

Lifting the lid : inside the Nintendo 64

Article scanné dans le magazine N64 n°01 (Avril 1997)

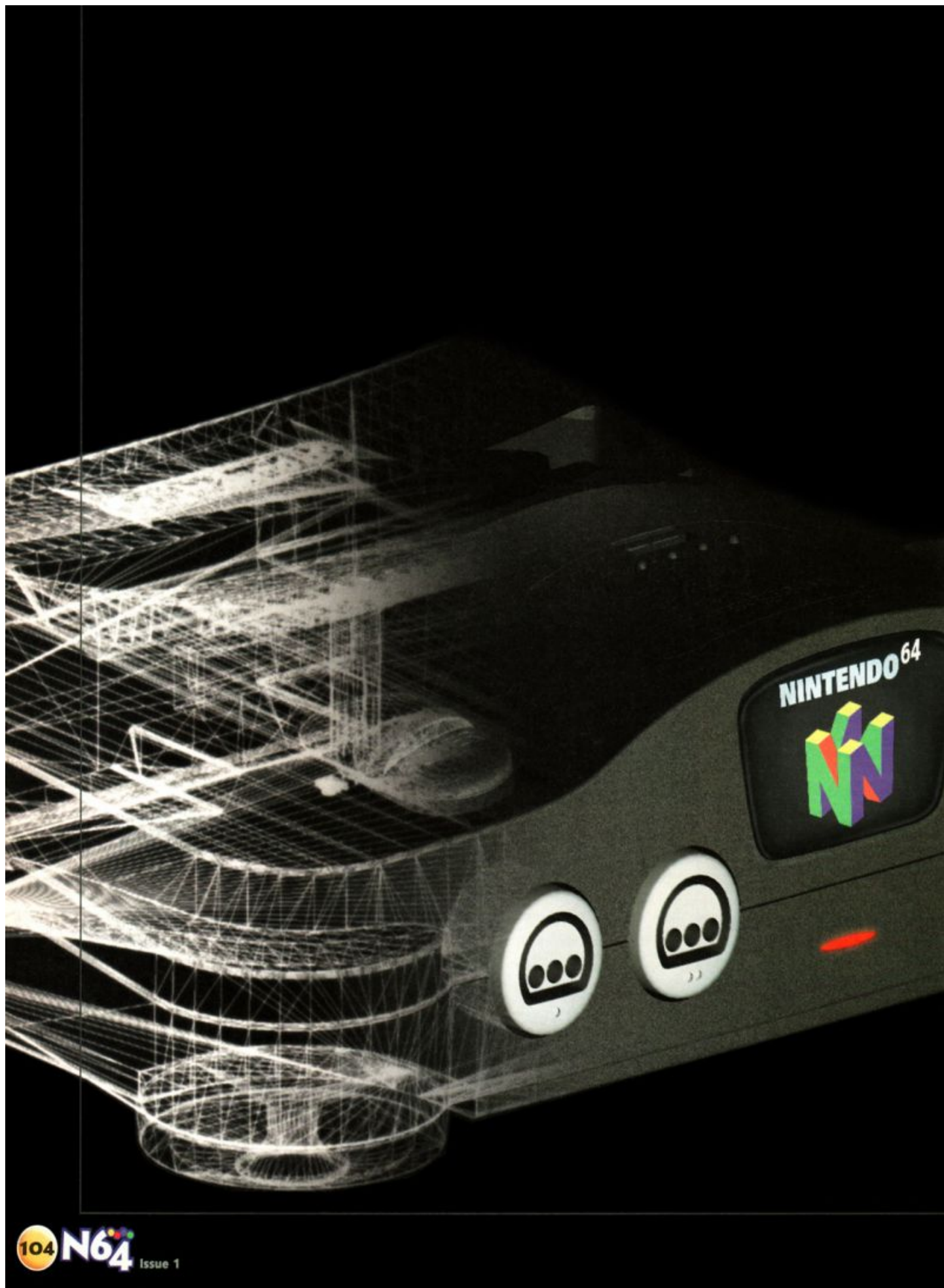
Sujet de l'article : Nintendo 64 (*)

How can something so great been squeezed into so small a box? Let's open one up and see..

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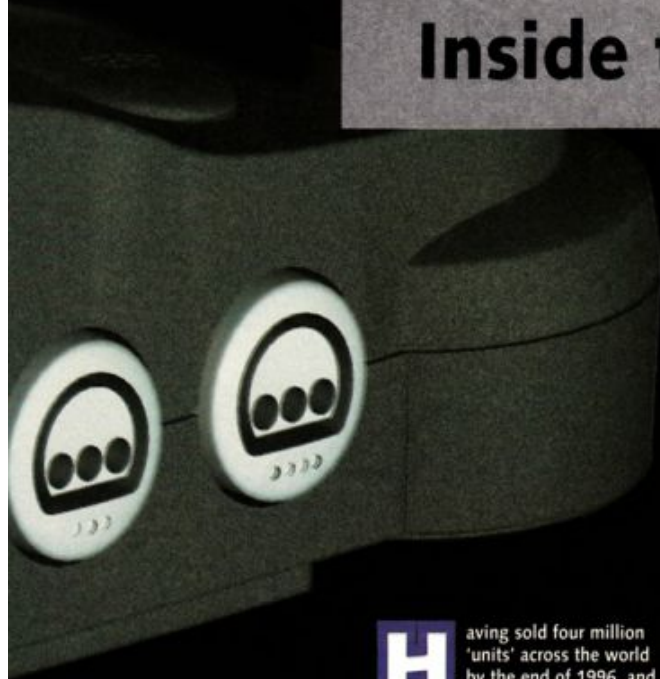
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How can something so great have been squeezed into so small a box? Let's open one up and see...

LIFTING THE LID

Inside the Nintendo 64



Having sold four million 'units' across the world by the end of 1996, and probably the same again since then, the Nintendo 64 has swiftly established itself as one of the most significant events of the late 20th century. In fact, not since the inventions of electricity, the flushable toilet, the wheel and fire has something been so eagerly snapped-up by the human race.

But why? Surely the Nintendo 64 is just another games console. Surely its arrival is just another step up the technological ladder, like the Saturn, the SNES and the NES were before it.

Ah. But no.

Previous games consoles have been designed by games console manufacturers. They've been based on previous games consoles, and made better – faster graphics, double the 'bits', CD-drives, more sound channels, more buttons on the controller. Nintendo came from the opposite direction entirely with the Nintendo 64. They teamed up with Silicon Graphics, a manufacturer of sophisticated, £10,000 graphics workstations who'd previously been more concerned with creating multi-million-dollar Jurassic Park inhabitants than chubby Italians. And, after doing

some complicated sums, they discovered that by chopping out a few non-essential components, and applying ruthless mass-production techniques, they could squeeze much of the power of a £10,000 machine into a box the size of a human lung, and sell it for less than everyone else's old-style consoles.

No-one quite believed them. Back in the middle of 1993, when Nintendo announced their 'Project Reality' deal with Silicon Graphics, Sega and Sony were beginning to steal Nintendo's thunder with their promises of new 32-bit consoles. Nintendo hadn't come up with anything similar,

GO! GO!

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after dithering over the SNES CD-drive for ages, and cynics wondered whether they'd just been trying to grab back the headlines by making the most outrageous claim they could think of. But over the months, as more details of Nintendo's new console began to emerge, with incredible-looking pictures of games, it became clear that Nintendo intended to keep their promise.

The result is the Nintendo 64, the first console that allows games designers to do, basically, anything. And the minds of Nintendo's carefully-cultivated band of developers have consequently been allowed to run riot. Shigeru Miyamoto has been able, at last, to create a *Super Mario* game in which his imagination roams without constraint. He's constructed an incredible 3D world where something new and surprising happens around every corner, and which the player can explore with complete freedom. In the States, Paradigm have been able to place *Pilotwings 64* players above a breathtakingly-realistic 3D landscape, providing, for the first time in a video game, a true sense of flight. Link's adventures in the next *Zelda* game will actually be enacted in front of you on the screen, rather than just being 'symbolised' by little sprites and text boxes. *Starfox 64* and *Blast Corps* look awe-inspiringly action-packed and it remains to be seen what's brewing in the minds of developers like Konami and Capcom.

And that's why the Nintendo 64 is causing such a stir. It's a combination of Nintendo's unrivalled talent for developing great games, and something completely different. People who've never before shown much interest in games consoles are looking at *Super Mario 64* in action and being instantly won-over. (We seem to get huge crowds turning up at the N64 office every lunchtime to try out the latest games.) And, at the same time, Nintendo devotees of old love it as well.

The Nintendo 64 is completely great. But, against our better judgement, over the pages to come we're going to pull one completely to bits in an effort to find out what makes it tick, and answer all those puzzling questions you'll no doubt have about it.

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MEMORY EXPANSION

Under this hatch sits a socket that allows extra RAM to be added to the N64, supplementing the built-in 4 Megabytes. The extra RAM isn't available yet (the bit of plastic in there at the moment is just an empty 'jumper', bridging the gap in the circuitry), but could be provided later, perhaps with the 64DD (see the news story on page 16) or with a particularly memory-hungry game.



ON/OFF SWITCH

Switches your N64 on. And then off again.

CARTRIDGE PORT

Carts engage with little pegs inside the machine, which, along with the security chips, prevent import carts from running on UK machines.

RESET BUTTON

Resets your N64 if, for instance, you're fed up with the lengthy 'congratulations' sequence on *Mario Kart 64*.



'GROWTH'

Only European N64s have one of these 'growths' on the controller cable. It contains, you'll be intrigued to learn, a ferrite core which is required by EC regulations and stops you electrocuting yourself with the buttons, or something. The 'growth' also doubles up as cable tensioner, so if you accidentally trip over your cable you won't damage it. Hurrah!

CONTROLLER PORTS

The N64 has four chunky, grey controller ports – twice as many as other machines – allowing for four-player games of *Wayne Gretzky* and *Mario Kart 64*. The controller ports receive inputs from the controllers and communicate with Control Paks and the forthcoming Jolt Pak.

The Nintendo 64: From conception to (eurch) birth



June 1993

Following the cancellation of their CD drive, which was to have plugged in underneath the Super NES and compete with Sega's Mega-CD, Nintendo suggest that instead they're going to begin work on a completely new console, separate from the SNES, to be launched in 1995.

The talk is of a 32-bit machine with a built-in CD drive, selling for under \$200 and targeted at the 32-bit console Sega have just revealed they have in development: the Saturn.

August 1993

Nintendo amaze the world by announcing Project Reality, a collaboration between themselves and

back

MULTI-OUT

Connects your N64 to your telly. The N64 produces composite and S-video signals, along with stereo left and right sound channels. (Unlike the Super Nintendo, the N64 doesn't produce an RGB signal.) The RF modulator supplied with the Nintendo 64 then combines all these signals into a single PAL signal, which goes into your TV's aerial socket. For a better picture you can bypass the modulator and use a composite or S-video cable to connect to your TV. See page 16 for details.

AERIAL SWITCH BOX

Saves you having to keep yanking your TV aerial in and out.

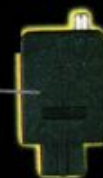


AC ADAPTOR

The black box that slots in here converts a 240V mains supply to the 3.3V and 12V supplies your N64 needs. Your efficient N64 consumes about 15 Watts of power – a quarter of that used by a 60W lightbulb.

RF MODULATOR

Instead of the stereo AV leads that other European N64s come with, UK machines are supplied with an RF modulator that converts the N64's output to one that can be plugged into any television. If you've got a more expensive television, and want to make the most of it, you'll need to invest in an AV, SCART or S-video cable. (There are some on page 16 of Planet 64.)



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EXPANSION PORT

But how could something so fine as the Nintendo 64 possibly be expanded? With the 64DD, that's how. (See page 16.) And who knows what else Nintendo might have up their sleeves?



high-end graphics workstation manufacturer Silicon Graphics. The result is intended to be a 64-bit console with the 3D graphics power of a £10,000 Silicon Graphics machine, selling – and this was the really amazing bit – for \$250. Sega and



Sony, who'd been discussing \$500 price points for their 32-bit machines, mutter comments about 'spoiling tactics'. No-one knows quite whether to believe Nintendo or not, but loads of pictures from Jurassic Park start cropping up everywhere: Silicon Graphics hardware produced the dinosaurs.

March 1994

Nintendo start to assemble their 'Dream Team', a group of developers who'll produce the first games

for Project Reality. Initially UK-based Rare sign up along with the American firm Williams. It's also announced that the two companies will together produce the Killer Instinct coin-op, which will later appear as a Project Reality game. Later, companies such as DMA, Paradigm Simulations, Acclaim, Sierra, Angel, LucasArts and Electronic Arts also sign up.

May 1994

Project Reality is still a long way off



Reality Immersion

The reason Nintendo 64 games look so much better than anything else is the Reality Immersion system that Silicon Graphics and Nintendo's experts have come up with. Reality Immersion is generated by a combination of the CPU and the Reality Co-Processor, and effectively means that your N64 has the essential components of a £10,000 Silicon Graphics workstation.

Some of the more important features of Reality Immersion are:

Anti-aliasing

The edges of shapes are blurred slightly, so you don't get jagged lines on the screen.

Texture mapping

Mapping a 2D pattern of pixels onto a 3D polygon.

Texture detailing

Having more than one texture for a particular object. The machine picks the right one, so detail is preserved as you zoom in.

Tri-linear mip map interpolation

(Good grief.) Mip stands for the Latin "multi in partem", and the technique involves calculating new textures for objects to stop them going all chunky close-up, and blending pixels together at a distance.

Load management

The number of polygons in an object is varied according to its distance from the viewer, so the frame update rate can be maintained without having to resort to the 'pop-up' or 'fog' effects seen on other machines.

Fog

Although, for the sake of realism, a fog effect can be generated.

Depth buffering

Hidden surfaces aren't drawn, to save processor time.

Gouraud shading

Colours polygons in a way that makes them appear curved.

Specular reflection

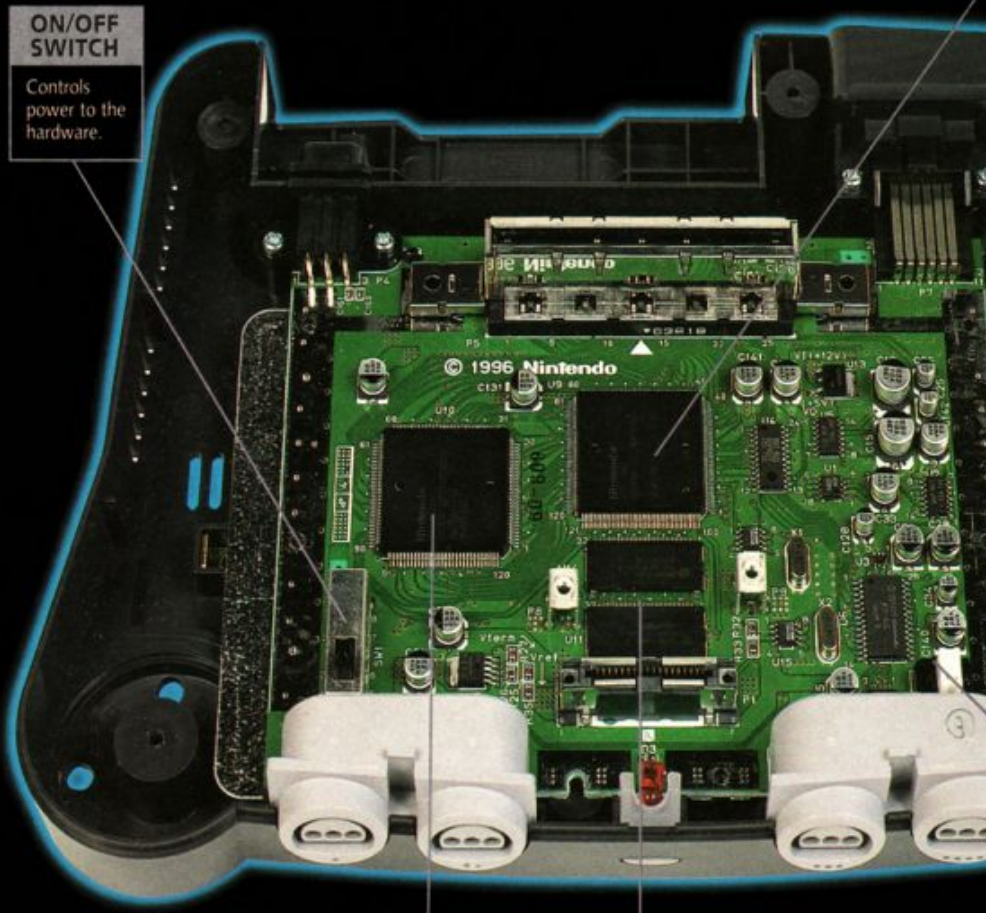
Light sources can be reflected off shiny surfaces.

All this is done automatically within the hardware (unlike the PC, PlayStation etc), so the games don't have to worry about it and can spend their time doing more exciting things.

what's in the box?

ON/OFF SWITCH

Controls power to the hardware.



CPU

At the heart of the N64 lurks a mighty R4300i CPU, which is responsible for decoding the instructions on game carts and issuing instructions to the rest of the circuitry. It's a 64-bit RISC chip running at 93.75 MHz, getting through 125 MIPS (million instructions per second), and was designed by (slightly confusingly) MIPS, a subsidiary of Silicon Graphics. They're the company that produces the high-performance graphics workstations used by companies like Industrial Light and Magic, the people who're doing all the special effects for (amongst many others) the new Star Wars films.

RAM

The N64 includes 4 Megabytes of on-board RAM (Random Access Memory), and more can be plugged in via the hatch on the top of the machine. RAM is writable as well as readable, so it's used for storing data (scores, the positions of characters and so on) as well as building up the picture that's displayed on the telly. A Rambus D-RAM system allows data to be transferred rates of up to 562.5 Mb per second, and a 128-bit wide data bus will shift two 64-bit numbers at once.



— a year at least — so Nintendo announce a stop-gap. They'll be producing a 32-bit machine after all, but it'll sell for under \$200 and be based around "Virtual Reality". Strangely, though, it won't be necessary to wear a special headset. The eventual result is the ill-fated Virtual Boy.

Also, up till now no-one had been sure whether Project Reality would be using CDs, like other so-called 'next generation' consoles, or stick with traditional Nintendo cartridges. Now Nintendo revealed that carts it would be, although they'd be huge: 100 Mbit ones.

July 1994

Project Reality has a new name: Ultra 64. The Nintendo/Silicon-Graphics/Rare alliance produces an early off-shoot, too: *Donkey Kong Country*, which

will be developed for the SNES by Rare using Silicon Graphics hardware. The idea is, with Ultra 64 still not due for a year at least



REALITY CO-PROCESSOR

The N64's breathtaking 3D graphics are largely thanks to this fellow – the Reality Co-Processor (RCP). Like the main CPU it's a 64-bit RISC chip, this time running at 62.5 MHz, and has been designed by Silicon Graphics specifically for the N64. Its main purpose in life is to generate the graphics you see on your TV screen, although it handles the sound side of things as well. The RCP can actually crack through half a billion arithmetic operations per second – about ten times as many as the Pentium processor in an average PC – and will generate around 160,000 rectangular polygons per second with all the N64's special effects enabled. The RCP and the CPU together make what Nintendo call the Reality Immersion system.

carts



One of the most troublesome stumbling blocks on the path to the N64's creation was Nintendo's dilemma over whether to store games on cartridges or CD. All Nintendo's previous consoles had used cartridges, going right back to the NES, while the N64's competitors – the PlayStation and Saturn – had plumped for the more fashionable new CD format. Nintendo issued statements on an almost monthly basis as they first decided to use CD, then cartridges, then CD again, then cartridges, then CD... No-one knew what was going on. In the end, though, Nintendo settled on cartridges, a decision that raised a few eyebrows.

CDs usurped cartridges – at least as far as Sony and Sega were concerned – for obvious reasons. While the amount of space on a cartridge is limited to the number of expensive ROM chips crammed into it, a CD can store an inconceivable amount – well over 600 Megabytes (Mb), compared to the 16Mb (or 128 Megabits) of *Turok*, the largest N64 cartridge so far. More importantly, a CD costs about 30p to manufacture, while the complex electronics in a cartridge cost several pounds. And, of course, cartridges tend to be viewed as 'old technology', while CDs seem new and exciting.

From Nintendo's point of view, however, cartridges still had the edge. They're much harder for bootleggers to copy, for a start, and Nintendo's security chip makes it extremely hard for third-party games developers to circumvent Nintendo and manufacture their own cartridges. Access times of cartridges are virtually zero, so you don't have to sit staring at "Loading – please wait" messages. Battery back-up can be incorporated into cartridges, so positions and scores can be saved in them. Cartridges don't get scratched (a major problem with PlayStation CDs). And there's no need to incorporate a costly and potentially unreliable CD drive into the machine. And in any

case, the full capacity of CDs is rarely used, with the actual game code taking up just a few Megabytes while the remainder tends to be filled with music and video footage of questionable benefit.

The Nintendo 64's hardware, meanwhile, makes it possible to create huge 3D worlds like *Super Mario 64*'s just by specifying a few polygon co-ordinates, so enormous games can be squeezed into tiny

spaces – *Pilotwings 64*, for instance, fits into less than 7Mb. And, better still, the N64's hardware includes data-decompression, so there's more actually packed into each cart than there might appear. If more space really is required (say for huge RPG games) the forthcoming 64DD drive (see *Planet 64*, page 16) should provide ample. This extra storage will also be writable, allowing players to customise games.

Inside a cart

ROM

The cost of memory chips is drifting gently downwards all the time, so N64 carts can be much heftier than their SNES forebears. A typical N64 cart is 64 Mbit (8 Megabytes), with *Mario Kart 64* coming in at 96 Mbit, 128 Mbit carts on the horizon, and a theoretical maximum of 256 Mbit.

Save-game chip

SNES cartridges used to store data in a small RAM chip supported by a battery. N64 carts, on the other hand, have a more sophisticated system involving an EEPROM (Electrically Erasable Programmable Read-Only Memory) chip that can store data without the need for a battery. It's only tiny (it'll record your *Mario Kart* lap times and cups, but you'll need a Controller Pak to store *Time Attack* ghosts), but is another thing that's just not possible with CD systems.



RESET SWITCH

Resets the CPU, causing it to restart the current game as if the machine had just been switched on.

to show that the SNES still has life in it yet.

November 1994

Sega launch their 32-bit Saturn, nearly a year before Ultra 64's projected release date. Nothing has yet been seen of any Ultra 64 games.

January 1995

Silicon Graphics announce that the chips that will



power the Ultra 64 are complete, and that the machine is on target to be launched by the end of the year. And, most importantly, it will be just as powerful as they'd always claimed.

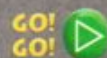
May 1995

Bad news. The Ultra 64 isn't going to be ready for the summer after all. The Japanese release date is now set at December, at Nintendo's Shoshinkai exhibition, with the US and Europe getting machines the following April. No reason has ever been officially

given, but it seems likely that the hold-up was with software. The Dream Team hadn't come up with anything that used the machine's full potential, and Nintendo's own internal development teams, led by Shigeru Miyamoto, were running late. At the time, it looked like a costly delay for Nintendo.

August 1995

Hints are dropped about the Ultra 64's controller, which will be 'revolutionary', providing more control over games than has ever been possible before.



taking control

Nintendo always lead the way with their controllers. When they launched the NES, everyone else was using clumsy joysticks and paddles; now joypads are the standard. When the SNES came out, the shoulder buttons on its controller were unique, and a vital aspect of *Mario Kart*'s steering; now everyone includes shoulder buttons on their joypads. And the Nintendo 64's analogue joystick is such a huge leap forward for video games that other manufacturers will have no option but to sheepishly follow suit. Just you see.



L AND R BUTTONS

As featured on the SNES controller, and likely to see much the same sort of use – cycling through weapons and so on.

Z TRIGGER

Used for launching rockets and taking photographs in *Pilotwings*, and using power-ups in *Mario Kart*. It's nice to have it there, although it can sometimes be awkward to use at the same time as the joystick.



D-PAD

This is the standard directional control, as seen on a hundred other controllers. Most N64 games are likely to use the analogue instead, although the two could be combined to provide a 3D movement and looking-around system in, say, a 64 version of *Quake*. The N64's D-pad is identical to the excellent one on the Super Nintendo.

JOYSTICK

This innocuous-looking, mushroom-shaped object is in fact the most innovative and vital part of the 64's controller. It's an analogue joystick providing 360° movement (rather than the up, down, left, right and diagonals of ordinary controllers) in varying amounts (rather than just on or off). Push it forward slightly, for example, and Mario will tip-toe. Push it further forwards and he'll jog, then run, then sprint. The joystick also lets you make smooth, gentle turns in *Pilotwings 64*, aim precisely at dinosaurs in *Turok*, and steer *Mario Kart* in gradual increments.

A AND B BUTTONS

These are your main fire buttons. There's nothing special about them at all.

COLOURED CONTROLLERS

Don't like grey? N64 controllers are also available in red, blue, green, yellow and black. The Japanese get a grey-and-black *Mario Kart* one, too.



C GROUP BUTTONS

There are four of these – the perfect number for moving the view up, down, left and right in *Mario 64* and *Pilotwings*, and walking about in *Turok*. In *Wayne Gretzky* and *Perfect Striker*, on the other hand, they're used for intricate attacking and defending moves, something they're not ideally placed for.

CONTROLLER PAK SLOT

Controller Paks (onto which you can save personal data like scores and set-ups) and the Jolt Pak plug in here, and there's talk of a slot-in light gun.



November 1995

At Nintendo's Shoshinkai show in Japan, 11 Ultra 64 games are displayed to the public for the first time. They look just as impressive as Nintendo had promised, although only two are playable, and none is anywhere near finished. The release date is correspondingly pushed back to April world-wide. And the name is changed again, too: to Nintendo 64.

February 1996

Oh dear. The Nintendo 64 now won't arrive in Japan until June, America until September with no release date at all set for Europe. But anticipation for the machine is now reaching fever pitch with *Super Mario 64* in particular causing an increasing stir.

June 1996

At last! The Nintendo 64 goes on sale in Japan on June 23rd, and sells 300,000 on its first day alone – equivalent to the first-day sales of the PlayStation and Saturn combined. Practically everyone buys a copy of *Super Mario 64* to go with their new machine. *Pilotwings 64* and *Shogi Chess* are the only other games available.

September 1996

The Nintendo goes on sale in the US with the initial 500,000 machines available selling out immediately.

March 1997

Europe at last gets its hands on the N64. At £250 the N64 sells out instantly in the UK, although that's unsurprising given that only 20,000 are brought into the country initially.

playing import games

While the Nintendo 64 has only just been launched in Europe, and only a handful of games are officially available for it, it's been out in America since last September and in Japan since June, and has built up a sizable catalogue of games in these countries. And, while many third-party developers like Acclaim and Ocean are releasing games virtually simultaneously across all territories, Nintendo themselves are delaying European release dates to, they claim, give each game some breathing space. So *Mario Kart 64*, available in Japan since December and the US since February, won't be reaching Europe until June.

That's an awful long time to wait, so many European N64 owners are likely to want to play the latest games as soon as they become available in the US and Japan. The only way to do this at the moment is by using an N64 sold outside Europe, which will contain a US/Japanese security chip. But within the next few weeks companies like Datel and Fire will be producing adaptors allowing import games to run on standard UK machines. We'll have more news of these in the next couple of issues.

Meanwhile, if you're planning to get a US or Japanese machine, there are a couple of things you need to know...

Using Japanese and US N64s in the UK

To play games on a US or Japanese machine – bought from an importer (several advertise in *N64 Magazine*) or brought back from your hols as a 'souvenir' – you'll need two things. First you'll want a multi-standard television that's capable of displaying an NTSC signal as well as the normal PAL one. Most televisions bought in the last couple of years should be fine, and Sony ones seem particularly compatible. Imported N64s come with three

phono outputs for video and the two audio channels, which can either be connected to similar inputs on your television or, via an adaptor, to a SCART socket.

Alternatively you may be able to track down a Nintendo S-video cable, which will give a slightly better picture if you've got an S-video input on your telly. The other thing you'll need is a step-down transformer to provide a 110/120 Volts AC supply for your machine. These cost about £30 from electronics shops like Tandy. Finally, if you want to be able to play both US and Japanese games on your import machine you'll need either

to make a small modification to its innards (see below), or to invest in a bridge adaptor.



Disabling the 'lock-out' on import machines

The only thing preventing US and Japanese carts from being interchangeable on US and Japanese machines are two pegs on a plastic rail inside the N64, which are spaced differently on the two machines. This rail can easily be removed, although doing so will invalidate any warranty your machine may have. (And we're not responsible if you break your N64 in the process.) The more expensive, though safer, alternative is to buy a bridge adaptor. (See Planet 64 on page 16.)

Step 1 Open the machine

Tricker than it may sound, owing to the curious screws favoured by Nintendo. A suitable screwdriver (a ZE1 tamperproof one) can be obtained from electronics suppliers, such as Maplin. Watch out for the RAM jumper while you're removing the lid.



Step 2

Locate and disable the rail

It's that bit of plastic into which the cartridge slots, with the two pegs on. Either unscrew and remove it, in which case you'll lose the use of the plastic dust flaps that protect the cart slot, or carefully take a hacksaw to the pegs and get rid of them.



Step 3

Reassemble your N64

You'll now be able to play both Japanese and American games.

All that remains now is for us to work out how all this stuff goes back together again. Hmm. Now, where does this little green bit go...

WHAT CART?

Nintendo 64 carts from around the world might look identical. But are they? Ooh no, missus.

AMERICAN CARTS

Although the code on the ROMs may be different, American N64 carts are electronically identical to Japanese carts.



JAPANESE CARTS

Japanese carts have a slightly different casing to US ones, to discourage imports, although a simple modification makes the two machines compatible.



HONG KONG CARTS

Carts bought in Hong Kong, interestingly, have American code (English language) but have holes in the Japanese style.



UK CARTS

UK machines and carts, meanwhile, have different security chips inside, and aren't interchangeable with US and Japanese machines and carts without an adaptor.



NEXT MONTH: N64 EXPLORES THE HISTORY OF NINTENDO, AND SPEAKS TO SHIGURU MIYAMOTO, THE FATHER OF MARIO!

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