



FEATURE - PART 5

(R)evolution of Portable Audio: Back in a flash

The path to portable digital music would be potholed with failed products and legal threats, but as Darren Yates writes, it was the personal computer that finally brought music into the 21st century.

Above: The iPod Mini in 2004 was Apple's first no-moving-parts music player (Image credit: Apple).

Below: The legendary Sony TCD-D7 portable digital audio tape recorder (Image credit: Binarysequence, CC BY-SA 4.0).

As we've seen throughout this series, any portable audio revolution is usually preceded by years, or even decades, of research and development before an idea reaches a level of maturity for it to take off. However, an idea of Toshiba electrical engineer Fujio Masuoka was so far-reaching, it was to have ramifications well beyond the field of portable audio. As tech giants Sony and Philips were prepping the Compact Disc, Masuoka's invention of fast-erase floating-gate memory would set in motion development of the world's first practical no-moving-

parts data storage device. The global tech industry, and portable audio in particular, were about to move into the fast lane.

No moving parts

Masuoka had already been quite prolific during his early days at Japanese tech giant Toshiba. He'd developed the 1Mbit Dynamic Random Access Memory (DRAM) chip in 1977, but his passion was for a memory chip that didn't need power to retain data. Electrically-Erasable Programmable Read-Only Memory (EEPROM) was the hot storage technology of the 1970s and unlike standard DRAM that powers our PCs today, EEPROM could retain data when power was removed. What made EEPROM so important for its time was that it only required an electrical voltage to erase data – previous EPROM chips required ultraviolet light to do the job. Even so, the erase process in EEPROM was still quite slow, but EEPROM nevertheless found use in early computer systems and still appears in many household devices and appliances (including washing machines).

Masuoka's 1980 invention enabled the erase process to occur

almost instantly, by grouping memory cells together in 'pages', to which a voltage could be applied, erasing the cells in bulk. The name 'flash' was suggested by this new erase speed. Sadly for Masuoka, however, Toshiba failed to grab its opportunity to lead the flash-memory market and in 1994, Masuoka quit Toshiba and returned to Tohoku University. Since then, Toshiba's Westinghouse nuclear plant division filed for bankruptcy in 2017, forcing Toshiba to sell a majority stake in its memory chip business, Toshiba Memory, to private-equity firm Bain Capital the following year. In 2019, the joint-venture rebranded as 'Kioxia'.

Digital Tsunami

The 1982 launch of the Compact Disc changed consumer expectations for audio quality. Years of dealing with background hiss and noise-reduction were gone thanks to this new tech delivering seemingly-perfect sound literally on a 'silver platter'. But Compact Disc didn't solve the next question – how to record digital audio. Sony's PCM-1 Processor and Betamax video cassette recorder (VCR)



combination may have been first, but with Sony conceding defeat in 1988 and releasing its first VHS recorder, neither Betamax nor VHS were the ideal option. However, the launch of Compact Disc opened the flood gates, as new media formats attempted to win over the home-recording market.

Digital Audio Tape

One of the first was Digital Audio Tape or DAT. Released in 1987, DAT was a cassette format larger than a MiniDV video-camera tape but smaller than the original Compact Cassette. Essentially, a DAT recorder was a mini VCR, pulling the 3.81mm-wide magnetic tape around a cylindrical drum recording head. Similar to VCRs, the head used a 'helical scan' technique in which multiple heads spun around at 1500RPM while the tape itself was pulled horizontally around the drum at just 8.15mm/second. DAT allowed for the recording of lossless PCM (pulse-coded modulation) stereo (two-channel) audio at up to 48kHz sample-rate and 16-bit depth (32/44.1kHz was also supported).

DAT resulted in some of the most compact recorders seen to-date, including Sony's TCD-Dx series. Other manufacturers also jumped on-board, including TASCAM, with its excellent DA-P1.

However, the Recording Industry Association of America (RIAA) was less enthusiastic. For the first time, the home user could make copies of CDs as good as the original - this led to an RIAA executive threatening to sue any company attempting to launch a consumer-grade DAT recorder in the U.S.

Sony's purchase of the giant CBS Records in 1988 reportedly calmed tensions, but in the end, DAT failed to achieve the success it did in Japan and faded from the market during the 2000s. Nevertheless, before the arrival of the optical CD-recordable format in the mid-1990s, DAT was the only lossless digital audio recording format available to consumers.

Digital Compact Cassette

Meanwhile, Philips couldn't just let go of its Compact Cassette and explored options to create a digital version. DAT's helical scan or 'rotary' head assembly was



expensive and costly to produce, so Philips combined with Matsushita to create a new type of stationary or 'fixed-position' head, similar to that used in the original compact cassette. What's more, Philips' aim was for this 'Digital Compact Cassette' (DCC) to use the original's 4.75cm/second tape speed and 3.8mm tape-width, but also make its DCC cassette decks backward-compatible and play original Compact Cassettes.

However, there was a problem - using a fixed head reduced the bandwidth to a point that standard pulse-coded modulation (PCM) was just not an option (which is why DAT used helical-scan heads).

The solution was launched in late-1992 and was equally as radical - Philips developed what was called 'Precision Adaptive Sub-band Coding' to reduce the audio bit rate from over 1.5megabits per second (1.5Mbps) to just 384kilobits per second (0.384Mbps). The compression format would eventually be rolled into the first MPEG audio standard (which was known as MPEG 1 Layer 1).

The DCC format also included commercial copy-protection to prevent home users making digitally-perfect copies of commercially-bought music DCCs. However, DCC didn't take with the market and by 1997, Philips had discontinued the tech and the 'compact cassette' era was effectively over.

MiniDisc

As Philips and Matsushita were readying DCC for market, Sony was putting the final touches on its consumer DAT-replacement. Instead of a cassette mechanism, Sony went for an enclosed 'floptical' disc-style format it called 'MiniDisc'. Rather than being purely magnetic, the disc media was a combination magneto-optical and used a

magneto-optical head. Like CD, MiniDisc used a laser diode to read data, but the difference here was that during writing, the laser was employed to heat the recording

"The 1982 launch of the Compact Disc changed consumer expectations for audio quality."

location while the magnetic portion of the head 'wrote' the data to the disc. Recordable discs would eventually be available in 60-, 74- and 80-minutes duration.

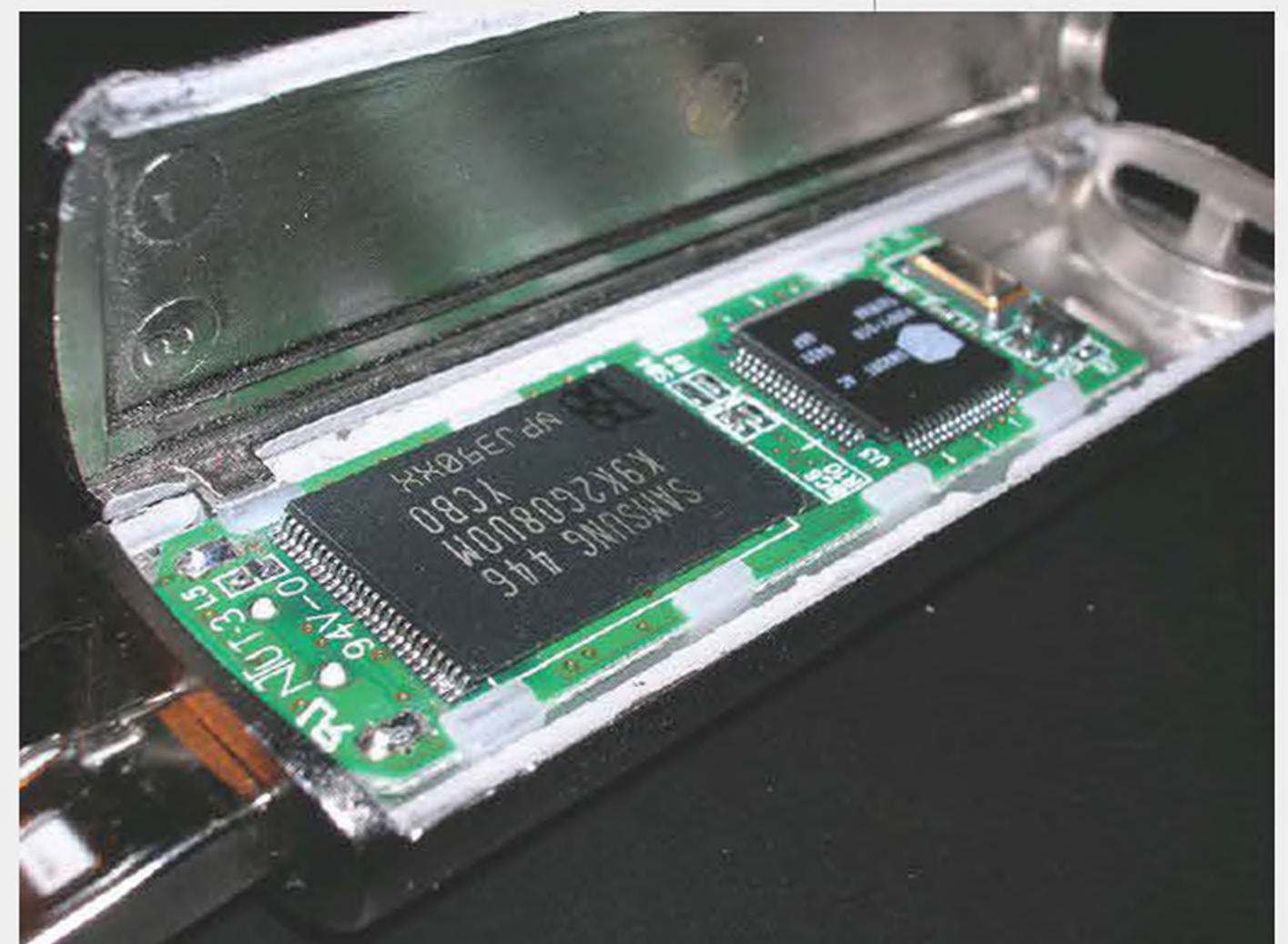
Like DCC, MiniDisc not only came with protection to prevent digitally-perfect copying, but also used audio compression. The compression format was a Sony-invention dubbed 'Adaptive

Above: DCC decks were backwards-compatible and could play your old analog cassettes (Image credit: JPRoche, CC-BY-SA 3.0).



Above: Philip's Digital Compact Cassette used audio compression to store digital audio on tape (Image credit: Paul Forsdick, CC-BY 2.0).

Below: Flash memory has made possible all of our portable devices (Image credit: Nrbelex, CC BY-SA .30).





Above: Still mechanical, but the original iPod changed the way many listened to music (Image credit: Apple).

Right: The Sony-designed MiniDisc used ATRAC audio compression to fit 80mins to a disc (Image credit: Ramon Vasconcellos, CC BY 3.0).



Transform Acoustic Coding' or 'ATRAC'. While it dropped the 1.5Mbps PCM data stream down to approximately 300Kbps, Sony did enable later MiniDisc systems to record in standard PCM format.

However, by the time it did, MiniDisc was fairing only marginally better than DCC. Sony doubled, then quadrupled the disc recording time through higher-compression ATRAC extensions 'LP2' and 'LP4', but LP4 was more suited to voice-recording than music. Nevertheless, MiniDisc only finally left the market when Japanese brand TEAC dropped its consumer and professional offerings in 2020.

CD-ripping

Until the arrival of flash-based music players in the late-1990s, music was typically a lossy

business – consumers had to copy LPs or CDs onto other media, whether cassette or MiniDisc, using analog-transfer techniques that resulted in an overall loss of audio quality. Flash-based music players (and later MiniDisc models) changed this and brought a new entertainment device to the process – the desktop computer. New terms such as 'CD ripping' and 'audio compression' entered the broader lexicon, as consumers began the search for software to 'rip' their music CDs into compressed audio formats such as MP3.

By now, Compact Disc technology was heading towards 20 years old – it arrived just weeks after the Commodore 64 home computer, so it's hardly surprising that little thought was given to the possibility that one day consumers could use their computers to make digitally-

perfect copies. But the mid-1990s 'Internet Revolution' had seen multimedia PCs with CD-ROM drives increasingly finding their way into homes. It's likely only that the earliest flash-based music players measured their storage in megabytes and not gigabytes that forced consumers to use lossy compressed audio formats such as MP3 and ATRAC, rather than use lossless PCM-format copying.

Peer to peer

In fact, the fear that led some music industry executives on a collision course with DAT was that consumers would begin making digitally-perfect copies of CDs and start sharing those tapes around, cutting the bottom out of the then-lucrative music business. While the DAT threat didn't eventuate, all the ingredients were ready by the late-1990s for a situation that potentially would be far worse.

In June 1999, those ingredients came together in the music-sharing website called 'Napster'. Combining almost-instant access to thousands of songs through a free and slick web interface saw Napster's star rise. However, it was more a 'shooting star', as the music industry rallied to the threat and filed lawsuits against the service. Just over two years later, Napster was shut down by the U.S. court system in July 2001. But with Napster, at one point, said to have had 80 million users, the growing realisation within the tech industry was that a new market opportunity beckoned.

Right place, right time

The story of how Apple nearly lost its way and survived thanks to US\$150million from Microsoft boss Bill Gates in 1997 is well known, yet in the space of just two years, the company went from rags to riches on the back of its booming iMac design. But Apple wasn't done yet and in January 2001, launched the app that would go on to change how millions around the world consumed their music – iTunes. The launch was also clever for iTunes being for Mac only. The iTunes app was reportedly a redesign and development of SoundJam MP, which Apple had bought the previous year. Quickly, Mac users became iTunes' greatest advocates as they began cataloguing and grouping their music library. However, iTunes itself was only

Below: The Sony MZ-RH1 was arguably the pinnacle of MiniDisc portability (Image credit: Zlois, CC BY-SA 3.0).





one half of a double-act that would change the music industry forever – and consumers didn't have long to wait.

One more thing

When Apple then-boss Steve Jobs announced in October 2001 the company's plans to become market leader in the digital music revolution, he didn't actually say 'one more thing' – but he did announce the product every other company then dreamt of having: the Apple iPod.

Apple certainly wasn't first to market with a portable audio player, but it had the right ideas at the right time. Only a matter of weeks prior, the music industry had successfully overcome the Napster threat, but any thought that it could stave off the future and expect consumers to go back to buying CDs forever was wishful thinking. The Napster furore would only be the beginning if the music industry didn't move with the changing demands of consumers.

Even without the Windows PC market, the iPod/iTunes combination was a winner. However, the first iPod was still an electro-mechanical device and not particularly sophisticated when you look back, relying on a 1.8-inch Toshiba hard drive of either 5 or 10GB capacity and powered by two ageing 90MHz ARM7-grade microcontroller chips. However, its revolutionary 'click wheel' control made navigating through song lists intuitive and easy. Apple was bringing a new design language to technology and consumers couldn't get enough.

Regardless of whether or not you're an Apple fan, the iPod completely transformed the portable audio market, changing how and where we consumed music. So entrenched in our psyche did the iPod become that it was only in 2022 that Apple finally announced the end of the iPod, with a 'last call' for the

last-surviving model, the iPod Touch, it's iPhone-without-the-phone player/app combo.

Buying music online

But by 2003, iPod storage capacity had risen from 5GB to 40GB, enough for over 10,000 songs and it was clear that ripping that many CDs was no longer an option. The same day the 40GB model was announced, Apple also launched the new iTunes store

and for the first time, consumers could legally purchase and download music online. A new Windows-version iTunes store client soon followed.

The staggering number of Napster users showed the vast potential of a music marketplace and it was during 2002 that Steve Jobs began the painstaking task of bringing the record labels on-board. Eventually, market heavyweights Warner Music and Universal agreed, provided safeguards to prevent wholesale copying (what became 'digital rights management') were incorporated. Further deals with BMG, EMI and Sony were

eventually sorted and a reported 200,000 songs were ready to go the day the iTunes Store launched in April 2003. But how did consumers respond? The store was an instant hit - more than one-million songs were purchased in the first week alone.

Market collapse

Nevertheless, what was so remarkable about the rise of the portable music player was just

how fast the global market for these devices began unravelling less than a decade later. Music sales continued to boom, but as per usual, a new device was

"Combining almost-instant access to thousands of songs through a free and slick web interface saw Napster's star rise."

coming - this time, one that would rewrite the definition of 'personal computer' and all but make the MP3 music player redundant.

Next time, in the final part of this series, we hit modern times, as Apple and new player, Google, sign the death warrant of the music player market with the launch of this new device that still shows few signs of slowing down. ■

Above: Music players rarely got smaller than the Apple iPod Shuffle (Image credit: Apple).



Above: The Diamond Rio PMP300 was one of the first flash-based audio players to hit Australia (image credit: Public Domain).

Below: The Sony PCM-1630 PCM adapter turned any VHS recorder into a digital audio recorder (Image credit: Akakage1962, CC-BY-SA 3.0).

