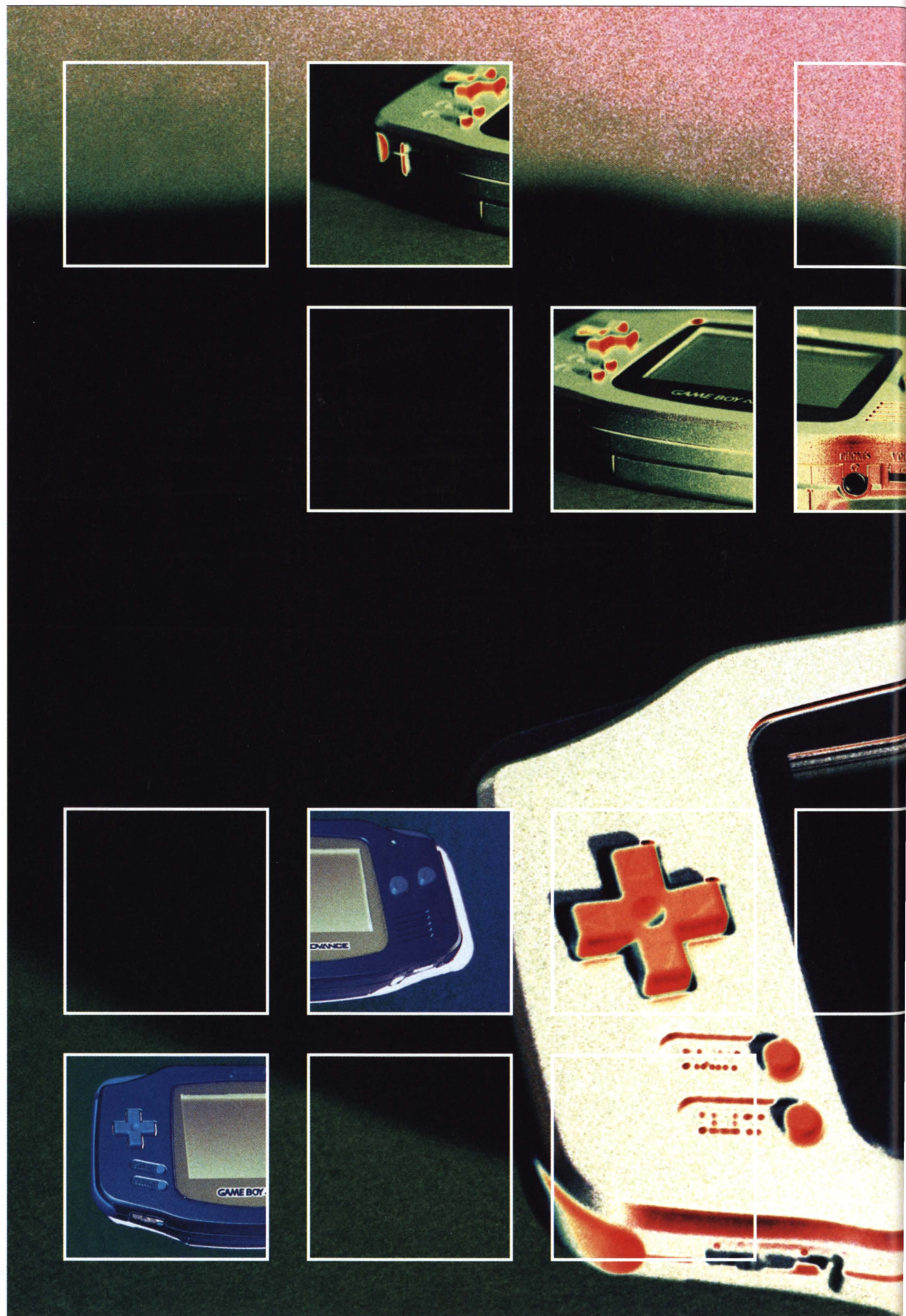
Specifications

CPU: ARM 32bit with embedded memory

Main RAM: 32Kb WRAM (CPU), 256Kb WRAM
(external of CPU)

Graphics RAM: 96Kb VRAM

Theoretical performance: 511 colours
simultaneously in character mode; 32,768
in bitmap mode

Estimated real performance: Performance
roughly comparable to the SNES

Graphics functions: Transparency, scaling,
and rotating effects

Audio performance: Stereo and Dolby Surround
supported through headphone terminal

Storage and media: Cartridge format, maximum
256Mbits, compatible with Game Boy and Game
Boy Color Game Paks

Input/Output: Headphone terminal, Game Link port

Networking: Nintendo plans to produce a cable
capable of linking the Game Boy Advance to the
GameCube as an external controller, and has also
announced the Communication Cable, enabling up
to four players to link up. A mobile phone adaptor
will provide wireless networking capabilities

Notes: The 32bit processor seems fairly versatile,
supporting both character and bitmap modes, and
giving developers leeway when it comes to working
on soundtracks. Also notable is the increase in
screen size, though once again it won't be backlit
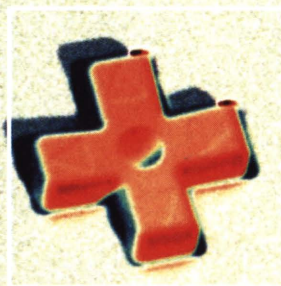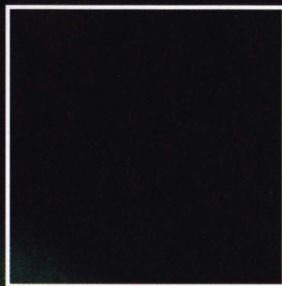
Manufacturer: Nintendo
Partners: ARM
Launch date: March 2001 (Japan),
July 2001 (US and Europe)
Launch price: ¥9,800 (£63)
Country: Japan

Focus: GB Advance

Will the technical superiority of Nintendo's new handheld safeguard the company's monopoly in the face of competition from mobile phone manufacturers? **Edge** wonders whether Game Boy can stay on top

GAME BOY ADVANCE

On Thursday August 24 at SpaceWorld 2000, Tokyo's Makuhari Messe Convention centre saw Nintendo's executive vice president, Atsushi Asura, unveil the company's next generation handheld: Game Boy Advance.

While it met with widespread approval from the videogame cognoscenti, mainstream consumers didn't bat an eyelid. With the demand for Game Boy Color necessitating a monthly production rate of 1.5million units, Nintendo has wisely chosen to delay the Japanese launch of the device until March next year. With the unit's predecessor thriving despite its obvious technical deficiencies, will the market sustain the release of a more expensive, more sophisticated, Game Boy?

Although Nintendo has been dominant in the handheld market for some time now, there are a number of players, including

How it works

With its highly integrated architecture that combines the new, 16MHz 32bit ARM CPU, the 8bit Game Boy CPU, the LCD control circuitry, embedded RAM and embedded ROM into a single chip, Nintendo has packed a wealth of high-performance technology into a small cost- and power-efficient product. To explain how it works in practice, **Edge** turned to **Greg Modern**, freelance programmer at Crawfish: "When the program first starts, you do all your initialisation. You copy all the graphics you want on to the VRAM, you download all the characters and you also download a layout so you can actually build up the screen.

"Then you go into your main loop. You read the joypad or the buttons, and whether the player has moved left, right, up, down or pressed one of the other buttons. Then you make changes to the screen.

"If you want to scroll one pixel, you set a value in a hardware register that will actually shift the screen across. If you move more than a pixel – say a character [eight pixels by eight pixels] – then you actually change the layout in the VRAM itself.

"Consider a fireplace animation. You'd have the characters for all the frames of animation in VRAM at the same time, and then you just change the layout area frame by frame. The hardware itself reads directly from the VRAM and uses it to display on the screen."

Advanced controls

While the performance of the Game Boy Advance bears superficial comparison to that of the SNES, there is one significant difference. The addition of two shoulder buttons to the handheld unit gives developers more leeway in terms of controller input, but this handheld is still two buttons short of the 16bit console.

Still, the Game Boy has survived for 12 years despite such drawbacks. Of more consequence is the possibility of using the unit as an input device for the GameCube. Details are sketchy, but it seems it will function in a manner similar to the Dreamcast's VMU but with a larger, colour screen. And it would be foolish to rule out the possibility of Miyamoto-san devising more innovative functionality.
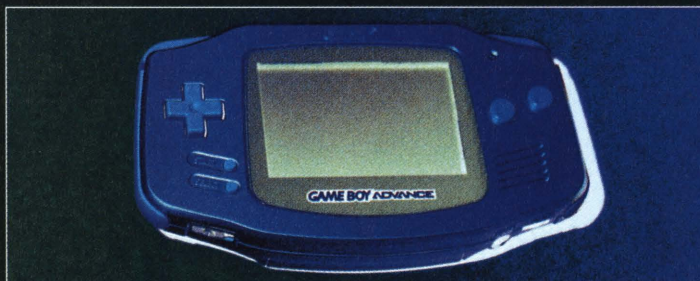
wireless handset manufacturers such as Motorola and Nokia, who could make the company's life more difficult in years to come.

Long life battery

Part of the success of the original Game Boy (and its cousin the Game Boy Color) is down to the fine line that Nintendo has walked between cost, efficiency, and technical capability. During the decade or so that Nintendo has been king of the handheld castle, it has seen off competition from the likes of Atari's Lynx, Sega's Game Gear, and, more recently, Bandai's WonderSwan.

The Game Boy's hegemony has rested on the twin pillars of intellectual property and true portability. Though featuring a bright, attractive screen, the Lynx, for example, was large and cumbersome, and like the Game Gear it required a massive investment in batteries on the part of

users. The apparent limitations of Nintendo's device, such as its poorly lit screen, were actually essential to ensuring a long battery life and lower cost to the consumer.

Equally significant were the killer applications that captured the hearts and minds of a very broad demographic. The unit was launched with *Tetris*, which wasn't so much a game as a phenomenon. Even now developers speak in hushed tones about the elusive '*Tetris* audience'. Some ten years later, when the machine could arguably be said to have been on its last legs, it was invigorated by the arrival of *Pokémon*. In between there were successive titles from developers who could take low development costs for granted.

In attempting to emulate the success of its distinguished forebears, the GBA doesn't yet appear to have a phenomenon title up its sleeve to guarantee high sales

figures. That is just the first hurdle.

The delayed launch of the device attests to the huge installed base of Game Boy and Game Boy Color owners. How will these consumers be persuaded to switch over to a more expensive piece of hardware when they are ostensibly happy with the current specifications of the platform? And with development costs set to rise to the region of £200,000 and above, will Nintendo find developers willing to come up with the sort of intellectual property that can convince those consumers to make the leap?

Such concerns acquire even greater importance against a backdrop of wireless handset manufacturers keen to muscle in on Nintendo's handheld monopoly. With the penetration of mobile phones increasing rapidly with extensive financial backing muscle, these rivals won't roll over as easily as Atari and Sega.

Input and output

The input/output capabilities of the Game Boy Advance are limited to just a headphone terminal and a single game link port.

The former is, of course, a mandatory requirement for those long car and train journeys, while the latter offers the potential for several peripherals to be added to extend the handheld's repertoire. Two grooves on the top of the unit have been designed to secure such add-ons.

The communication cable, announced at SpaceWorld, will enable up to four players to compete together, and will be complemented by another adaptor that facilitates such link-up play via an infrared connection.

The *Mario Kart Advance* demo that was running at ECTS would suggest that one or other of these will be an essential purchase.

While the Game Boy Advance is no PlayStation2, it will acquire rudimentary multimedia functionality with a mooted colour printer and camera. But the peripheral that offers the greatest potential is the mobile phone adaptor. Miyamoto-san has already hinted at some of the ways in which such connectivity has the potential to heighten gameplay. The videogame-specific design of the Game Boy Advance should ensure a strong showing against competition from other handset manufacturers.

1989 Game Boy
Somewhat larger than a standard pocket and featuring a rather modest looking black and white screen, its success against Atari's Lynx and Sega's Game Gear was due in large part to *Tetris*.

1996 Game Boy Pocket
A smaller, lightweight version of the original Game Boy.

1998 Game Boy Pocket Light
Only released in Japan, this required two extra batteries to power a rudimentary lighting system. This trade off, however, did not meet with widespread enthusiasm.

1998 Game Boy Color
The last major update to the original Game Boy formula was not as radical as Game Boy Advance, but it did add a colour palette and an improvement in speed.

Of course, the Game Boy Advance does have a few things going for it. Nintendo of America's vice president of engineering, **Jim Merrick**, is bullish.

"The hardware design of Game Boy Advance doesn't really address a particular demographic so much as it defines the leading edge of the handheld market," says Merrick. "The larger, brighter, higher-resolution screen is easy to appreciate, as is the addition of more buttons. Nintendo has also taken great pains to make sure that Game Boy Advance is able to withstand the bumps and bruises that come with being a handheld."

Indeed, ergonomic design and technical specifications will form the basis of the unit's success. Whereas the original Game Boy was analogous to the NES, its successor is more comparable to a high-powered SNES, capable of transparency effects, scaling, and rotating effects via software emulation of Mode 7. It is also equipped with enhanced audio capacity, and will allow rudimentary 3D. British Game Boy specialist Crawfish has already developed an engine that is capable of *Doom*-style presentation.

Backwards, forwards
Merrick points to backward compatibility as a crucial feature. "Since Game Boy Advance can play all of the more than 1,000 existing Game Boy games, we will carry that momentum with us," he predicts.

"But the new features of Game Boy Advance will allow handheld games to take the most significant leap forward yet," Merrick adds. "Nintendo will bring many of our best-loved games and characters in new versions that will highlight the Game Boy Advance and make it as essential to gamers as its predecessors have become."

Nintendo's stable of well-established brands will certainly be fundamental in seeing off the challenge from mobile phone vendors. While firms like Motorola may have a shortcut to the consumer in the shape of communication technology, the Game Boy Advance is the only place gamers are likely to find the likes of Mario and Pikachu.

Says Merrick: "The key is, as it has always been, great software. Nintendo and our licensees have a ton of software in development for Game Boy Advance that will knock your socks off."

Similarities with the architecture of the SNES would certainly seem to afford Nintendo the luxury of a ready pool of coding talent. By the time the N64 replaced the SNES, developers like Rare were at the height of their 16bit dexterity. Projects that were shelved several years ago can now be resurrected with relative ease,

Mobile phone adaptor

Pictured here with the Game Boy Color, this phone adaptor will be compatible with the GBA. Miyamoto-san says connectivity could redefine game design.

GameCube

The ability to link the GBA to the GameCube promises to invigorate game design. **Edge** hopes it fares better than the Dreamcast VMU.

Communication cable

Multiplayer *Mario Kart Advance* at ECTS was the first of many titles to illustrate the immense potential of fourplayer link-up.

Battery pack

A rechargeable battery and charger provides ten hours play after a two-hour charge. Essential for the hardcore handheld gamer.

+ A clear technical step forward
+ Game Boy is a hugely successful brand
+ Key games like *Mario Kart* and *Castlevania*
+ Multiplayer connectivity
+ Compatibility with wireless devices

∧

An advanced machine

The Game Boy saw off all comers, but it didn't face the giants that GBA will have to repulse...
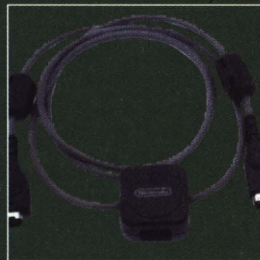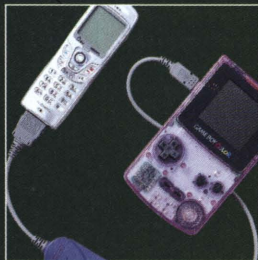
But still a boy

∨

- The already huge Game Boy installed base may restrict sales
- Hard to shift some Game Boy franchises to new technology
- Competition from Wonderswan Colour, GP32, and 3G mobiles
- No backlit screen
- Relatively expensive

guaranteeing a quick and plentiful supply of quality titles.

That might allow developers time to get to grips with the design implications of the platform's advanced networking functionality. "We have significantly improved the communications capability of Game Boy Advance to allow us to create new gaming experiences," explains Merrick. "Not only can we communicate better and faster when playing head to head with another Game Boy, we can also connect up to four GBAs together for simultaneous, head to head play."

But perhaps the most intriguing connection is to the Nintendo GameCube. GBA can transfer data to and from GameCube much like the Transfer Pak for N64. It can also be used as a high-resolution 'private' viewscreen for a GameCube game, or even as the controller. "Imagine using the GBA's screen as the map overlay in *Perfect Dark*, or for private

play calling in a sports game, or even to hide your character's health, power-ups, or other information from other players' eyes," Merrick enthuses.

Handy man

If GBA is to match the achievement of its predecessors, intellectual property and technical efficiency will once again be of paramount importance. With the already vigorous handheld market being further enriched by the entrance of wireless players, connectivity could prove as significant.

But the crucial advantage that the platform has over the likes of Bandai and Motorola is that Nintendo is still seen, among technologically unaware parents, as the best present to give to their kids to shut them up. Support for Nintendo, from whatever quarter, can only be good news for the more discerning gamer.

Mario Kart

Owing more to the 16bit incarnation than to the inferior N64 outing of the franchise, *Mario Kart* lured the crowds at ECTS despite being only 30 per cent complete.

WaiWai

Bearing more than a superficial resemblance to *Mario Kart* but without the presence of plumber himself, it remains to be seen whether *Wai Wai* can sell on gameplay alone

Castlevania

The *Castlevania* series has distinguished itself on previous incarnations of the Game Boy. This latest instalment could even rival the 32bit version.

Napoleon

Realtime strategy arrives on the handheld market. If a diminutive Italian plumber can charm gamers, why not Napoleon – a diminutive French autocrat?

KuruKuru

Although unlikely to have as significant an impact as *Tetris*, *Kuru Kuru* nevertheless proves a compelling prospect

Soft focus
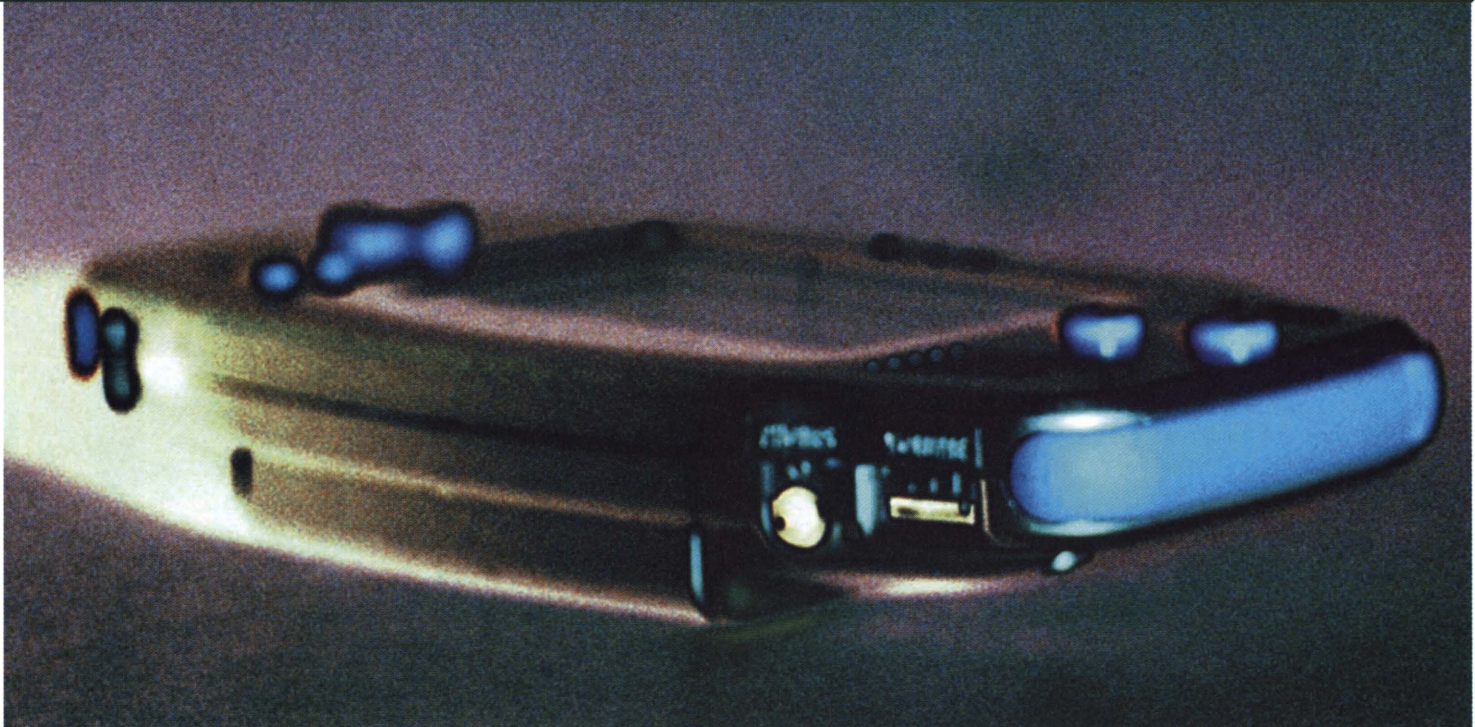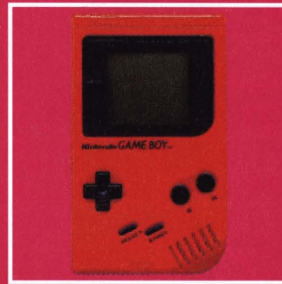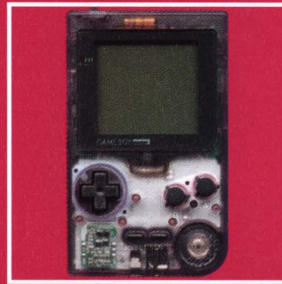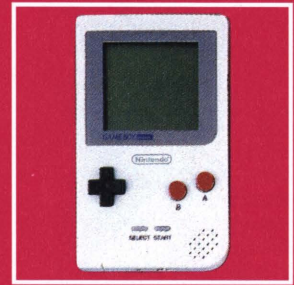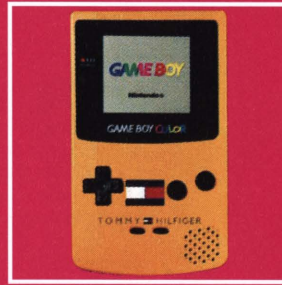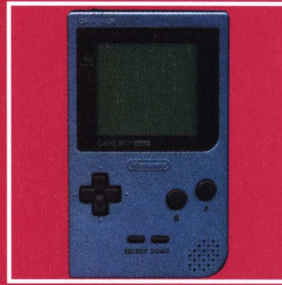
Ages of Game Boy

A celebration of the little machine that grew up to win over the world
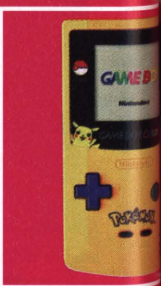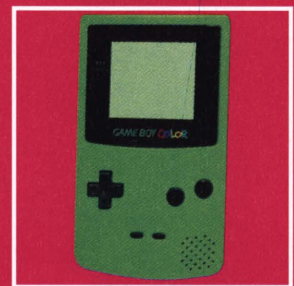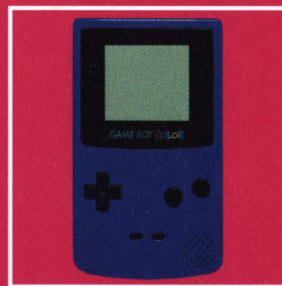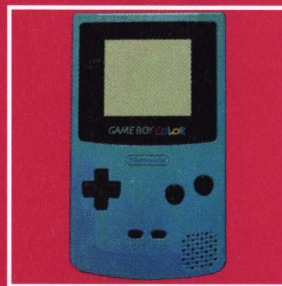
B oth small and massive all at once, the Game Boy has defied the march of time, soaring to become the all-time world champion of videogaming.

PlayStation? Forget about it. Nintendo's pocket battleship has conquered more than 100 million bags, jackets and combat pockets since setting sail in 1989, including eight million in the UK. Twenty-plus flavours of the platform have hit the shelves over the last decade, not to mention the ingenious and hilarious camera and printer.

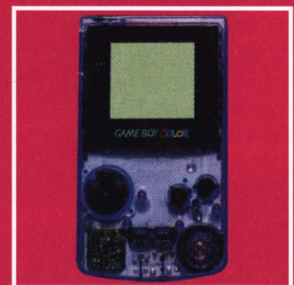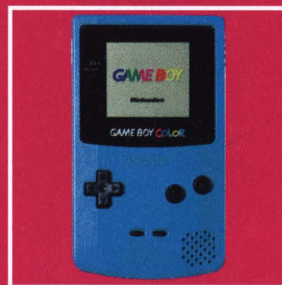Game Boy's range of 1,000 games has shifted 400 million cartridges worldwide, generating billions of pounds for the Big N and its cohorts.

Stacked in a hypothetical pile, the 8mm-thick carts would tower some 3,200km into space. And while there are incalculable kilometres of utter dross in the pile, countless more consist of true classics – not least the game which must rate as the number one killer app in the history of videogaming: *Tetris*.

Pajitnov's devastatingly addictive puzzle game was what gave Game Boy an appeal far beyond Nintendo's traditional demographic. Not that the younger players have been ignored; in a word, *Pokémon*.

But all good things must come to an end. On August 24 this year Nintendo announced the Game Boy Advance, a 32bit widescreen iteration of its handheld. While Game Boys Classic, Pocket, Light, and Color aren't quite ready for the attic just yet, **Edge** has gathered together some of the clan for a family reunion.

From the ultra-rare Japanese Pikachu-edition Pocket Light to the contemporary hues of the colourful Colors, the lineage includes over two dozen relations – not to mention the occasional, estranged Super Game Boy uncle. All in all it is, without doubt, a hardcore gamer's delight.

Focus: GScube

Despite bearing chilly nickname 'The Fridge', Sony's bulky realtime rendering box is already raising temperatures over in Hollywood
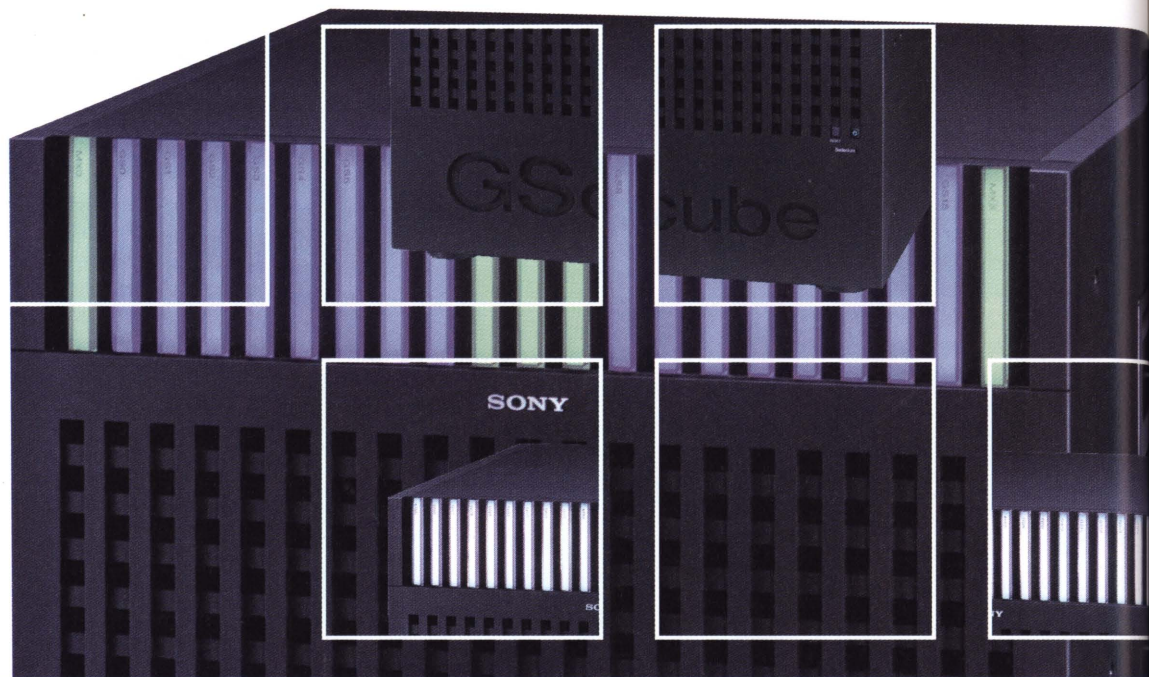
Specifications

CPU: 16x Emotion Engine (each 128bit, 294.912MHz)

Graphics processor: 16 x enhanced Graphics Synthesiser (147.456MHz)

Main RAM: 2Gb

Memory bandwidth: 50.3Gb/s

Graphics RAM: 512Mb

Theoretical performance: 1.04Gpolygons/s

Estimated real performance: 65Mpolygons/s

Sound RAM: up to 128Mb; up to four of the chip pairs can be reconfigured from handling graphics to handling audio

Audio performance: up to 16 channels, 16bit, four channels per configured soundboard

Storage and media types: None

Input/Output: parallel bus, 1024bit for data transfer, 32bit for control

Networking: GScube is controlled externally by a host computer and fed data by a server

Notes: Massively parallel design exploits the true power of Sony's proprietary chipsets

How it works

Like PlayStation2, the GScube's highly flexible architecture is designed to enable content creators to use its processing power in whatever way they see fit.

The different chip pairs can be used to tile-render, by breaking the whole screen down into 16 different parts, each of which are drawn by a separate Emotion Engine and Graphics Synthesiser pair. But pipeline rendering is also a possibility. The key to the unit's overall performance is strict load balancing to ensure each chipset is used as efficiently as possible.

This is one of the reasons why, despite the fact that in theory the GScube prototype is more than 16 times more powerful than a standard PlayStation2, in practice the performance boost is limited to a factor of ten.

The production version of GScube is rumoured to feature up to 64 chips running in parallel, with Sony predicting a staggering hundred-fold power improvement with this configuration.

No one could say Sony lacks ambition. After stamping its identity across the electronic entertainment industry with PlayStation, the aim of the console's successor is nothing short of complete domination of the ways and means of all digital entertainment.

For, contrary to popular belief, PlayStation's successor is not PlayStation2. Rather it is the combination of the Toshiba-engineered Emotion Engine processor and its Graphics Synthesiser companion that are at the heart of Sony's future.

This was first hinted at when Sony Computer Entertainment was re-absorbed back into Sony Electronics proper. At the time **Nobuyuki Idei**, Sony's president, told *Business Week*: "This is the first time that system largescale integrated circuits have become a concept driver. So we need close collaboration between the parent company and SCE as an application creator."

The man responsible for the chipsets, CEO of Sony Computer Entertainment America **Ken Kutaragi**, was simultaneously recalled to Japan, and promoted

Reality engine

It's somewhat ironic that Sony has chosen SGI as its strategic partner to provide the broadband server to feed the GScube. For it was as back in the mid-'80s that the then-named Silicon Graphics first brought realtime parallel processing power to the CGI industry. And as proof of how fast the industry is changing, only two years ago, the movie 'Antz' was created using 270 SGI ORIGIN 2000 boxes (3400 pictured below). Now Sony is close to doing it all in realtime on a GScube.

Emotion Engine chipset

At first sight, the games console market and the high-end workstation market have little in common, so it's an indication of the converging power of modern processor designs and Sony's lateral thinking that the Emotion Engine processor (below) and Graphics Synthesiser have been primed to fill both niches.

Insect rendering

Shown at SIGGRAPH using *RenderWare 3* as a viewer, the prototype GScube can render PDI's 'Antz' in realtime. Scenes contain more than a million triangles.

Realtime fantasy

Shown at SIGGRAPH, Square's *Final Fantasy* movie is exactly the kind of CGI intensive product that Sony has designed the GScube to deal with.

+ Highly flexible architecture
+ Superfast rendering performance
+ Expect pricing to be highly competitive
+ Broadband is the future
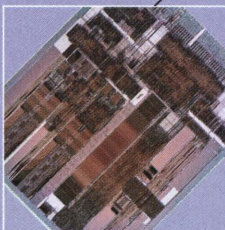+ Has the full weight of Sony behind it

∧

Sony boxes clever

Cuba Lingua: input and output

While the GScube is an enormously powerful machine, it has to be controlled by an external host computer and fed data by a server.

At SIGGRAPH, Sony announced a strategic partnership with SGI, which will provide the broadband server technology to be used in conjunction with GScube. SGI demonstrated its new high-performance modular ORIGIN 3000 series server, which has been designed to throw graphical data to be rendered in realtime by the GScube.

GScube is a phenomenally powerful piece of hardware – perhaps too complex to actually use?

Stuck in a corner?

∨

- Difficult to exploit to full potential
- Only as strong as the middleware support
- Relies on server and control host
- Presupposes desire for change in movie industry
- Still a work-in-progress technology

to president and CEO of the company's worldwide operations.

"As Sony Computer Entertainment fused the technology of computers and the world of entertainment to create and evolve a new market called Computer Entertainment, we are now pioneering the creation of realtime digital entertainment through an extension of the technology of PlayStation2," Kutaragi told the world. Both PlayStation2 and GScube are complementary parts of that plan.

While PS2 targets the home videogame market, the GScube is an attempt to capture the digital entertainment field, both in terms of content creation and distribution. Labelled a 'graphics visualiser' by Sony, the GScube's grunt is provided by a parallel combination of teams of Emotion Engine and Graphics Synthesiser chips. First demonstrated at the

SIGGRAPH 2000 show, Sony displayed what it referred to as a prototype box, which consisted of 16 Emotion Engine and enhanced Graphics Synthesiser chips.

An obvious addition to the latter is increased amount of RAM. The much-criticised 4Mb of video RAM of PlayStation2 has been ramped up to 32Mb. And while the prototype consists of four modules with four pairs of chips in each, future iterations will be scaleable, with the top-level model rumoured to be a 64-chip monster. GScube needs this much processing power because Sony has set out to try and completely change the way the film industry operates. Simply put, the GScube is designed to render the high-resolution CGI of movies like 'A Bug's Life' and 'Antz' in realtime.

At present such computationally intensive content must be created scene by scene,

with each frame taking up to seven hours to render. At SIGGRAPH, however, the GScube prototype showed its ability to render scenes from 'Antz' in realtime, at almost render farm quality. The output was running at 60fps in progressive scan at a resolution of 1920x1080 pixels. As this is twice the quality of the digital HDTV standard, Sony had to use a specially developed monitor to display it.

Similarly, Sony is targeting digital cinema distribution and broadcasting. Another SIGGRAPH demonstration saw the GScube working with an IMAX Digital Projection Lightning 15sx projector to generate realtime content for cinemas. Using the GScube in conjunction with a broadband server such as a SGI ORIGIN 3000, films could be digitally downloaded to cinemas via a high-speed network.

Photography: **Martin Thompson**
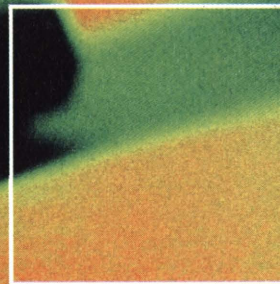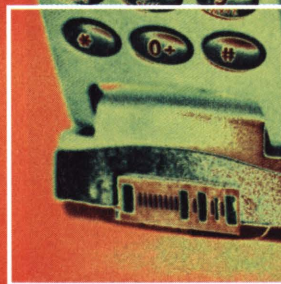

Focus: R380s

All the smart money is on wireless gaming enjoying a huge surge in popularity over the coming years. While hamstrung by sluggish WAP loading, the Ericsson R380s has a large screen that's ideal for anyone interested in mobile gaming

Specifications

CPU: ARM922T RISC processor, 32bit, 140-200 MHz
Graphics processor: none
Other processors: Digital Signal Processor (DSP)
Main RAM: 32Kb
Memory bandwidth: n/a
Graphics RAM: none
Theoretical performance: n/a
Estimated real performance: n/a
Graphics functions: n/a
Sound RAM: n/a
Audio performance: n/a
Storage and media types: 1.2Mb internal RAM, SIM smartcard with 32Kb or 16Kb of Flash RAM
Input/Output: Hands-free port, RS232-compatible serial link to PC
Networking: 9.6Kbps modem for connection to the GSM network standard at either 900MHz or 1,800MHz frequency, in-built infrared IrDA SIR optical link at 115.2Kbps

How it works

As with most mobile phones, an ARM processor sits at the heart of the R380s. The exact specifications are tightly guarded, but designed specifically for high-performance, low-overhead operations, the 32bit chip is probably a version of the core ARM9TDMI processor – most likely the EPOC-compatible ARM922T, which is enhanced by ARM's Thumb 16bit instruction set. That's a high-specification chip for a mobile phone.

The R380s requires such performance because of its PDA functions. It can store up to 10,000 contact details using its internal 1.2Mb of RAM, and has an appointments calendar and notebook as well as email and SMS messaging capabilities.

The other major internal component is the Codec DSP chip, which deals with speech and signal processing (analogue to digital) and communication functions required by GSM.

The setting is this year's E3 show. Amid the showgirls, wannabe actors in alien suits and paranoid execs stands a CEO from one of the latest wireless games start-ups. He looks around, sees the past, and says: "In two years this will be a very different place."

That change is already underway. As devices such as phones and PDAs get more powerful, so the scope of the game industry will be expanded and diluted. Multibillion-dollar companies from the consumer electronics and telecoms space will aggressively position themselves in the game market.

Nokia attended E3 for the first time in 2000, while Motorola unveiled its Game Boy-lite A009 device at ECTS, as well as poaching Sony's European development director to head its game operation. Not to be left out, Ericsson recently spent $7million acquiring US developer Red Jade.

Nevertheless, as even its proponents admit, the present incarnation of wireless gaming is not something to phone home about. Software, notably the WAP browser used to access the mobile Internet, is its biggest limitation.

Overseen by the WAP Forum, all WAP-enabled phones essentially run the same software standard, currently WAP 1.2. This has the advantage of ensuring content written in WAP Markup Language (WML) can be accessed by all phone types. In contrast, the Japanese version of WAP, i-Mode, is a proprietary system controlled by the national telecom monopoly-holder NTT.

While the European approach does encourage competition, it also stymies the pace of technological advance. This is one of the reasons that Nokia and

PC handshake: input and output

Thanks to its PDA functionality, the R380s has an extensive communication suite, which allows it to synchronise data with a PC using a standard RS232 serial connection. It also has an infrared port for communication with other phones and similarly equipped PDAs, laptops and PCs. However, because the R380s's EPOC operating system does not support dynamic menus, it is not compatible with Ericsson's high-speed, wireless BlueTooth technology, or other Ericsson peripherals such as its MP3 player.

1996 GH688

Ericsson's slimline business-oriented GH688 demonstrates mobile phones' growing ability to handle data and network communications.

1997 GF 788

The tiny GF788 is one of the first Ericsson phones to utilise the flip design which enables phone size to shrink while maintaining speech quality thanks to its acoustic channel.

1999 T28

The dual band T28 contains the design ethos of the GF788, introducing a magnesium alloy chassis and the dynamic menu system which supports accessories such as Ericsson's MP3 unit, chat board and FM-radio module. It is Ericsson's lightest phone to date.

2000 R320

The first of the R-series of business phones, the R320 is essentially a T28 stretched to incorporate a WAP browser and larger backlit screen.

+ Beautifully designed and built

+ Looks great

+ Largest screen of any WAP phone

+ Good preinstalled game

+ Touch-sensitive screen

+ Neat software, including handwriting recognition

∧

Best of the present

Great hardware, shame about the software

Worst of the past

∨

- Slow browser

- Limited by WAP technology

- Too big and expensive for massmarket

- Can't download content

- Not BlueTooth compatible

Ericsson develop their own browsers. But, as well as being limited by monochrome screens and a tiny amount of client-side processing power, the slowness of connecting to a server is a real obstacle for WAP.

Why size matters

Ericsson's R380s, generally recognised as the best WAP phone now available, remains bedevilled by such issues. On average it takes 25 seconds to connect to a gateway and a couple of seconds to access a page of new information.

For those with the patience, however, it is the only device on which to play WAP games, thanks to its 360x120-pixel touch-sensitive screen. Because the information it downloads remains 120 pixels wide, the screen size means that text is more efficiently displayed and can be wrapped next to images, removing the need for scrolling.

The only game that makes full use of the R380s's screen is the preinstalled version of *Othello*, developed through Symbian's EPOC program. The R380s is the first phone to ship using the EPOC32 operating system.

Yet, as is the way of mobile phones, the R380s is already old news. The next generation of devices operating on package switching networks such as GPRS will result in phones that can download and run content – the emergence of mobile phones as open platforms.

They will also have colour screens and, while they won't threaten the Game Boy, they will be more viable games machines with the crucial advantage of in-built connectivity. The dawn of mobile gaming is upon us. Almost.

Soft focus

TicTacToe

While it is one of the simplest games available, this four-by-four, multiplayer version of *TicTacToe* is eminently enjoyable.

Chess

Created by the UK grandmasters at Bored of Games, this version of chess shows off the R380s's screen to its best advantage.

3D Tanks

Obviously limited by WAP's turn-based ability, Wapscallion's *3D Tanks* title is one of the most sophisticated games available
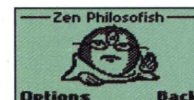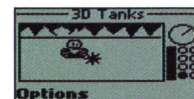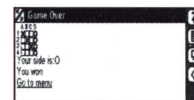
Alien Fish Exchange

Now available on iTV and the Web, *Alien Fish Exchange* is one of the most high-profile WAP games, particularly in the US.

In Cold Blood

A text-based version of Revolution's *In Cold Blood* was recently launched on Ubi Soft's Ludiwap portal.

Gangsters

Another traditional game to make the jump to WAP is Hothouse's *Gangsters*.

Mobile technology is converging at a frantic pace, and Ericsson's R380s smartphone is the first next-generation product to be available to consumers. How hard is it to pack WAP browsing, email and SMS capabilities, plus a full-size touch-sensitive screen into a mobile phone? **Edge** asks Ericsson's senior product manager Colin Ellis

B oasting nine years in the still-nascent mobile phone business, **Colin Ellis** undoubtedly counts as one of its veterans. Now senior product manager at Ericsson, there are some throwbacks to the old days he still retains. "I personally prefer a slightly larger phone because I've got big hands," he admits. "I'd put an absolutely tiny one in my back pocket and sit on it. They don't like that – I'm not a small bloke."

What were the main criteria when designing the R380s?
It was to integrate personal information

and graphics with a good resolution and have a four-greyscale design.

For readability and battery life, there's a backlight built-in, but also we've added a screensaver so it will power the screen down when it's not in use. Screen technologies are always a challenge when designing any product. The better the display, the more impact it is likely to have on battery life. Power management in any mobile product is key.

Is the 3.6V Lithium ION battery particularly special?
The R380s is one of the few products that doesn't share the common Ericsson

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product manager
Ericsson

> # Colin Ellis

talking technology

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management and messaging capabilities into a device the size of a mobile phone – so that at the end of the day you could just stick it into your jacket pocket without you ripping the lining out.

It looks a lot like Ericsson's first R-type phone, the R320s. How does it differ?
The top-to-bottom and side-to-side dimensions are the same – 160mm long, 50mm wide. The only one that is different is the front-to-back, at 26mm, because there's a lot more packed into this model. It's a bit heavier, too – 164g with a battery – and a little bit deeper than the R320s.

Do you set a weight or a size limit for mobile phones at Ericsson?
Not really. It depends on what the product

is made for. You'll see phones that are small, such as the T28, and you'll see phones that are built like brick outhouses, like the R250, which is the industrial product. So it's finding the balance to fit the target market. That will determine the limits you can go to.

Obviously the large touch-sensitive screen was key to this design.
Displays are critical in any product. What we were looking for in the R380s was a display that could support both text

"What we were looking for in the R380s was a display that could support both text and graphics with a good resolution"

battery pack. Firstly, because it holds the stylus, and also because it's designed to provide a balance between power and weight. It had to be specifically designed for this product.

Who developed the phone's software?
The operating system is EPOC. The R380 is the first Smartphone to come out of the Symbian relationship [the software group set up by Ericsson, Nokia and Psion, which developed EPOC] as a unique product rather than just an OEM, as

we did with the MC218 [Ericsson's PDA].

The browser is an Ericsson designed and developed browser. At the time the Symbian relationship did not have a reference model for this product, so as a result we had to go out and develop our own. Ericsson was one of the founding members of the WAP forum – the first WAP product on the market was the MC218.

Do you view the R380s as a games machine?

The bigger the display, the more opportunity you have for remote and online gaming. The marketplace for WAP gaming is growing daily, but it's not the phone's primary design. It has a game pre-installed on it, though [Othello]. In this iteration of the product, it's not designed as an open platform with the ability to download content.

As the technology evolves then that is definitely something we will be looking at, but this is a product rather than a platform. In the future it's key that people will want to use these products in a whole range of different devices. The ability to access online gaming through the WAP browser is a significant opportunity, and our future products will definitely enhance and utilise the ability to download and to install content.

What is Ericsson's take on the future of gaming for mobile devices?

As a hardware vendor, we have to take account of both our infrastructure capabilities and our handset capabilities. We have got to be careful in balancing our customers needs. In some markets, we'll see operators saying to us: "We want you to develop a complete network solution including network services, including gaming," and in other markets they will say: "Hands off, that's ours."

When the bandwidth is there, particularly in the 3G timeline, then online gaming will be important. Up until recently the bandwidth hasn't been there, though.
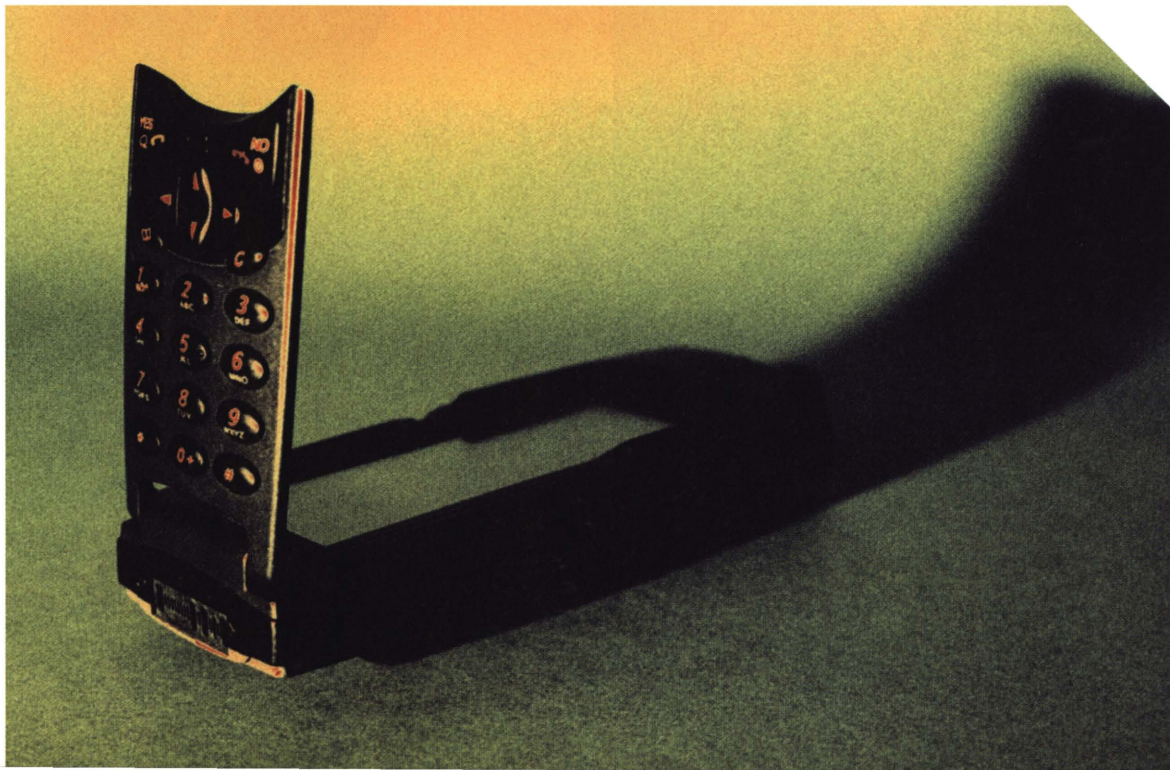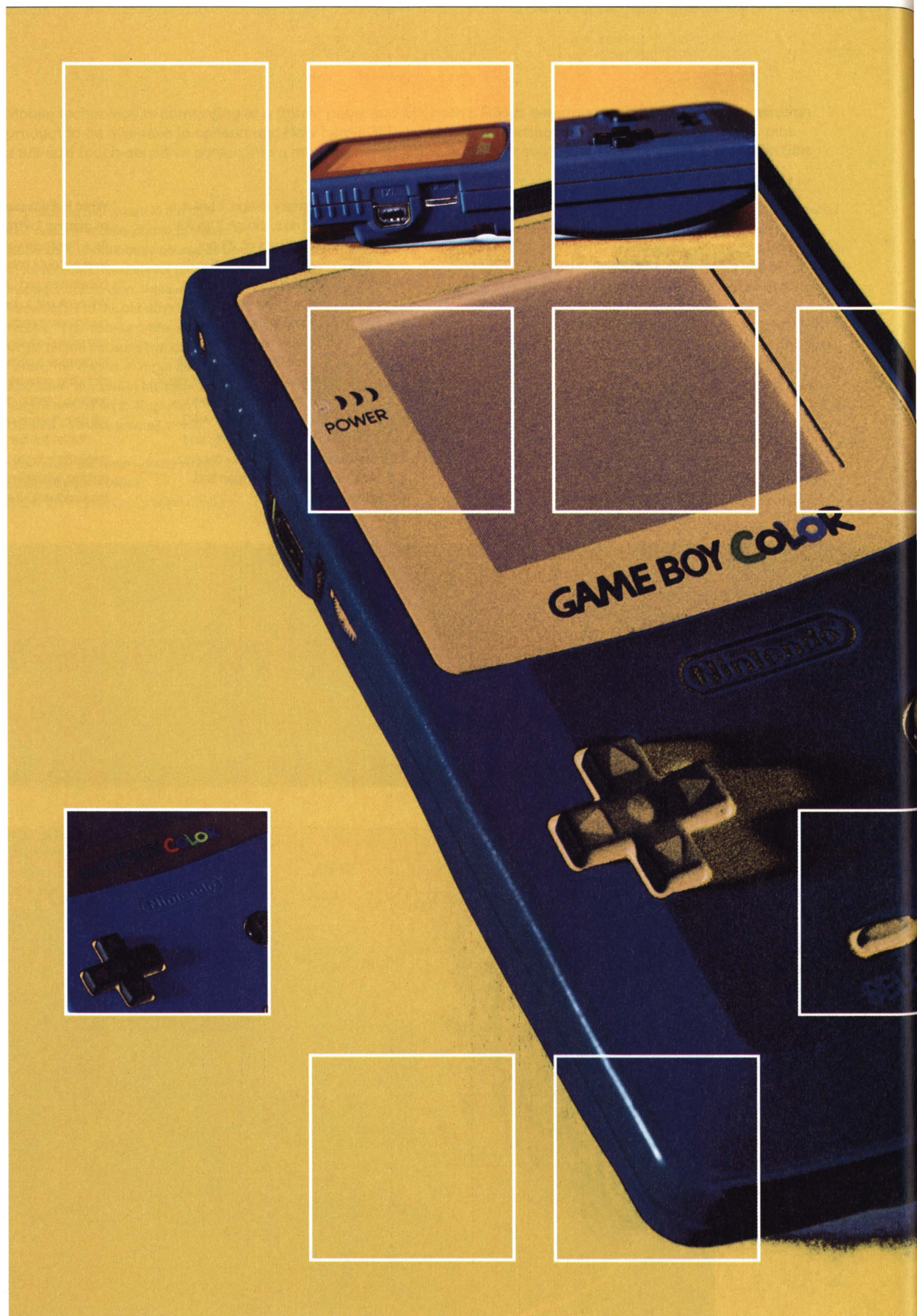
Specifications

CPU: Sharp 8bit custom CISC Z80. Dual Mode. It has two modes, Single (1.05Mhz) and Double (2.10Mhz)

Graphics processor: None

Other processors: n/a

Main RAM: 32Kb

Display: 2.3" TFT liquid crystal display from Sharp. Resolution 160x144 pixels

Graphics RAM: 16Kb VRAM

Performance: 32,768 colour palette with support for 10, 32, or 56 colours onscreen.

Sprites: 40 of either 8x8 or 8x16, with ten sprites per line. Sprites comprise of four colours with one always transparent. Maximum 768 tiles available

Graphics functions: Raster effects, image flipping, layering technique for simultaneous display of 256 colours

Sound: Single mono speaker

Audio performance: Four channels, FM stereo (with headphones)

Storage and media type: ROM cartridges – 256Kbit, 16Mbit for GB-compatible games. Up to 64Mbit ROM and 128KB RAM

Input/Output: Eight directional D-pad, A, B, select, and start buttons, power switch, volume control, DC 3V in, headphone jack, infrared, EXT serial port, ROM cartridge slot

Networking: Mobile GB adaptor for mobile phones, serial port, infrared port

Size: 75mm(w)x133mm(h)x27mm(d)

Weight: 138g

Power: 2 AA batteries

Battery life: 10 hours

Notes: The unit has twice as much video RAM (16K) and four times more main RAM (32K) than the Game Boy. The custom CPU has two modes, Single at 1.05Mhz for original mono Game Boy titles, and Double at 2.10Mhz for GBC only titles. Backward compatibility limits the CPU to just 8bits

Manufacturer: Nintendo
Partners: Sharp
Launch date: September 1998
Launch price: £70
Country: Japan

Focus: GB Color >

It took Nintendo ten years to upgrade its handheld to include a colour screen.
The results were astounding, with GBC shifting more units than PlayStation

Japanese philosophy undoubtedly states somewhere that a tree can only grow and flourish if it has strong and healthy roots. The colour version of the Game Boy could only be built on strong foundations. Even before the update, Nintendo's handheld was already among the most successful videogame consoles of all time. Whatever the future throws at it, Game Boy will flourish. Its roots are strong and healthy.

The engineer behind the original Game Boy was Gumpei Yokoi, who headed up the 45-man R&D#1 team that planted the seeds of Game Boy in the early '80s with his Game & Watch LCD games.

Criticism over Game Boy's monochrome screen was perhaps inevitable, but Nintendo's president, Hiroshi Yamauchi, had instructed R&D#1 to forgo colour for cost and efficiency. It was an inspired move. Despite the fact that it wasn't as powerful as other handheld machines, Nintendo bypassed the battery life nightmares that dogged competitors such as Sega's Game Gear and Atari's Lynx.

The hardware was principally designed to be cheaply manufactured for maximum consumer penetration and to provide a platform for Nintendo's classic games. Sporting only two action buttons and a D-pad, the Game Boy could emulate NES games accurately and offered truly portable gaming with interchangeable game cartridges at an affordable price.

The icing on the cake was surely *Tetris*. Bundled with the hardware, *Tetris* is now synonymous with Nintendo's handheld. A simple puzzle game, it was a textbook killer app. The game's straightforward nature, married to the simplicity of the Game Boy hardware, meant that anyone could pick up and play on the handheld.

Game Boy also benefited from a host of games utilising Nintendo's famous franchises such as *Mario*, *Donkey Kong*, and *Zelda*. The company could certainly feed its tree well.

Pocket rocket
Wildly successful as it was, by 1996 the five-year-old Game Boy needed a boost, and it was delivered with the introduction of the Game Boy Pocket. The unit was slimmer than the original, and came in several case colours. It boosted a larger visible playing area, albeit only displayed in black and white. Indeed, internally the technology remained unchanged. It wasn't until 1998 that the
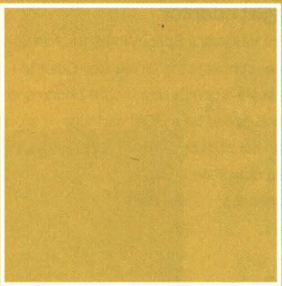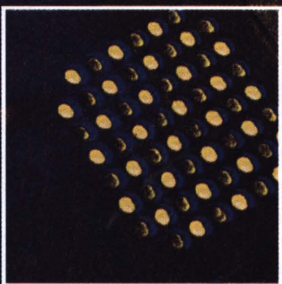
Game Boy camera

A primitive digital camera that can capture up to 30 black-and-white pictures, which can then be edited. The unit slots into the Game Boy cartridge port, and has an adjustable lens with the handheld's screen acting as a viewfinder. Panoramic and montage modes are available, and games can incorporate the user's own face.

Game Boy printer

A companion piece to the camera, the Game Boy Printer enables images captured using the camera to be preserved for posterity. Printouts come as stickers, but the unit is finding other uses as developers seek to utilise it. Requires its own power supply and is connected to a Game Boy via a link cable.

Mobile GB adaptor

Unveiled at this year's SpaceWorld, the mobile GB adaptor connects the Game Boy Color to the Internet via a compatible mobile phone and a browser supplied on a ROM cartridge. It allows for the transfer of data between users and can be used to download new information as well as online gaming.

Game Boy Color arrived. Cunningly, Nintendo married the new colour screen with the familiarity offered by backwards compatibility. Not only could the new unit accommodate larger and better games, in colour, it could play every Game Boy game ever released.

Backwards compatibility has proven itself so well that it's a feature of Nintendo's next handheld, the Game Boy Advance. Development for Game Boy Color remains relative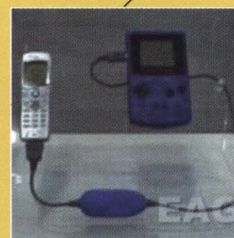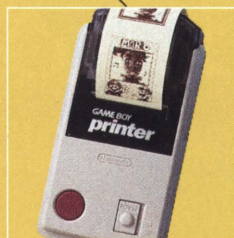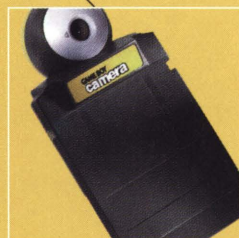ly simple compared to next-generation consoles. The relatively crude level of the graphics results in gameplay being all-important – there's nothing else to hold the player's attention. The software can be turned around in an average of six months, with perhaps extra two or three needed for twoplayer games. But that's not to say that the options open to a developer are limited. With clever programming, developers can get

as many as 2,800 colours onscreen at once, with around 20 colours per line. However, given other limitations, this is only really useful for hi-colour static background images – although codeshops are working around this.

The Game Boy Color now boasts a European installed base figure of more than six million units, of which more than 1.3m have been sold in the UK. Globally, Nintendo has taken sales of the Game Boy family past 100 million units.

Glorious Game Boy

Then there's *Pokémon* to consider. The series' success has led to the handheld outselling the PlayStation, and it has offset the poor performance of the N64 for Nintendo. Ideally suited to the Game Boy hardware, the *Pokémon* titles exploit the handheld nature and communication capabilities of Game Boy, rather than requiring fancy graphics, with the appealing

creatures swapped between Game Boy owners either via a link cable or through the infrared port.

Pokémon and Game Boy will doubtless continue in step, with Nintendo releasing *Pocket Monster Crystal* in Japan in this December for ¥3,800 (£25) and a mobile Game Boy adaptor enabling online battles or the exchange of *Pokémon* over a mobile phone.

Such innovation comes despite a lack of competition. With Sony stubbornly resisting the handheld fray, competition most recently came from SNK's Neo-Geo Pocket and Bandai's WonderSwan. Both sported monochrome screens, but lacked the software catalogue and support of Nintendo's veteran. A colour version of the Neo-Geo was released, but within a year withdrew from the US and UK markets.

Bandai will launch a colour version of the WonderSwan at the end of the year, and although strong

software support is promised, no one expects it to usurp the Game Boy. Unlike in the static console world, there is one clear leader in handhelds, and taking on Nintendo's powerhouse will require incredible ambition, or plain madness.

Even Nintendo will not release its Game Boy Advance against the Game Boy Color. True to form, it is reaping all it can from its existing hardware before replacing it with its own superior technology. The biggest obstacle to Game Boy Advance's success could be the success of current technology. Game Boy Color could have been introduced a decade ago. By playing the waiting game, by letting its monochrome machine take root, the console has lasted an unrivalled ten years. There seems no limit to the handheld's lifespan, or to where it might take portable gaming in the future.

Soft focus

Pokémon Gold

All aboard the *Pokémon* train. There are no signs of the series slowing down, with the release of the *Pokémon Gold* and *Silver* versions due next year.

Aliens

Aliens: Thanatos Encounter provides an experience akin to *Alien Breed* on the Amiga. Two-handed weapons and a working motion tracker are vital for survival.

Zelda

The arrival of a *Zelda* game is an event on any format, and it certainly got the Game Boy Color buzzing. Data can be swapped between the two titles in the *Mysterious Seed* series.

Obi Wan

The Game Boy has always thrived on licensed products. The *Star Wars*-based Obi Wan title recreates the lightsaber action of the blockbuster prequel.

Mario Tennis

The Game Boy version of the N64 title *Mario Tennis* can trade data with its big brother game via the Transfer Pak.
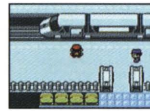
How it works

On powering up, an internal chip checks the inserted game ROM is genuine. If so, the internal ROM is disabled and the cartridge program executed. The main CPU is similar to the Intel 8080 Z80 chipset with slight variations in instruction sets. A total of 32Kb of work RAM is available, with game code is executed from the 32K ROM area. The first 16K of this ROM area is fixed and is referred to as the home bank. The next 16K of ROM is switchable, so access to the whole of the ROM is possible.

The main Game Boy screen buffer, used mainly for background scenes, consists of 256x256 pixels, of which only 160x144 pixels can be displayed on the screen. This equates to 32x32 tiles. An area of VRAM known as Background Tile Map contains the number of tiles to be displayed. Additionally, a fixed window overlays the background, and is generally used as a status display in games.

Two new DMA transfer modes allow data to move from ROM or RAM to VRAM at a constant rate, regardless of CPU use. Tile graphics or maps are copied to VRAM using Horizontal Blank DMA (HDMA) which allows other processing to take place. General Purpose DMA (GDMA) performs a similar function, though the CPU cannot process anything else until GDMA has finished.

+ *Pokémon*
+ Easy to develop for
+ Long battery life
+ Small size and weight
+ Cheap games

∧

Game, set and match

Boy talk: input and output

Backwards compatibility and *Pokémon* has led to a massive user base, but its ageing technology will slow progress in 2001...

The cartridge slot, traditionally the method by which games are loaded, can also transfer non-game data. The serial port (the EXT port) supports speeds of up to 512Kbits per second, and is better able to support twoplayer games than previous Game Boys. An infrared port is also able to transfer data, but will not support multiplayer gaming.

The Game Boy has proved itself to be more than just a game machine, and Nintendo seems keen to encourage creative use of the unit – as witnessed by the introduction of a digital camera and printer peripheral. The connectivity of the handheld has also expanded its capabilities. The Game Boy mobile adaptor will allow for the swapping of data over the Internet via a mobile

phone, encouraging the social aspect of gaming that Nintendo believes will develop.

Despite its dated technology, the Game Boy is finding more fans. A recent deal with manufacturer Singer allows it to interface with that firm's sewing machines. Other uses for a Game Boy now include an MP3 player as well as a PDA and a TV remote via the infrared port.

No longer a boy

V

- A boy grown old
- 8bit technology looking dated
- Only two action buttons limits gameplay
- Small screen size
- Less support expected when GBA arrives
- Screen not backlit
- Limited sound
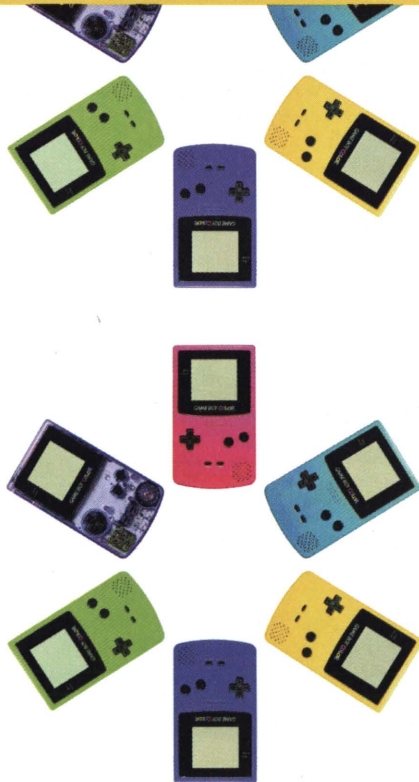
How the Boy was born

1982 Game & Watch

Nintendo adapted pocket calculator LCD technology to produce cheap pocket sized games. More than 40m Game & Watch units were sold in Japan and Asia.

1983 Famicom

The NES, or Famicom as it was known in Japan, is launched. The software format of choice was the ROM cartridge, allowing the hardware to play different games.
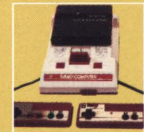
1989 Game Boy

The Game Boy is launched in Japan, marrying Game & Watch portability with the interchangeable (and profitable) game cartridge system. The Game Boy eschews power for portability and battery life and is reincarnated as the neater and smaller Game Boy Pocket years later.

Focus: Indrema Entertainment System

Can the Indrema Entertainment system really challenge Sony and Microsoft's offerings, or is it the new 3DO?

With a quixotic contempt for the harsh realities of a market that already looks unlikely to support four consoles, Indrema is bringing out a fifth, the Indrema Entertainment System (IES). But despite the company's bullishness, it will have a hard time selling its open source box as an X-Box beater.

The first in a planned series of IES products, the L600 looks powerful enough, with on-paper specifications comparable to Microsoft's console and boasting an impressive range of multimedia functions, including digital TV capabilities. Indrema developers are already supported with by a Web site that offers dev kits to download free and a forum for developers to exchange ideas.

But will consumers be won over on a large scale? Its upgradeability and multimedia positioning are as likely to confuse them as it will alienate developers who have to target ever-changing specifications. Lowering the entrance barriers to the lucrative console software market is laudable, and has met with widespread enthusiasm from small independent software companies, but no big names have yet announced plans to develop for the machine. Most of the titles mooted for launch have already appeared on other platforms – hardly marking the unit as a must-have amongst its target demographic of high-end gamers and *Linux* devotees.

Without exclusive franchises, the IES looks like going the way of the 3DO. It does have some potential appeal to home coders, though, which could give it an extended lease of life.

How it works

The hardware is an enhanced version of the x86 template. The software architecture of the IES features three layers: the first handles direct hardware interfaces; the second is the API support level; and on top is the application layer. Supported APIs include OpenGL and tools include a version of *Codewarrior* from Metrowerks.

Input and Output

The Indrema's four USB ports allow the unit's standard controller to be attached, and digital audio output will support Dolby Digital surround sound. More interesting is the high-speed Internet port, which Indrema hopes will turn the unit into a multimedia device capable of Web browsing, email, and TiVo-style TV recorder functionality.

Is the Indrema the latest in a long line of multimedia failures?

Offering video playback, and a host of multimedia functions that were cutting edge when units was introduced to Europe in 1992, the Philips CD-i failed to challenge the stranglehold that Sega and Nintendo had on the home leisure market due to poor marketing and distribution. The games weren't great either.

The brainchild of ex-EA boss Trip Hawkins and backed by the likes of AT&T and Time Warner, the 3DO was envisaged as the global standard for CD-based home entertainment when it was introduced in 1993. But although positioned as a multimedia system, gamers saw an expensive console with very little quality software.

The jury is technically still out on VM Labs' NUON technology, which allows games to be played on DVD players. But with games like *Myst* – first seen in the early '90s – it is unlikely that this will capture the attention of gamers, despite its shortcut to the living room. Its 'games chip in a box' idea has been pinched by Nintendo and Sony too.

Specifications

CPU: 600Mhz, manufacturer yet to be announced
Graphics processor: Future-generation Nvidia (upgradeable via a slide bay)
Main RAM: 64Mb
Memory bandwidth: Over 5Gb/sec
Graphics RAM: 32Mb DDR
Graphics functions: Transform and lighting, full-screen anti-aliasing, HDTV resolution
Audio performance: MPEG2 dual stream hardware acceleration
Storage and media type, with capacity: Integrated DVD player, 8/30/50Gb Hard Drive Option
Input/Output: S-Video, Component HD, stereo, Digital Audio Out (Optical), four USB universal ports
Networking: 100 Mbps Ethernet port
Notes: On paper the Indrema seems well equipped, but multimedia functionality and upgradeability could dilute its focus as a games-platform.

+ Open platform offers easy entry to developers
+ Impressive specifications
+ Commitment to supporting its development community

∧

Return to the source

Despite good technical specs, the IES may confuse consumers and coders alike

Open questions

∨

- Indrema is not an established brand
- Lack of exclusive killer franchises
- Multimedia functionality
- Uncertain target hardware

illustration: **Richard May**

YU'LL BE MIN

PAUSE (FOR BREATH)

Console: PlayStation
Computer: PC
Handheld: Game Boy
Genre: Action/adventure
Chip: 3Dfx Voodoo Graphics
Game: *Wipeout*
Graphics: Polygons
Sound: Sampled
Memory: 2Mb VRAM
Media: CD-ROM
Character: Lara Croft
Man: Shigeru Miyamoto
Country: Japan
Magazine: Edge

Intellimouse
Apple's one-button mouse is hardly
ideal for games, so a replacement
such as Microsoft's Intellimouse
Explorer is essential
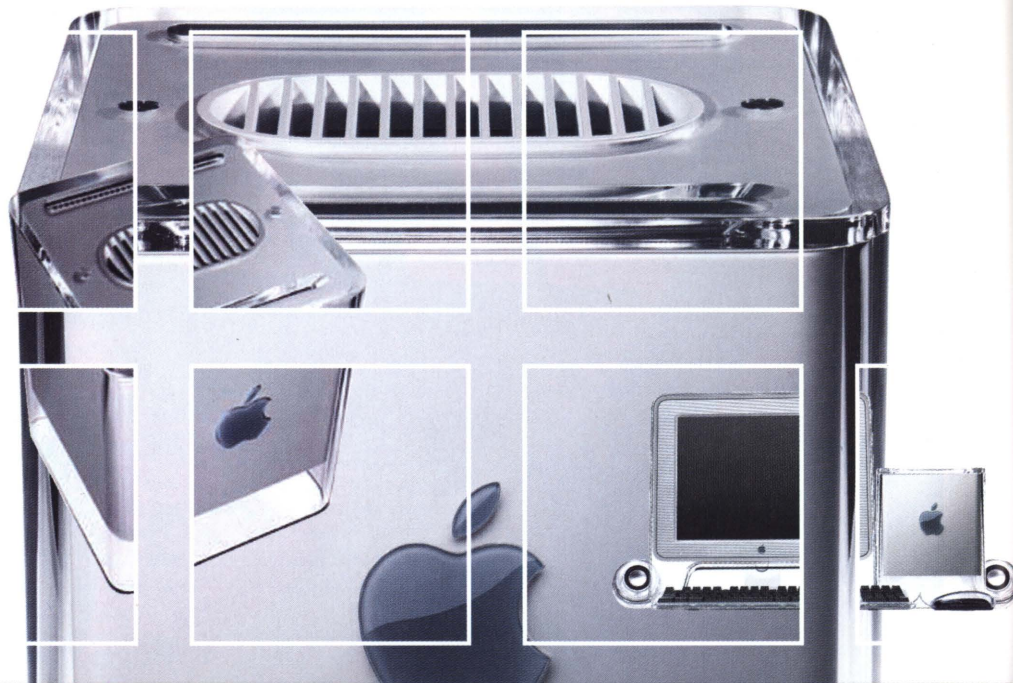
Specifications

CPU: PowerPC G4, 32/128bit, 500MHz

Main RAM: 128Mb (up to 1.5Gb)

Memory bandwidth: 0.8Gb/sec

Graphics hardware: ATI Radeon

Graphics memory: 32Mb

Graphics features: Integrated transformation,
clipping and lighting, superscalar rendering,
single-pass multi-texturing, full-screen, line
and edge anti-aliasing, specular highlights, cubic
environment mapping, fog effects, texture lighting,
video textures, reflections, shadows, spotlights,
LOD biasing and texture morphing

Theoretical performance: 30m polys/second

Estimated real performance: 32bit 1024x768
Quake III Arena at 50fps

Storage: 30Gb hard disk, DVD-ROM drive

Input/Output: two USB ports, two Firewire
(IEEE 1394) ports, 100Mbps Ethernet,
56Kbps modem, VGA display

Networking: 56Kbps modem, 100Mbps
Ethernet, optional AirPort wireless Ethernet

Notes: As a general-purpose computer, the
Macintosh comes in a wide range of configurations

Focus: Mac G4 Cube

After the phenomenal success of iMac, Apple has produced the most desirable
Macintosh yet, which features ample CPU and graphics performance, but is
the platform destined to remain one step behind the PC in the gaming stakes?

How it works

Apple's machines have used the PowerPC processor since 1994. Arguably
a cleaner, more efficient design than Intel's Pentium, the PowerPC has ample
power. The G4 includes a 128bit vector unit called the Velocity Engine, similar
to Intel's streaming SIMD extensions found in the Pentium III. This gives the
G4 a theoretical peak performance of 3.6 gigaflops.

The graphics side of the G4 Cube is handled by a 2xAGP slot. ATI's latest
32Mb Radeon graphics card offers the same kind of performance benefits as
the latest products from nVidia and 3Dfx. Industry standard IDE hard disks,
a PCI bus and PC100 RAM slots help to keep the system cost down.

Once a pioneer in personal computing, the Apple Macintosh floundered in the mid-'90s. The relentless advance of Intel's CPUs and Microsoft *Windows* left the Mac occupying a niche role on the desktop.

The PowerPC microprocessor, first used in 1994, was certainly a match for the Pentium, but the Mac's once unique graphics capabilities could not keep up with ever improving massmarket PC graphics accelerators. The games scene on the Mac was dominated by releases from relatively small publishers, with

only a handful of major titles being released on both Mac and PC platforms.

Steve Jobs, CEO of Apple, wants this situation to change. Current Macintosh models, such as the diminutive G4 Cube, can be bought with ATI's new Radeon 3D accelerator pre-installed, and all iMacs now feature the ATI Rage 128 card.

Additionally, both 3Dfx and nVidia have announced Macintosh versions of their latest graphics hardware, bringing new purchasing choices to a once barren market.

The rebirth of cubism

1984 Apple Macintosh
The original Macintosh: 128Kb RAM, 64Kb ROM, nine-inch monochrome display, 8MHz Motorola 68000 CPU, one-button mouse. Many elements of the original design are still in place.

1994 Apple PowerPC 8500
The first PowerPC-based Macs, running at a Pentium-bashing 80MHz. The new, powerful Macintoshes were backwards compatible with 680x0-based machines thanks to software emulation.

1998 iMac
Apple reborn in new translucent colours with the iMac, first seen in 'Bondi blue', but soon followed by five fruity flavours. The iMac became Apple's most successful computer, with new users coming to the Macintosh for the first time in years.

1999 G4 microprocessor
Described as a supercomputer on a chip, the PowerPC G4 made its debut in the Power Macintosh range. Faster than a speeding Pentium, the G4 has yet to appear in the iMac, but offers PC-beating performance to Apple's professional customers.

Soft focus

Warcraft III
Warcraft III from Blizzard Entertainment is due at the end of 2001. Blizzard recently acquired its long-time Mac porting partner, Future Point.

Halo
Bungie Software has assured Mac fans that *Halo* will still come out on the Macintosh next year, in addition to PC and X-Box.

Star Trek Voyager: Elite Force
Star Trek Voyager: Elite Force has been ported to the Macintosh by Weslake Interactive, and will be published by Aspyr Media.

Heavy Metal: FAKK2
Contraband Entertainment produced the Macintosh version of *Heavy Metal: FAKK2*, using the *Quake III* engine.

Summoner
Volition's *Summoner* was seen first on PlayStation2, but it will appear on the Mac (and PC) next year.

Manufacturer: Apple Computer
Partners: Motorola/IBM (PowerPC CPU),
ATI (graphics hardware)
Launch date: July 2000
Launch price: £2,000 (model featured excluding monitor)
Country: US

Warcraft III

Halo

+ Beautiful-looking computers
+ Popular with consumers and first-time buyers
+ Powerful CPU and legacy-free hardware
+ 3D graphics now on a par with PC
+ Apple continues to innovate in a stagnating industry

∧

Apple's juicy fruits

Cuba Lingua: input and output

The G4 Cube clearly demonstrates Apple's commitment to new I/O technology, with none of the so-called 'legacy' serial and parallel ports seen on Intel-based PCs.

Two 12Mbps USB are provided to attach low-bandwidth peripherals, including the keyboard, mouse and speakers. A pair of 400Mbps Firewire (IEEE 1394) ports support digital video, external hard disks, and other data-intensive devices. Networking is provided in the form of a 56Kbps modem and built-in 10/100Mbps Ethernet. Apple's wireless Ethernet technology, AirPort, is an optional extra.

It looks gorgeous, but will the Mac ever make it to the mainstream?

A poor harvest

V

- Not keeping up with Intel-based PC's performance
- Mid to high-end machines are too expensive
- Small market share means fewer software sales
- Microsoft *Windows* is seen as the standard OS
- Apple is up against all the PC manufacturers

The RISC fix
The PowerPC G4 processor used in Apple's high-end products was designed jointly by Apple, IBM, and Motorola. While it's a modern and efficient RISC design, the problem with the G4 is that it is currently stuck at a maximum clock speed of 500MHz.

Since most consumers believe that CPU clock speed is a good measure of overall machine performance, Apple is suffering from a perceived 'megahertz gap' with Intel-based PCs. Until faster versions of the chip become available in early 2001, Apple is attempting to placate customers by offering dual-processor versions of its high-end products.

Apple's software support for games has been improving, with OpenGL now built in to the Macintosh operating system. The platform's game sprockets API is somewhat equivalent to Microsoft's DirectX libraries, offering standard methods to read input devices, handle audio and deal with networking.

The next version of Apple's OS will be the all-new UNIX-based Mac OS X, which is intended to address the technical limitations of the current system.

Apple's core problem
Since the iMac was introduced in August 1998 around three and half million machines have been sold. The fact remains, however, that the installed base of Macs is dwarfed by the number of Intel PCs out there, and that this is unlikely to ever change.

The improved profile of the Mac as a consumer product has led many existing PC publishers to start considering it as a viable platform. In the last couple of years the number of games released for the Mac has increased, but the new arrivals are almost exclusively ports of existing PC products. A Mac port of a proven PC product can be a relatively inexpensive way to attain extra sales. Still, Mac users have become used to waiting months or even years for versions of PC titles, mainly due to the scarcity of Mac programmers. This situation will improve, with some publishers developing Mac and PC versions simultaneously, but the Mac is likely to always play second fiddle.

The PC industry has yet to come up with a successful Intel-based equivalent to the multi-coloured iMac, and the G4 Cube shows that Apple can consistently wow the crowds with its industrial design. This points to a future where the Mac leads in looks and style but will have to follow the PC's larger installed base for innovation in games.

Focus: Palm IIIc

The latest colour Palm was not specifically designed to be a games machine, but developers are exploring the possibilities

The Palm series of handheld computers is the most successful of its kind. Its manufacturer, Palm Inc, is going head to head with Microsoft's PocketPC platform, and for the time being appears to be winning, with sales of around nine million units and a market share hovering at 70 per cent. To combat Microsoft's *Windows CE* (and Symbian's *EPOC*), Palm has also licensed its operating system to other manufacturers. You can now buy *PalmOS*-based devices from Sony, IBM, and Handspring.

The Palm IIIc is Palm's first machine with a colour screen, and game programmers have been among the first to take full advantage of it. Few purchasers of a Palm will primarily intend to use it for games, but once all their addresses and power-lunch appointments have been entered, Palm users' thoughts inevitably turn towards the entertainment potential of their new toys.

Quite a handful

Software coders have risen to meet the occasion, and the *PalmOS* now sports hundreds of games, mostly from small, independent developers. The platform is also beginning to receive attention from larger houses, notably Infogrames with its Palm version of *V-Rally*, and *Tiger Woods PGA Tour Golf*, licensed from EA Sports by WhiteHorse Software.

While not yet a rival to Game Boy Advance, the future seems bright for the Palm platform in general. Palm is committed to wireless Internet connectivity, offering many gaming possibilities.

Other *PalmOS* machine manufacturers are also pushing the hardware. Sony wants its Palm device to be a handheld multimedia machine, and Handspring is offering faster CPUs and better colour graphics. As the number of machines running PalmOS grows, the opportunities for gamers and developers will only improve.

How it works

The Palm IIIc has a 20MHz Motorola DragonBall EZ CPU at its heart. The DragonBall series is based around Motorola's successful 68000 line, with additional on-chip subsystems for LCD display control, serial I/O and memory management.

The 2Mb of flash memory stores the operating system and applications, and the contents of the 8Mb of main RAM is preserved by the lithium-ion battery. The battery is recharged using the cradle, which is also used for synchronising with your desktop computer.

The 160-pixel-square TFT LCD display can display 256 colours from a palette of 4,096. Sound is provided by a simple single-channel synthesiser and built-in speaker.

Input and Output

There are two communications ports on the IIIc: an RS232 serial port and an IrDA-compatible infrared port. Both are capable of communicating at 115.2Kbps.

The infrared port in particular makes multiplayer games possible. The serial port is used for backing up the RAM to a desktop PC, and for attaching peripherals such as a modem to enable email and Internet access. The Palm VII, currently available only in the US, includes a wireless modem built-in.

The Palm has six buttons and its screen is touch sensitive, which opens up various options for hands-on control of games.

Ancient Red

Ancient Red, from SkeNext, is an RPG modelled after the PC game *Diablo*.

Void

Elite anyone? *Void* by Giles Goddard features the classic mix of vector graphics and space trading.

V-Rally

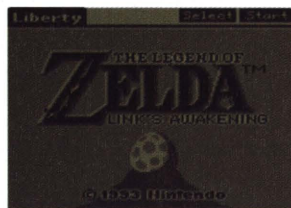Infogrames partnered with Palmtop Software to bring *V-Rally* to the PalmOS.

Zap!2000

Zap!2000 from Astraware sets the standard for Palm shoot 'em ups.

Liberty

Gambit Studios' *Liberty* is a Game Boy emulator for PalmOS. Frame rates are slow, however.

Specifications

CPU: Motorola Dragonball EZ 20MHz
Main RAM: 8Mb
Flash ROM: 2Mb
Graphics: 160x160 pixels, 256 colours on-screen from 4096
Sound: Single channel, built-in speaker
Storage: Battery-backed RAM
Input/Output: Serial RS232, Infrared IrDA
Power: Lithion-ion rechargeable battery (two weeks between charges)
Operating system: PalmOS 3.5
Size: 127x79x17mm
Weight: 190g

+ Opens up a fresh audience of potential gamers
+ Good compromise between processing power, physical size, and battery life
+ *PalmOS*-based machines made by multiple manufacturers

∧

A firm grip

How does the Palm fare against dedicated handheld hardware from the likes of Nintendo?
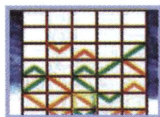
A sweaty palm

∨

- Doesn't play games as well as dedicated hardware
- Few commercially released games
- Entertainment not a focus for Palm
- Could do with better control buttons

Focus: WonderSwan Color

The polychromatic successor to Bandai's cult favourite might prick Nintendo – in Japan, at least

W hen he left Nintendo in 1996, the late creator of Game Boy, Gumpei Yokoi, went back to basics. The result was Bandai's WonderSwan.

Boasting a monochrome display just as the competition turned to colour, the £35 price tag, long battery life, and support from the likes of Square, Namco and Capcom nevertheless ensured its popularity among otaku.

Now a colour version has arrived, with online connectivity and an affiliation of sorts with Sony further distinguishing the unit from the competition. Indeed, Sony might have already had an influence. The unit sports two direction pads that allow it to be positioned either vertically or horizontally, PS2-style.

Sadly, Bandai hasn't planned a western release.

Final Fantasy

Final Fantasy, first seen in 1987 on the NES. With a 16bit overhaul, it was the killer app for Bandai's first handheld.

Gundam Vol 1

Side 7 supports the downloading of new units from Bandai's Gundam Web site via the WonderGate.

Gumpey

An intriguing puzzle game created by WonderSwan father Gumpei Yokoi, *Gumpey* goes full colour, and offers twoplayer link play.

I/O

A single EXT port provides connectivity to devices including the WonderGate, an adaptor that connects the handheld to the Internet via a mobile phone. Also, a USB connector will be available, enabling the exchange of information with PlayStation2 and PC. Specialised cartridge adaptors are being developed for flash memory cards such as Sony's Memory Stick.

+ Inexpensive
+ Strong software support
+ Can connect to PS/DC
+ Internet enabled
+ Screen can be used horizontally or vertically
+ Decent battery life

∧

In wonderland

Connectivity and strong software support are big pluses, but Nintendo is a fearsome opponent

Dying swan

∨

- No built-in headphone socket
- Unlikely to see release in Europe
- Strong, dominant competitor
- Less powerful than Game Boy Advance

Manufacturer: Bandai
**Partners:** Sony
Launch date: December
Launch price: ¥6,800 (£44)
Country: Japan

Specifications

CPU: 16bit, 3.072Mhz
Graphics processor: Unspecified
Main RAM: 512K VRAM/WRAM shared
Display: 2.8" FSTN LCD, 224x114 pixels
Performance: 241 colours onscreen from a palette of 4,096
Sprites: 128, with 28 total sprites per line
Graphics functions: Scrolling, sprite manipulation
Sound: Four-channel digital sound
Audio performance: Stereo sound
Storage and media type: Flash ROM Max 512 Mbit, EEPROM Max 31Kbit
Input/Output: ROM cartridge slot, EXT port, 13 buttons: X 1-4, Y 1-4, Start, A, B, Volume and Power
Networking: 9600bps/38.4Kbps through WonderGate peripheral and mobile phone
Size: 12.80cm(h)x7.43cm(w)x24.3cm(d)
Weight: 96g
Power: One AA battery
Battery life: 20 hours
Notes: More capable than Game Boy Colour, but underpowered compared with Game Boy Advance, the WonderSwan Color faces an uphill battle

Focus: GP32

Yet another would-be Game Boy pops into view. Can online functions help the Korean GP32's cause?
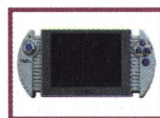
O ut of nowhere, a new entrant on the handheld scene has announced its intentions to upset the apple cart.

With the GP32, Game Park is concentrating its efforts on Internet connectivity. Software will be delivered via the Internet, either using a PC as a base station or else directly, using a mobile phone connected to the unit. An embedded MP3 player, Internet browser, and media player will strengthen (or weaken) the GP32's case, positioning it as a multimedia Web-based platform rather than simply a games machine.

Game Park is an unknown quantity, but as regards raw specifications, the GP32 looks a competent gadget. The software support it garners over the next six months will be crucial to the platform's chances.

Highmoss

The GP32's RF connectivity offers an interesting spin in this little-known RPG, with up to four players able to participate simultaneously.

Neo Panzer

In the tank squad game *Neo Panzer*, players pick the best combination of tanks and weapons for the mission in hand.

Dungeon And Guarder

Dungeon And Guarder is another RPG-tinged title that features fourplayer action.

I/O

The GP32 will use a PC as a base from which to download games. Game Park hopes to develop games that can be played on a PC and then transferred on to the GP32. The unit's own mobile Internet function will be accessed through a mobile phone, with a wireless RF adaptor providing multiplayer capabilities.

+ Open source development program
+ Free development kits
+ High specification
+ Largest screen of current handhelds
+ Software edistributed
+ Embedded MP3

∧

32 ways to leave GB

Is the GP32 just a Game Boy wannabe, or can connectivity carve it a niche in the market?

But why bother?

∨

- An unknown quantity
- May be expensive
- Details scarce
- No named software partners

Manufacturer: Game Park Inc
Partners: Unknown
Launch date: March 2001
Launch price: Under $150
Country: Korea

Specifications

CPU: Custom ARM 32Bit RISC CPU, 60Mhz
Graphics processor: Unspecified
Main RAM: 8Mb SDRAM, EEPROM back-up
Display: 320x240 pixel 3.8" colour STN-LCD reflection thin-film liquid crystal
Performance: 256 colours
Sprites: Unspecified
Graphics functions: 3D graphics, alpha blending, hardware scroll. Maximum 50fps. Sustained 20fps
Sound: 16bit PCM sound chip
Audio performance: Four channel mixing general Midi sequencer, 128 melody instruments, and 500 percussion instruments
Storage and media type: ROM 8Mb memory pack, downloadable games
Input/Output: Eight-direction joystick, four action buttons, display control, volume control, EXT ports
Networking: RF wireless, portable Internet connectivity, PC interface, Internet streaming
Size: 157mm(h)x71mm(w)x28mm(d)
Weight: 212g
Power: Two AA batteries or DC adaptor
Battery life: Approx. ten hours operating time
Notes: The GP32 is perhaps the most technically impressive next-gen handheld. Its online connectivity could revolutionise the way games are distributed

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OPEN WITH CARE

Console: PlayStation3
Computer: Cisco Router
Handheld: UMTS Mobile Phone
Genre: Online
Chip: Emotion Engine
Game: *Shenmue*
Graphics: Bezier Patches
Sound: 3D Audio Surround Sound
Memory: 10Gb hard disk
Media: DVD
Character: Player avatar
Man: Bill Gates
Country: France
Magazine: Edge.com

Specifications

CPU: Zilog Z80A 8bit processor, 3.5MHz

Graphics Processor: Multi-chip ULA (Uncommitted
Logic Array) converting video RAM into TV signal

Main RAM: 16K/48K (roughly 0.02/0.05MB)

Memory bandwidth: n/a

Graphics RAM: 1K

Theoretical performance: 16 colours onscreen,
16 moving UDGs (user-defined graphics)

Estimated real performance: Two colours onscreen
to avoid colour clash, smooth 2D visuals, flickering
monochrome polygons

Graphics functions: DRAW, PLOT, CIRCLE and
others. INK, PAPER and BORDER customisable.
FLASH, INVERSE and colour clash available.

Sound RAM: None

Audio performance: One channel via a piazzo-
electric speaker. Ten octaves

Storage: Audio cassette, around 50K per five
minutes. Compatible with fast, if unreliable, Sinclair
Microdrive magnetic tape technology

Input/Output: Two 3.5mm microphones, Edge
connector .

Networking: Almost. Prestel Adaptor planned,
but cancelled

Notes: Slow custom BASIC using single-keystroke
BASIC keyword entry
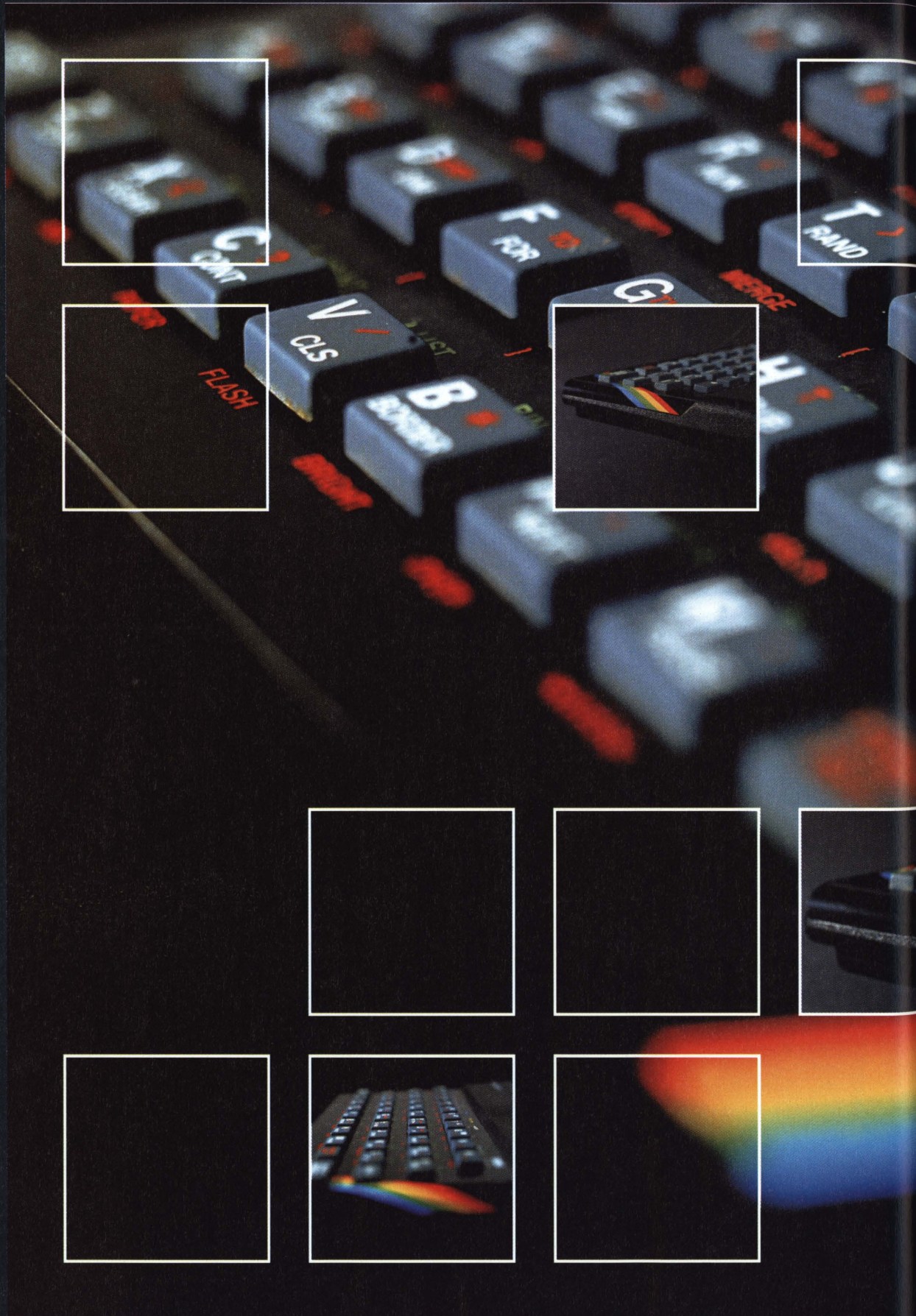
Manufacturer: Sinclair Research Ltd
Partners: Nine Tiles Cambridge, Timex Dundee
Launch date: April 1982
Launch price: £130 (16K), £180 (48K)
Country: UK

Focus: Spectrum

Designed to appeal to parents keen to introduce their children to computers,
the ZX Spectrum unwittingly spawned the UK videogame industry. **Edge** learns
the fascinating story behind the project from the man himself, Sir Clive Sinclair

In an unfair world, one of the greatest injustices is that the general public files **Sir Clive Sinclair** under the category of 'ridiculous electric buggies'.

Ill-advised the C5 might have been, but it was a well-meaning whimsy funded by a previous Sinclair invention that had made its way into millions of bedrooms and brought programming within reach of the UK game industry figureheads when they were still in short trousers.

With the ZX Spectrum, Sinclair became the happy father to the UK game industry. The birth, unsurprisingly, was a painful one.

In 1981, Sinclair Research Ltd had two hugely successful computers to its name. But with component prices plummeting and dozens of companies making a grab for a slice of the computing action, it was likely to

be a matter of months, not years before the thunder was stolen from the ZX80 and ZX81. Sinclair resolved to make his own products obsolete before his rivals developed the products that would do so. As a result, in September 1981, a team of 20 engineers crammed into tiny cubicles in a small office in King's Parade, Cambridge, reporting directly to Sinclair, set to work on what would become the Sinclair ZX Spectrum.

The seed of an idea

Sinclair's success was built on selling the cheapest computers in the world, and an elegant plan ensured the Spectrum would be no exception.

"We simply recycled our old ZX80 and ZX81 architecture," he recalls. "We had the concept of utilising just one bank of RAM, rather than separate memory

Controlling the Spectrum

The Spectrum's primary controller, and the choice of many owners over the expensive joysticks that were available, was its keyboard.

A sheet of rectangular rubber keys, placed over the flat, touch-sensitive membrane of the ZX81 keyboard, the Spectrum keyboard's soft, moist 'dead flesh' feel was far from suited to business applications, but proved curiously effective for gameplaying.

As Sir Clive Sinclair himself admits, the Spectrum's cursor keys would never have been placed in a row along the top of the keyboard if he had guessed that the machine would be used primarily for games. Developers helpfully provided a 'redefine keys' option for most games – Q for up, A for down, O for left, P for right, and M for fire emerged as a favourite layout.

The thin coating of metal beneath the rubber was prone to rubbing away with prolonged use, and, naturally, it was usually the 'J' key – crucial on the ZX Spectrum when typing LOAD"" to bring a game into memory – that faded first.
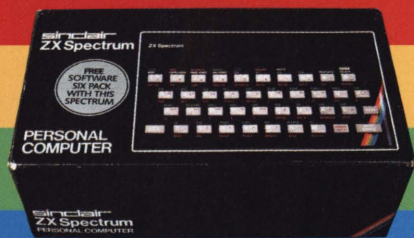
That the ZX Spectrum was created in just five months is incredible enough, but the effect that Sinclair's small, humbly packaged computer caused was nothing sort of phenomenal

areas for data and video. We squeezed the control routines and the BASIC for the whole machine on to one tiny ROM, and we took advantage of the television sets and audio players already in people's homes to avoid having to supply those ourselves.

"With our core market being parents buying computers as presents for children, there was simply no point trying to sell a machine for £500," he adds.

Aside from a crystal-controlled timer and the extra chips needed to improve upon the ZX81's slow black-and-white display and pitiful one kilobyte of memory, Sinclair's marketing manager wasn't far wrong when he succinctly summed up the Spectrum as simply "a ZX81 with colour."

Sinclair cannibalised its existing technology throughout. The new computer needed a real keyboard, so a cheap sheet of rubber keys

(nicknamed 'dead flesh' by reviewers) was placed over the ZX81's own flat, touch-sensitive membrane. The Spectrum's 16K ROM program, which ran the machine and housed a unique version of BASIC, was fundamentally an expanded ZX81 ROM – itself an enlarged version of the two-year-old ZX80 code. The cheap Zilog Z80 CPU was replaced with the Z80A, the slightly faster follow-up.

"That processor really was the limiting factor," laments Sinclair.

Rick Dickinson, the man behind the Design Council Award-winning ZX81 case, was asked to bring a sleeker, more marketable look to Sinclair computing, while squeezing 192 BASIC functions onto just 40 keys. An injection-moulded black case was chosen against the ZX81's vacuum-formed box – a rare case of Sinclair spending money to make money –

and colour was liberally applied to tart up the dust-coloured rubber keys.

"Looking back, I'm not quite as pleased with the Spectrum as I was with the ZX81," says Sinclair. "It's still quite a cute machine."

Maybe, but for the computer newcomer, the Spectrum oozed futuristic appeal.

Short gestation time
Sinclair demanded that the machine be turned from initial specifications to first production model in just five months.

"It's hard to believe how quickly we worked back then," he notes. "It was mainly thanks to having such an agile, enthusiastic, talented team."

The Spectrum was shunted from prototype to manufacture with no room for testing or benchmarking. **John Grant** of ROM developer Nine Tiles remembers

How it works

The Spectrum was primarily controlled by two big chips – the Z80A CPU itself, and the ULA (see diagram) – and, with no separate video RAM, running the average Spectrum game was a simple case of the former reading and writing directly from and to main memory.

The Z80A fetched program code straight from RAM via its address and data buses one line at a time, and calculated accordingly, writing information to the 16K section of memory devoted to the screen whenever the program demanded. Meanwhile, the ULA accessed the screen memory independently and passed the information on to the TV.

While most early games relied on built-in input/output routines, by the beginning of 1984 most developers used custom code for writing to the screen, reading the keyboard and so on, which led to the ROM firmware being largely ignored once the game was underway.

Thanks to an outdated BASIC interpreter with its roots in the ZX80, Spectrum software crawled along until '100% Machine Code' became a common sight on cassette inlays. Programmers familiarising themselves with the Spectrum's interrupt system, which called the Z80 to a regular, split-second halt, also made for smoother, faster play.
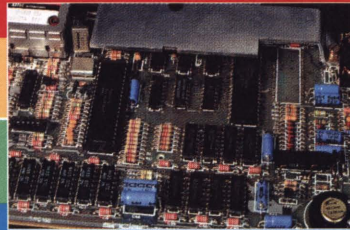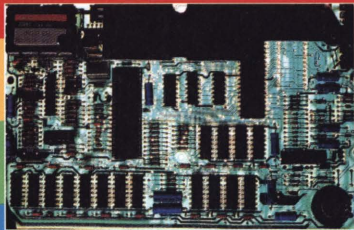
"people designing circuits on their bench, soldering in another resistor or logic gate to see what happened, then, if it worked okay, sending it off so 10,000 could be manufactured."

"It wasn't so much engineering as improvisation," Grant says wryly. Components were overclocked as a matter of routine, new versions of BASIC were hastily tested on laboratory ROM chips which were still being tested themselves, and routines to control future peripherals were coded without finished hardware to hand.

Many of the Spectrum's most loveable quirks were the result of ingenious shortcuts and tricks to keep cost at a minimum. For example, with colour information for 49,000 pixels contained in just 256 bytes, the infamous 'attribute clash' was born, as pixels battled with each other to retain their own colours. The machine's stubborn

inability to load a game after scores of attempts might have been due to the tape-handling routine being, in Grant's words: "tested with around three cassette recorders before being sent off to be manufactured."

With completion approaching, Sinclair's new colour computer, internally referred to as the ZX82 throughout development, required a name.

"We wanted something new that stressed the colour aspect of the machine," Sinclair recalls. In the event, it was the girlfriend of Nigel Searle, Sinclair's marketing director, who suggested the name 'Spectrum'. The ZX remained to reassure customers that they were buying into Sinclair's next step in home computing – and to remind those in the know that the machine wasn't too far removed from its older siblings, in order to forestall any possible disappointment.

Labour pains

Devising a new computer in five months was already some achievement, but then came the tricky part, with the Spectrum's launch seeing the company besieged by problems.

In February 1982, Nine Tiles' Steven Vickers and Sinclair's Richard Altwasser had departed to build their own Sinclair-beater, leaving an unfinished ROM in early Spectrum models that required a plug-in circuit board (known as the cockroach) to work. Meanwhile, an early manufacturing problem and phenomenal demand for the machine resulted in ten-month delays in delivery, and a formal reprimand from the Advertising Standards Agency.

Once production stepped up, however, Sinclair sold a staggering 250,000 units a month. It was a British success story that encouraged Margaret Thatcher
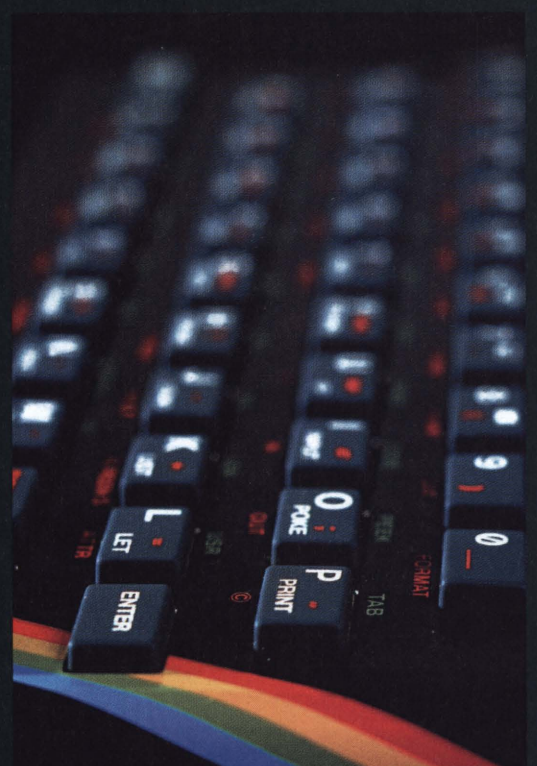
The cassette deck's finest hour

Steven Vickers of Nine Tiles, the Cambridge company responsible for the Spectrum's ROM, planned for the machine to communicate with a wide variety of add-ons, but his departure from Sinclair and the hasty completion of the project led to his plans being unfulfilled.

Sinclair's Microdrives (relatively fast magnetic tapes which worked not unlike the doomed 8-track audio machines) did make it, but they emerged late, expensive, and bugged, with commercial games already having found their natural home on cassette.

Technically, Spectrums could be networked together, and Sinclair boasted of plans to hook the machine up to Prestel, an '80s-only Ceefax for home computers. But with most Spectrum owners preferring to cluster around the keyboard for multiplayer gaming, the plans came to nothing.

However, as long as there was a television and cassette player to hand, the Spectrum's audio/visual inputs and outputs could be exploited, and taught the UK the importance of cleaning tape heads and twizzling the player's azimuth head in order to successfully load a game.

The Edge connector was the computer's most powerful I/O port, with a large portion of the Spectrum ROM given over to handling peripherals connected to it.

+ Incredibly cheap for
a home computer

+ Huge installed user base

+ Loyalty to Sinclair brand
and Sir Clive Sinclair

+ Thousands of games
available

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The original 'X' factor

An eccentric's family

It was the biggest-selling home computer of all time, and yet the ZX Spectrum range was at an end before 1987. Why?

After marketing digital multimeters for a hobbyist market, and pioneering pocket calculators and portable televisions for a world becoming obsessed with modern technology, Clive Sinclair turned to the product that would make him his fortune: the personal microcomputer.

1977 MK-14: A build-it-yourself computer for hobbyists that was little more than a circuit board and a hexadecimal keypad, with National Semiconductor's sweetly named 'Scamp' processor at its heart. Thirty thousand sold.

1979 ZX80: The first Sinclair computer designed for the average Joe, and cheap and compact enough to appeal. At the time, the ZX80 was little more than Sir Clive's means to earning money for development of his pet project: flatscreen TVs.

Why it wasn't enough

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- Pace of industry led to
16bit machines superseding

- Technically superior
Commodore 64 chosen
by many

- Sale to Amstrad
took Spectrum out
of Sinclair's hands

- Often regarded as little
more than a child's toy

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to brazenly present a machine to the Japanese premier as proof of the UK's technological superiority – which must rate as one of the most delicious ironies to date, more so given Sinclair's demise.

Of course, it soon became clear that the Spectrum was largely being bought in order to play games, which took Sinclair very much by surprise.

"Initially, the target audience were people who wanted to learn about computers," explains Sinclair. "We realised some of that would be done through games, with Spectrum owners typing in games programs printed in computer magazines."

In fact, the flood of game software came as a direct result of Sinclair's original dream. Teenage coders, tinkering with type-in programs and exploring the Spectrum's foibles courtesy of Stephen Vicker's superb manual and their own ingenuity, soon broke free of their bedrooms with breathtaking pace, and began creating, marketing, and selling commercial software within months of the machine's launch.

Those youngsters grew up to be the Peter Molyneuxs and Dave Perrys of today. And both they and the rest of the Spectrum-owning masses hold a special place in their hearts for the Spectrum and Sinclair himself, who hasn't left home computers behind just yet.

"We were working on some ideas for a very advanced games machine back in '85," he recalls. "I'd actually got the display working – one with which you could actually see a 3D world without glasses. I'd love to return to it. That would be very exciting, wouldn't it?"

Colour clash in three dimensions? **Edge** can hardly wait…

ZX Spectrum peripherals

Several companies including Sinclair marketed joystick adaptors that plugged into the Spectrum's expansion port and accommodated a huge range of arcade-style sticks. Derby-based firm Kempston emerged as the most successful. Also available: mice, digital steering wheels, and, infamously, plastic surfboards fitted over the keyboard.

1981 ZX81: No sound, no colour, and a membrane keyboard, but a sub-£100 price point made the ZX81 an irresistible purchase for hundreds of thousands of UK homeowners eager to take the technological leap.

1983 Spectrum+: Rumours of a follow-up to the Spectrum were borne out: just a Spectrum 48K with a new keyboard, and not even a proper keyboard at that. Soon after, the original 16/48K model was discontinued.

1985-87 Amstrad series: Following financial troubles, Clive offloaded the computing side of Sinclair to Amstrad, who bolted tape recorders and disk drives onto the existing Spectrum to create the +2 and +3 models.

Soft focus

Manic Miner

With the UK largely unaware of Shigeru Miyamoto's work, British teenager Matthew Smith perfected platformers in 1983 with *Manic Miner*, awash with pixel-perfect jumping.

Knight Lore

Chris and Tim Stamper created the first of many sensations with the isometric adventure *Knight Lore*, an oft-cloned slab of Spectrum-straining software.

The Hobbit

Hitherto the reserve of room-sized mainframes, text-based adventures strode into the mainstream with Beam Software's colossal *The Hobbit*, which oozed atmosphere.

Daley Thompson's Decathlon

A rip-off of Konami's *Track & Field*, *Daley Thompson's Decathlon* was hardly original. But how many veteran gamers don't remember bashing those rubber keys for a new record?

R-Type

R-Type was closer to the arcade original than owners of a six-year-old machine had any right to expect, and brought multiple colours back to a washed-out Spectrum line-up.
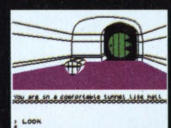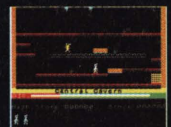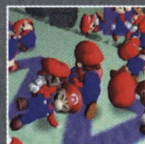
Using the covermounted PC CD-ROM

The disc on the cover of this special edition will run on any multimedia PC. Insert the CD-ROM into your drive and the menu program will autorun if you have this feature enabled. If the disc does not run automatically, double-click on the edge.exe file found in the root of your CD drive. You may be prompted to install DirectX 7.0a. After a few seconds you will be presented with an introduction screen. Clicking on 'no game' will open up a menu showing a selection of hardware platforms. Simply click on the appropriate icon to go to that section. Clicking on 'game' will introduce you to an interactive menu: the first icon selected becomes a target. If you are able to select 12 icons of the same type before the timer counts down, a hidden demo will open up. Hitting the wrong icon deducts one from your score. If you select less than 12 icons, you will go to the appropriate section without unlocking the secret demo.

The **Edge** disc has been thoroughly tested at all stages of production. We recommend that you always run a virus checker on any software before running it. Future Publishing Ltd cannot accept any responsibility for disruption, damage and/or loss to your data or your computer system which may occur while using this disc or the data on it. Ensure that you have up-to-date backups of data contained on your hard drives before running any new software.
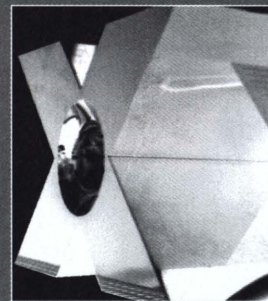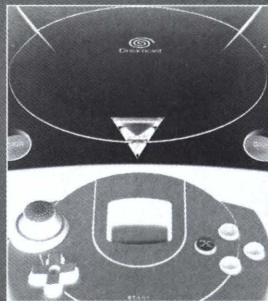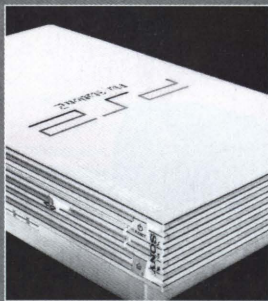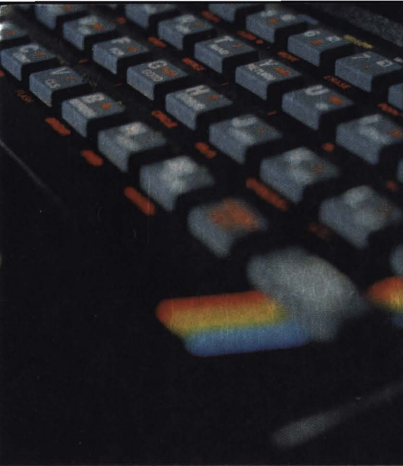
PC CD-ROM content

Those not lucky enough to attend Sega's Dreamcast Premiere event, which took place at The Empire Cinema over the weekend of ECTS, will be able to view extracts from the showreel by selecting the Dreamcast icon. Highlights include *Phantasy Star Online* and *Gun Valkyrie*. Likewise, a selection of video from Nintendo's Spaceworld event can be found in the GameCube section, including *Metroid* and *Star Wars* demos, and a promotional video under the Game Boy Advance section. There are also several PlayStation2 demos, featuring the likes of *Ridge Racer V* and *Tekken Tag Tournament*, and Microsoft's *Raven* demo can be accessed by clicking on the X-Box icon. Finally, there is a multiple-choice quiz, consisting of 100 questions designed to sort out the Hardcore Gamer from the Massmarket Martin.