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ORIGINAL ARTICLES

Addendum: After this article was published, the author received an e-mail from former Soundstream engineer Jules Bloomenthal correcting some information in this article about the sampling rates of various prototype Soundstream systems.

Mr. Bloomenthal's corrections:

"Our two-channel prototype, which recorded the Santa Fe Opera in 1976 and was demonstrated at the AES convention in New York later that year, sampled at 37.5 kHz. At the convention, several listeners mentioned lack of 'air' and so, in building the 4-channel recorder that was to become the company workhorse, we increased the sampling rate.

The first 4-channel machine was finished a mere day or two before the Fox direct-to-disk sessions; we were invited to attend as a 'backup'. That machine sampled at 42.5 kHz (not 32 kHz, as you report)."

-- Tom Fine 11/08

The Dawn of Commercial Digital Recording

Although wide-spread digital commercial recording is only about 30 years old, much mythology and many claims of "firsts" have sprung from the mists of time. This article seeks to set the record straight, relying on first-person accounts whenever possible, and provides detailed discographical information for the ground-breaking examples of early commercial digital recording.

Digital pulse-code modulation (PCM) for sound transmission and recording developed in the world of telephony, dating from the 1930s. The first music-recording company to commercially release digital recordings was Denon (Nippon Columbia), in Japan. At a May 1989 Audio Engineering Society (AES) conference, Denon engineers recounted their early digital experiences, and made the claim that Denon's parent company, Nippon Columbia, using Denon equipment, made the first U.S. commercial digital recording, in late 1977.

Others have claimed various "digital firsts" in the U.S. A system from Soundstream was in use at U.S. recording sessions as early as 1976. But it was 2 years later when Soundstream's second-generation system was used as the primary recording device for a commercial release, widely regarded as the first digital recording of symphonic music in the U.S. Around the same time, a prototype of 3M's digital system, set up to make test recordings in a Minnesota studio, made a recording that was judged sonically superior to what the studio's direct-to-disc system produced and the resulting chamber-music album was the first digital recording to win a Grammy®.

In Europe, Decca Records engineers, in the company's famed Recording Centre, designed their own digital recording system and premiered its commercial use at the annual New Year's Day extravaganza in Vienna, 1 January 1979. This was the first commercial digital recording made by a European record company.

What follows is a chronological history of the dawn of digital recording. The author has conducted extensive research, obtained original-release LP records and/or later-release compact discs when possible, and interviewed participants in some of these recordings. To the best of the author's knowledge, the handful of recordings described in this article are the first steps into the digital recording world, the first move away from the analog technologies that built the commercial recording and recorded-music businesses. Following the dawn of digital recording, analog-master recording gradually became the province of a few die-hards, and the digital Compact Disc replaced all analog playback formats as the consumer mass

medium for recorded music. The CD is now seeing its sunset, as Internet distribution seems destined to become the primary music-release format for a new generation.

Midnight: The Evolution of Digital Transmission and Recording

Digital Pulse-Code Modulation was invented at Bell Labs in the 1930s and first used as a telephony technology. In World War II, the military phone line between London and the Pentagon was compromised and the Germans were able to break the non-digital security system. Engineers at Bell Labs developed a PCM-based encrypted-transmission system called SIGSALY, which was deployed in 1943.[1] The system eventually grew to 12 terminals before being retired in 1946. Patents on the 12-channel encryption system were classified until 1976. SIGSALY represented the first digital quantization of speech and the first PCM transmission of speech.

Fast-forward to the 1960s, at the Technical Research Laboratory of Japan's NHK broadcast network. Engineers there developed a monophonic PCM audio recorder in 1967, and by 1969 they had a working 2-channel stereo recorder.[2] The NHK system featured a 32kHz sampling rate and 13-bit resolution. It used an industrial helical-scanning videotape recorder as its storage medium.[3] This concept of converting PCM digital audio into VTR-compatible signals would remain in use well into the 1990s. Indeed, many if not most first-edition Compact Discs would be mastered using the Sony 1600/1610/1630 systems based around a U-Matic 3/4-inch VTR, and the earliest digital recording devices marketed to consumers and smaller-scale professional operations were PCM-to-VCR adapters such as the Sony PCM-F1 (introduced in 1981).

Around the same time NHK was perfecting the stereo PCM audio recorder, the British Broadcasting Corporation was experimenting with using PCM technology to improve television broadcast audio quality. The BBC's challenge was to improve the quality of the transmission lines between their broadcast center and far-flung transmitters. Their solution, deployed in 1972, was a 13-channel PCM system, with audio converted to digital at the broadcast center and converted back to analog at the transmitters. The system was still in use 10 years later. BBC Research Department also developed in the early 1970s a 2-channel PCM recorder, and some of these technologies were later licensed to 3M, which unveiled its Digital Mastering System in late 1977. In the U.S., the Public Broadcasting System and Digital Communications Corp. in 1973 developed the DATE (Digital Audio for Television) system to send video and PCM audio signals over a common transmission system, combining up to 4 audio channels into a single digital data stream.[4]

Pre-Dawn: Denon Introduces Music to Digital

Nippon Columbia, known outside of Japan primarily by its Denon brand, was both a major music-recording company and an equipment manufacturer. Its record company by the late 1960s was investigating how to improve LP sound quality, and criticism centered on distortions caused by analog tape recorders. Denon was a pioneer in the revival of direct-to-disc recording, and Denon engineers visited and collaborated with NHK's PCM pioneers. Denon's stated purpose: "To produce recordings that were not compromised by the weaknesses of magnetic tape recorders."[5]

In 1969-1971, Denon leased an NHK stereo PCM recorder and conducted numerous test recordings. Retired Denon engineer Dr. Takeaki Anazawa told the author: "We got a lot of ideas about improvement of (the) system from these experiences." Denon's tests also resulted in two commercial albums, the first commercial use of PCM digital technology. Indeed, the first commercial digital recording was Nippon Columbia NCB-7003, "Something" by Steve Marcus, released January 1971. The only other commercial release to come out of these early Denon/NHK recordings was Nippon Columbia NCC-8004, "The World of Sutomu Yamashita," according to Anazawa.[6]

Satisfied that PCM digital was an improvement over analog tape, Denon engineers set out to develop their own VTR-based system. Their goals were improved audio quality and multi-track recording capability, which then made the system viable in most commercial recording settings of the 1970s. In 1972, Denon unveiled the DN-023R, an 8-channel system featuring 13-bit resolution and a sampling rate of 47.25kHz. The system used a Hitachi (then called Shiba Electronics) 4-head open-reel broadcast VTR as its storage format. Anazawa noted: "We used the low-band mode of the VTR, for black and white (video). The reasons were stronger (performance) than color mode for tape drop-out and less cost." Anazawa said, with the DN-023R, "we could edit music recordings and cut (LP) discs using advanced (preview) head" to control lathe-automation.[7]

Denon deployed the DN-023R system immediately and used it to make commercial-release recordings throughout the 1970s. The first LP made with this system was Nippon Columbia NCC-8501, Mozart: String Quartets K. 458 and K. 421 by the Smetana Quartet. This album was recorded 24-26 April 1972, at Aoyama Tower, Tokyo, and released in October 1972. Denon also released at least six other digital-recording LPs in October 1972, including classical, jazz and traditional Japanese music selections. Denon also made the first commercial digital recording in Western Europe, at Notre Dam de Rose outside of Paris on 2-3 December 1974, Bach "Musical Offering" BWV 1079, by the Paillard Chamber Orchestra. The LP was released in May 1975.

In 1977, Denon developed a smaller, improved PCM recording system, the DN-034R, for location recording. Anazawa said the DN-034R was an 8-channel system that again used the 47.25kHz sampling rate, but improved resolution by using "14 bits with emphasis (equivalent with 15.5 bits)." The system also allowed for over-dubbing, crucial for rock and jazz recording.[8] Digitally, this system was very close in resolution to the 48kHz/16-bit system later used in the Digital Audio Tape (DAT) format (DATs could also record 44.1kHz/16-bit, the Compact Disc standard).

In November 1977, Nippon Columbia producer Yoshio Ozawa brought the DN-034R, along with Anazawa and Denon engineer Kaoru Yamamoto to New York City's Sound Ideas recording studio for a series of jazz sessions engineered by Jim McCurdy. The first album, recorded 28 November 1977, was "On Green Dolphin Street" by sax-man Archie Shepp. This LP, released as Nippon Columbia YX-7524 in May 1978, was the first digital recording intended for commercial release made in the U.S. Interestingly, the first Nippon Columbia LP release to come from these sessions was "Manhattan Fever" by Frank Foster and the Loud Minority (YX-7521, recorded 29-30 November 1977 and released in April 1978). In all, seven jazz albums were recorded at Sound Ideas in November and December 1977 using the DN-034R system. And, by the time the compact disc debuted in 1982, Denon had more than 400 digital recordings in its vaults.[9]

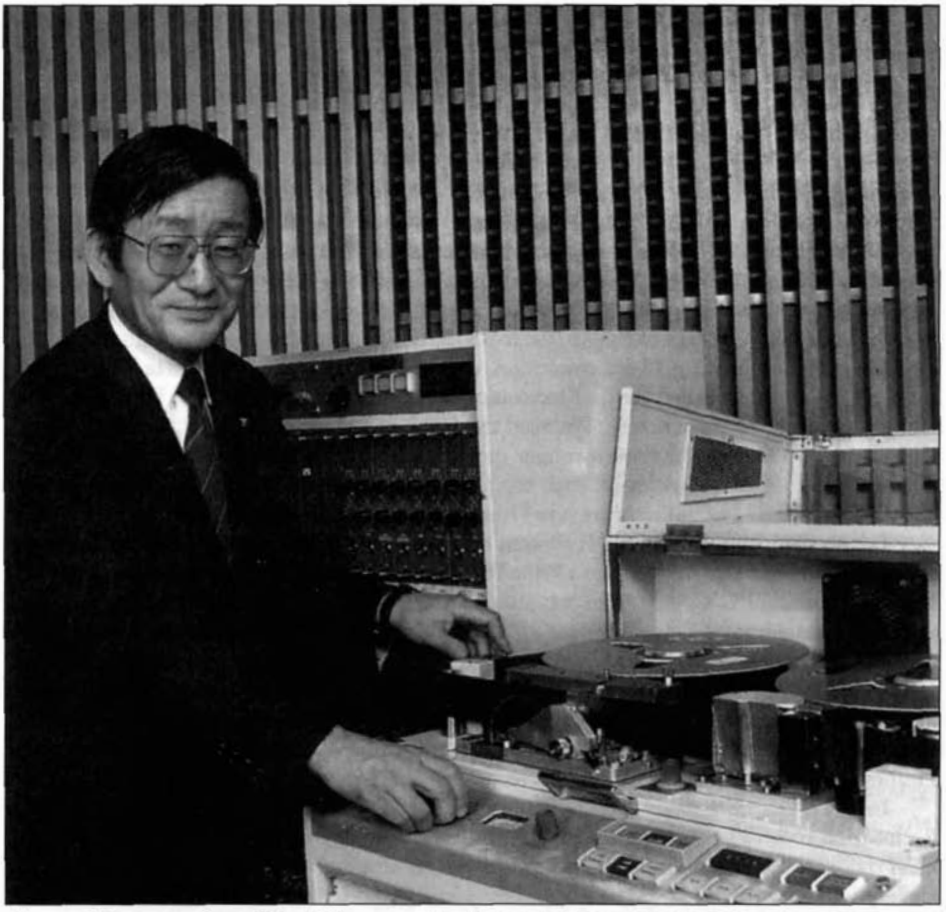

Figure 1. *Denon engineer Takeaki Anazawa standing next to the original Denon DN-023R digital recorder. Source:* Audio Magazine.

First Light: Telarc and Soundstream Birth American Digital Recording

Back in the birthplace of PCM, the United States, engineers at multiple companies started looking at digital audio recording in the 1970s. Out in front of pack was a University of Utah professor, Dr. Thomas Stockham. In his lab in Salt Lake City, Stockham developed a digital audio recording and editing system, first using computer tape drives and later using a Honeywell linear instrumentation recorder.[10] Stockham's editing system, which ran on a DEC mainframe computer and allowed visual editing of musical waveforms, was a direct precursor of the modern digital audio workstation and computer-

based recording and editing. Stockham also pioneered digital signal processing, creating computer programs to reverse the distortions inherent to the recording horns used to make Enrico Caruso recordings in the early 20th Century.

By 1976, Stockham had a digital recording company, Soundstream, and a recorder capable of 16-bit resolution with a sampling rate of 37.5kHz. The Soundstream system had a proprietary audio unit that included analog-to-digital, metering/level controls and digital-to-analog circuitry. This unit fed digital output to and received digital input from the Honeywell instrumentation recorder.[11] Now it was time to go out in the field and make some music recordings.

As part of its summer 1976 season, the Santa Fe Opera performed *The Mother of Us All*, with music by Virgil Thomson and text by Gertrude Stein. New World Records, with a Rockefeller Foundation grant, recorded the production[12] and the prototype Soundstream recorder was on hand for what Stockham, in a 1994 interview with *Audio*, called "the first real-world recording we made."[13]

Session recording engineer Jerry Bruck recalled, "prior to the actual sessions, Tom Stockham contacted me to find out if I would permit him to bring his prototype, operational Soundstream recorder and run a tape in parallel with mine. I readily agreed, and he and his assistant were installed in a room at the (Santa Fe) Armory and given a feed from our multi-track board (recording console)." Bruck added: "I knew that were dealing with something different when Tom called me on my intercom to say that he had noted a hum on our feed. Surprised, I turned up our monitor (speaker), but heard nothing amiss. I asked him what level he thought it was. He checked and called back: 'It's about eighty dB down.' Awk!"[14] At that time, the best tape recording/noise-reduction systems were capable of 70dB dynamic range, so hum at -80dB would be buried in tape background noise. Bruck said the Soundstream equipment "was only 2-track, but (Stockham) was satisfied that we could learn a lot from comparison of the two recordings. This we did after the first session, and it left an indelible impression on me that digital, while not yet perfect in all details, was clearly the recording medium of the future."[15] The New World 2-LP set, NW-288, was made from a mix-down of Bruck's 16-track analog tape.[16] Stockham told *Audio*, "everything worked perfectly" with his tests, "then we demonstrated the recordings at the AES Convention in the fall of 1976."[17]

Soundstream's demonstration caught the ear and attention of writer and sometime recording engineer Bert Whyte. In August 1977, Whyte engineered Virgil Fox solo organ sessions at Garden Grove Community Church in California. The sessions, for Crystal Clear Records, were to be direct-to-disc, with ace mastering engineer Stan Ricker in charge of the lathe. The Soundstream system was used to make another series of test recordings from the same audio feed. The Soundstream machine used for this session was still a 16-bit/37.5kHz sampling rate system, two channels.

There are some factual disputes surrounding these sessions. The initial releases, in late 1977, were indisputably the direct-to-disc recordings (at least according to all LP cover text and art and the dead-wax inscriptions), and Ricker said these LPs were the purpose of the sessions. Ricker added, "Soundstream digital was used as a backup on those sessions."[18] The Soundstream recordings were eventually released on Ultragroove Records in 1981 as "The Digital Fox" Volumes 1 and 2, carrying the back-cover headline "The First Digital Recordings Made in the United States."[19] Whyte, in his regular *Audio* column, later claimed "I used Tom (Stockham's) digital recorder to master my Virgil Fox

Figure 2. *Archie Shepp – "On Green Dolphin Street," recorded 28 November 1977 at Sound Ideas in New York, was the first all-digital commercial recording made in the United States. Made by Denon using the Denon 034 multi-track system. Image shown is the booklet cover for the Denon CD released in 1984.*

organ recording for Crystal Clear in 1977."[20] Stockham, in the 1994 *Audio* interview, said, "we went to Crystal Clear records and did a recording of Virgil Fox, and those recordings were stunning – very, very interesting. That started our cash flow going,"[21] suggesting Soundstream was hired to record the sessions along with the direct-to-disc crew (or, alternately, suggesting that the Fox recordings were enough to convince others to hire Soundstream to make digital recordings). One possible scenario is that the record company hired Soundstream as an insurance policy in case the finicky direct-to-disc process failed on a key take, or in case the recordings sold well enough to wear out the

direct-to-disc master parts. The Ultragroove Records liner notes claim: "This album contains the same repertoire as the Direct To Disc recording previously released on Crystal Clear Records, however, the performances and frequency balances are different."[22] Whatever the case, the Soundstream tapes were not commercially released until 1981 and thus do not constitute a "first" for-release commercial orchestral recording.

That honor belongs to what was then a small Cleveland, Ohio-based classical label, Telarc (now part of the Concord Music Group). Telarc founders Jack Renner and Robert Woods heard one of the Soundstream demonstrations, at the November 1977 AES Convention in New York, and were impressed but asked Stockham to extend the sampling rate to allow for full 20Hz to 20kHz frequency range (the prototype Soundstream system allowed for 20Hz to beyond 15kHz). Renner, in a *Stereophile* interview, remembered: "There I was, somebody who'd issued two direct-to-disc recordings ... and we were demanding of Tom Stockham ... that he make his machine better." To their surprise, Stockham agreed and in late January 1978, he notified Renner he had improved his system to 50kHz sampling rate and 4 digital audio tracks and was ready to work for Telarc.[23] Renner explained: "We had originally requested the upgrade because we felt the (high frequency) 'brick-wall' (filter) of the (prototype) system was just too limited on the high end. We wanted to hear more overtones, etc., more air, and 'stuff' there that was just not present in the (original) design."[24]

For their first digital recording session, Telarc contracted legendary band-music conductor and teacher Fred Fennell, who, Renner noted, was also a Cleveland native. Fennell chose for the session Gustav Holst's two *Suites for Military Band*, along with Handel's *Music for the Royal Fireworks* and a transcription of Bach's *Fantasie in G* major for band. The recordings took place 4-5 April 1978 at Severance Hall, Cleveland,[25] and were released shortly thereafter to critical acclaim and much mainstream media coverage. The *World Book Encyclopedia's Yearbook* described the LP as "the bass drum heard 'round the world," referencing the loud bass drum beats in the Holst suites.[26] Ricker, who mastered the original Telarc LP, remembered the music as "incredibly dynamic ... a challenge to cut because of those bass drum beats."[27]

Renner recalled the sessions this way: "Fennell's reaction (on hearing the Soundstream playback) was simple – 'Wow!' At the sessions, we had writers from every major audio magazine of the time. There was a feeling on the part of all concerned that this was something special. Editing was done in Salt Lake City at Soundstream (headquarters). At the time, the Soundstream editing system was way ahead of its time. It was (computer) disc-based editing and pretty sophisticated at the time."[28]

Telarc's LP was the first classical intended-for-release commercial digital recording in the U.S. Renner considers two other 1978 Telarc recordings to be "firsts": "First digitally-recorded, commercially released orchestral recording in the U.S." – Robert Shaw conducting the Atlanta Symphony and Chorus, Stravinsky: "Firebird" and Borodin: "Polovtsian Dances," Telarc 80039, recorded June 1978; and "first digitally-recorded, commercially released recording of a world-class major orchestra ANYWHERE in the world" – Loren Maazel and The Cleveland Orchestra, Moussorgsky: "Pictures at an Exhibition" and Rimsky-Korsakov: "A Night on Bald Mountain," Telarc 80042, recorded October 1978.[29]

Some of Telarc's Soundstream digital recordings have been reissued on hybrid SACD's. Telarc re-mastering engineer Paul Blakemore said the company made direct-digi-

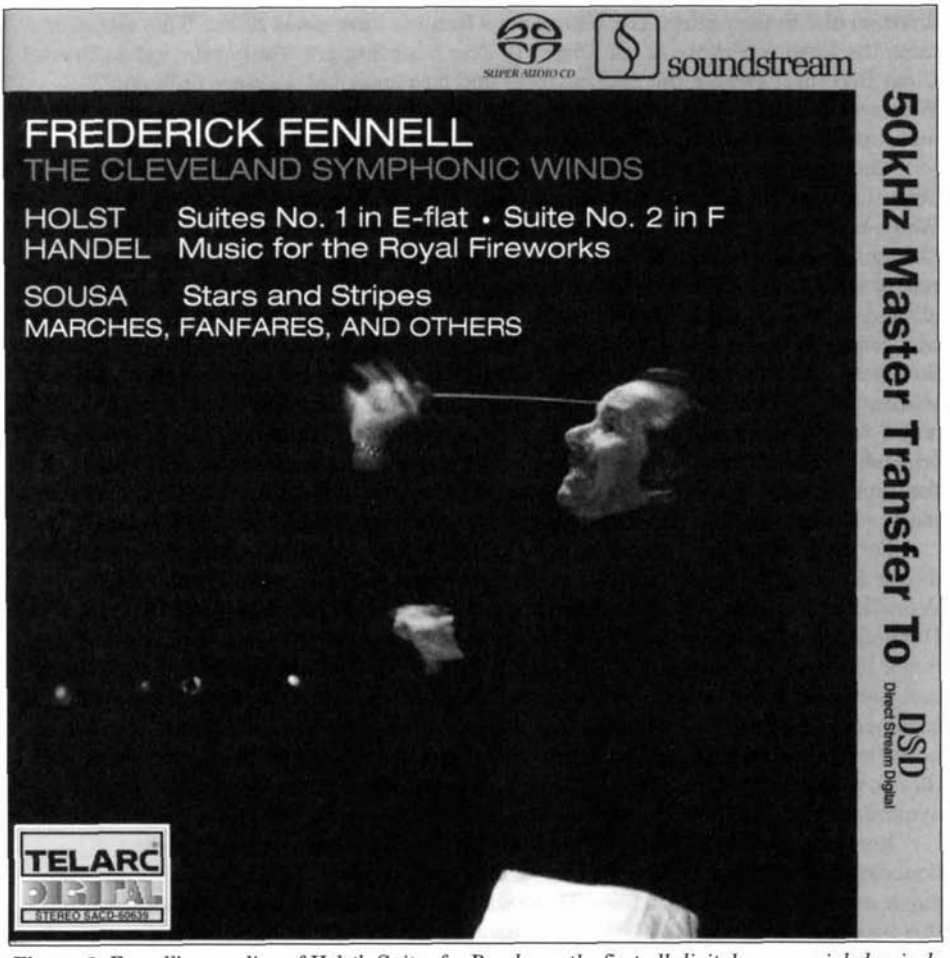

Figure 3. *Fennell's recording of Holst's Suites for Band was the first all-digital commercial classical recording made in the U.S. The album was nicknamed "the Bass Drum Heard 'Round the World" and was even mentioned in the* World Book Yearbook *covering 1978. Sessions took place 4-5 April 1978 in Cleveland for the then-tiny Telarc label. This image is the cover to the booklet for the reissue SACD, released in 2004. The recording used the Soundstream system, the final version with 50kHz / 16-bit PCM recording.*

tal transfers from the Soundstream electronics to a new direct-stream-digital workstation, which eliminated PCM sample-rate conversion problems associated with earlier reissue CDs. For all but a handful of the hybrid SACDs, the CD audio layer was made by playing back the DSD transfer to analog and then converting to 44.1kHz/16-bit CD format using Telarc's proprietary analog-to-digital converter, which was built by Stockham; the earliest reissues in the series were sample-rate converted in the digital domain. Blakemore said,

he settled on the digital-analog-digital method after much comparative listening, noting "there is a subtlety of stereo depth, clarity of pitch, and effortlessness to the sound using the analog transfer that doesn't come across with the direct digital interpolation." He added: "I have no idea why this would be the case, but if you are listening on a high enough quality playback system you can hear the difference quite clearly."[30]

Dawn: The 3M System, A Grammy and 32 Tracks of Rock 'n' Roll

Around the time Stockham was finalizing his Soundstream system, the giant 3M Company in Minneapolis, Minnesota, was testing their own digital recorder. 3M's system, designed around some of the BBC's developments, was first shown as a prototype at the November 1977 AES Convention in New York. The 3M system was aimed at the world of professional multi-track recording, as was typical for chart-topping rock and roll albums. 3M designed a 32-track self-contained linear recorder that used special-formulation 1-inch tape moving at 45 inches per second. The 16-bit system featured a sampling rate of 50kHz and allowed for over-dubbing and editing.[31]

In mid-1978, 3M installed their prototype recorder, capable of recording only two channels, at Sound80 Studios in Minneapolis. The machine was nicknamed "Herbie" after Sound80 co-owner Herb Pilhofer.[32] A recording session, in June according to several participants,[33] featured the St. Paul Chamber Orchestra under the baton of Dennis Russell Davies, performing Copland's "Appalachian Spring" and Ives' "Three Places in New England." The session was to be direct-to-disc, with the 3M prototype used as a backup recorder.

Exactly what happened at that recording session is the topic of some dispute. Former SPCO musician Bill McGlaughlin recalled it this way: the ensemble had "done a number of direct-to-disc sessions with Sound80, and this session was intended to be direct-to-disc as well, but at the last minute the boys from 3M showed up with a digital machine ... which they asked to try out in parallel ... (we) did three takes of each (work), and on the Copland there was one take that did not go well, and the other two had technical problems with the cutter (LP cutting lathe)."[34] The liner notes on the resulting LP (Sound80 Records DLR-101) suggest the digital master was planned all along: "This landmark record represents the unique combination of 'direct-to-disc' (*sic*) recording philosophy with the exciting new digital recording technology. Recorded on the 3M Digital Audio Mastering System ... these performances are also completely spontaneous and unedited – played in 'real time' (including the pauses between movements) – as though recorded directly onto the master disc."[35] McGlaughlin added: "They turned to 'Herbie' to save the day and ended up preferring the sound of the 3M machine."[36]

A Sound80 press release published in *Recording Engineer/Producer* provided another data point. In announcing "the first two albums recorded digitally using 3M Company's new" system – the SPCO album and a record by the jazz group Flim and the BB's – Sound80 noted "the studio used the digital prototype experimentally as backup during direct-to-disc recording sessions. The prototype-produced digital tapes from these sessions were judged superior to the direct-to-disc masters and the digital albums resulted."[37] Tom Jung engineered both of the 3M system's premiere studio sessions.

Figure 4. *Dennis Russell Davies conducts the St. Paul Chamber Orchestra in the recording session for Aaron Copland's "Appalachian Spring." This recording, using the 3M Digital Mastering System, was the first commercial digital recording to win a Grammy.® Image from the inner gatefold of the original LP jacket.*

Whatever the case, the Copland recording won for Davies the 1979 Grammy® for Best Chamber Music Performance,[38] and was thus the first commercial digital recording to win a Grammy®.

The 3M system was later finalized and put to market and by 1979 several studios were making all-digital multi-track recordings. The first all-digital album made in the traditional multi-track way used for most popular/rock/jazz albums since the 1960s was Ry Cooder's "Bop 'Til You Drop," released by Warner Brothers in 1979. The album, produced by Cooder and engineered by Lee Herschberg, was recorded at Warner Brothers' North Hollywood studio in California.[39]

Dawn in Europe: The Decca Digital System and New Year's Day in Vienna

Like many of their American counterparts, the major European music labels by the late 1970s were thinking and talking about digital recording, but were waiting for someone else to actually release some commercial digital recordings. Denon had made digital recordings in Europe starting in 1974, but the hometown labels had not yet taken the plunge.

U.K.-based Decca Records had an extensive history of self-generated technological innovation, dating from the early days of electronic recording. Decca's engineer F.A. (Tony) Griffiths, in a February 1980 AES Convention presentation, reported that by 1977 the company had conducted "experimental digital recordings" and "were convinced that we should start to build up a library of digital audio recordings."[40] Decca engineers who visited the November 1977 AES Convention in New York found it "obvious that no satisfactory system of recording and editing would be available in the marketplace for some time, and we therefore decided to develop our own system."[41]

Decca undertook a crash development program in 1978 and came up with a system that used a heavily modified IVC helical-scan video transport and proprietary Decca-built electronics.[42] The system featured a sampling rate of 48kHz and 18-bit resolution and allowed for computer-controlled editing similar to commonly-used video editing systems.[43]

The Decca system was 2-channel. In his AES presentation, Griffiths explained: "A multitrack recorder was not attempted ... In the Decca Record Company it is customary to record two track stereo at a classical recording session, with multitrack providing only a safety/backup role."[44]

After making test recordings throughout the summer and fall of 1978, Decca premiered the system in for-release recordings of the Vienna Philharmonic's gala 1979 New Year's Day concert under the baton of Willi Boskovsky. The resulting 2-LP album, Decca D147D2, was the first commercial digital recording made by a European record label. *Gramophone*, reviewing the 1996 2-CD reissue, called it "a recording of considerable historic significance."[45]

Decca's digital system was improved over the years and was still in use in the 1990s. In 1997, then parent company Polygram closed down Decca's Recording Centre, ending 60 years of in-house design engineering and innovation.[46]

A day after Decca's first commercial digital session, Philips started four days of sessions with Sir Neville Marinner, recording Handel's Opus 3, six concerti grossi, using the Sony 1600 2-channel PCM system. This was first released on Philips LP 6514114 (CD 411482-2).[47]

Figure 5. *Cover for CD booklet of Virgil Fox – "The Digital Fox, Volumes 1 and 2" on the Bainbridge label. Despite the claims of "The First Digital Recordings Made in the United States," the Soundstream recordings were an adjunct to a direct-to-disc session and the digital masters were not issued on LP until 1979. The sessions took place 28 August 1977 at the Garden Grove Community Church, California.*

Daybreak: The Digital Audio Era

By the beginning of the 1980s, all major record companies had embraced digital recording in one form or another. Analog multi-track would continue to play a major role in rock and pop recording well into the 1990s, but digital classical and jazz recordings quickly started piling up. However, digital technology's bigger role in the early 1980s was ushering in a new consumer mass medium.

Philips and Sony launched the digital Compact Disc in 1982, and by the end of the 1980s CDs were out-selling LPs.[48] Soon thereafter, CD sales passed pre-recorded cassettes and by the mid-1990s CDs were the near-exclusive music mass medium in North America, Europe and Japan.

Many of the historic digital "first" recordings cited in this article were eventually released on CD; some are now out of print. (see "The Dawn of Digital – The "Firsts"" listing on page 14.)

Acknowledgements

The author wishes to thank Jay McKnight, chairman emeritus of the Audio Engineering Society's Historical Committee, for the suggestion to undertake this research. Members of the AESHC e-mail list, as well as the Association for Recorded Sound Collections e-mail list, were extremely helpful with discography information, first-hand recollections and contact information for some of the digital pioneers interviewed for this article. Analog-to-digital transfer expert Richard Hess was generous with his time and knowledge and provided several key pieces of technical information.

All of the gentlemen interviewed by phone and/or e-mail were very generous with their time and patiently answered even the most simplistic of questions. The author is most grateful for their groundbreaking work and their priceless first-person recollections. Furthermore, the previously published first-person accounts cited were absolutely necessary to complete this article.

Thomas Fine *is a member of ARSC and owns an analog-to-digital audio transfer studio based in his home north of New York City. His studio serves mostly archive and educational-institution clients, specializing in transferring magnetic and grooved-disc media to high-resolution digital formats. Fine is also an avid collector of music recordings and a student of recording-industry history. He can be reached via e-mail at tom.fine@gmail.com.*

The Dawn of Digital – The "Firsts"

First digitally-recorded commercial release:
"Something" by Steve Marcus and Jiroh Inagaki (Nippon Columbia NCB-7003)
Recorded in Tokyo, September 1970 (Denon prototype system)

First digitally-recorded classical album:
Mozart: String Quartet No. 17 in B flat minor, K.458 'Hunt'
Smetana Quartet (Nippon Columbia NCC-8501)
Recorded 24-26 April 1972, Aoyama Tower, Tokyo (Denon DN-023R)

First all-digital recording in Western Europe intended for Commercial Release:
Bach: Musical Offering, BWV 1079
Paillard Chamber Orchestra (Denon OX-7021)
Recorded 2-3 December 1974, Notre Dam de Rose, outside Paris (Denon DN-023R)

First all-digital recording in U.S.A. intended for commercial release:
"On Green Dolphin Street" by Archie Shepp (Denon MJ-7262)
Recorded 28 November 1977 at Sound Ideas, NYC (Denon DN-034R)

First all-digital classical recording in U.S.A. intended for commercial release:
Holst: Suites for Military Band Nos. 1 and 2 / Handel: Music for the Royal Fireworks / Bach: Fantasie in G major
Frederick Fennell conducting the Cleveland Symphonic Winds (Telarc 5038)
Recorded 4-5 April 1978 at Severance Hall, Cleveland, Ohio (Soundstream)

First Grammy Award-winning Digital Recording:
Copland: Appalachian Spring / Ives: Three Places in New England
Dennis Russell Davies conducting the St. Paul Chamber Orchestra (Sound80 DLR-101)
Recorded June 1978 at Sound80 Studio, Minneapolis, Minnesota (3M prototype system)
Winner – Grammy Award, Best Chamber Music Album, 1979.

First all-digital classical commercial recording by a European company:
"New Year's Day in Vienna"
Willi Boskovsky conducting the Vienna Philharmonic (Decca D147D2 / London LDR-100012)
Recorded 1 January 1979 at the Muskikvereinsaal, Vienna (Decca system)

Etc: Early Digital Recording released Later (thus, not a "First")
Virgil Fox – "The Digital Fox" volumes 1 & 2 (Ultragroove UG-9001 and UG-9002)
Recorded 28-31 August 1977 at Garden Grove Community Church, California (Soundstream prototype system.

NOTE: The Soundstream prototype was an adjunct system to these direct-to-disc sessions. The Soundstream tapes were released as LPs in 1981.

Sources

Aside from the sources cited in the footnotes, the author used the publications listed below for background/historical information in preparing this article. Also, extensive efforts were made to obtain and listen to all of the pioneering commercial albums mentioned in this article. Success was had for all except the first two commercial releases from Nippon Columbia/Denon. In the case of the Telarc and Decca classical albums, recent re-mastered CDs were obtained. In the case of the Denon Archie Shepp album, the early-era CD, now out of print, was obtained. In the case of the SPCO, Virgil Fox and Ry Cooder albums, original LPs were obtained.

Background information sources, not specifically quoted or cited in this article:

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