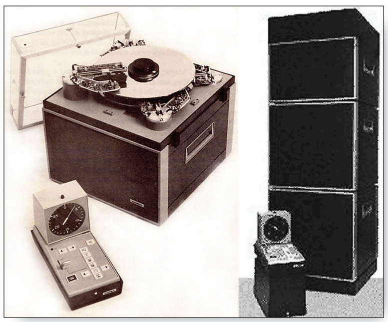


Figure 5.10 Once again, Ampex performed some radical innovation and engineering, and developed the first hard disk video server. In 1965 they field-tested a disk recorder on a CBS football telecast. In 1967, Ampex introduced the HS-100. Analog video, not digital video data like today, was laid down in concentric tracks. Each track stored one frame of video. The disk rotated at 1800 rpm and had 30 seconds of record capability. Above is the complete system. The bottom two "cases" are the electronics. The top case housed the disk drive. The controller to the left is not radically different than ones used today.

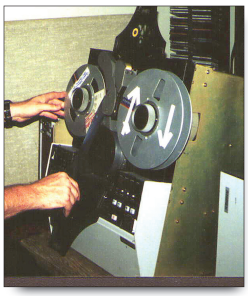
The Instant Replay Arrives

The First Disk Recorder

Although VTRs became increasingly stable, and thus reliable, and they were integrated more tightly into the truck, they continued to do basically the same thing: Record and play back in real time. In the early '80s, when a few Ampex AVR-2s quads could still be found on trucks, newly minted production people would look askance at the engineer who insisted that the machine couldn't produce a still picture. But the first few generations of VTRs, namely the two-inch quad VTR, could only play at real time and then only after a few seconds of going through the process of "locking up." Locking up was the process of getting the massive two-inch reels of tape up to the right speed and then getting the rotating video heads to trace down the center of the video tracks.

By the early '60s there was experimental use of these massive machines to give the sports viewer another look at an interesting play. The quad would be put into record before the play started and record the action, and then be stopped and put into rewind. Most quads had no shuttle speed control: it was flat out or nothing. If small reels of tape were used, the in point of the recording would often be overshot. If large reels were used rewind started very slowly and the time to get back to the in point was too long. So operators would often rewind the tape back to the in point and a couple of seconds more by hand. This made for very tired arms at the end of the game. By this time, VTRs had a "ready" mode in which the video heads were always spinning. This saved time on lockup but was hard on the heads. This provided for replays in real time only. How instant this process was, was open for debate.

With the introduction of the disk recorder (see Figure 5.10), variable speed or motion was obtained by how often the disk heads moved from one track to the next during playback. If the heads stayed on a track for only one revolution before moving to the next, video was played back at full speed. If the heads stayed on a track for two revolutions before jumping to the next rack, then playback was at half speed; three revolutions between jumps was one-third speed, etc. If the heads stayed over the same track continuously then motion was stopped. Any playback speed could be selected with the controller. Another first with the HR-100 was that video could be played in reverse. By the late '60s slow-motion replay had arrived. These devices are often referred to as "slo-mos" in the industry. This remained the only way to do slow motion until the mid 1970s, when the VTR took back this initial disk foothold into video recording. But it took a brand-new tape format to do it.

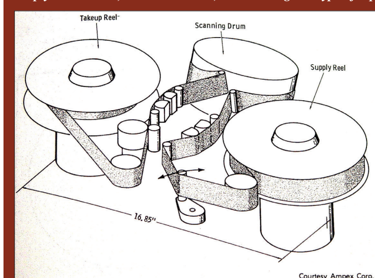


Helical VTRs Take Back the Replay and Dominate

Figure 5.11 *These new VTRs used one-inch tape and were much smaller than what had come before. The Ampex VPR-2 shown here is only missing a TBC and some monitoring to be a complete system. The VPR-2, along with the BVH-1000 from Sony, represented the first Type C VTR. Type A was a Japanese tape format that used one-inch tape. Type B was a European segmented format, like quads that used one-inch tape and a very small helical head, which required five tracks to be recorded per field of video. The Type C was a compromise between Ampex and Sony, as each had one-inch VTRs under development with similar formats. The Type C VTR could be used as a slo-mo operated much like the HR-100, with one major advancement. Instead of 30 seconds of record capability, an hour tape could be used. Now every play could be kept if desired and a highlight reel built afterward. The VPR-2 was even designed to work with the HR-100 controller. As often as not though, replay operators using VPR-2s would manually turn the takeup reel by hand (the reel with arrows on it to the left) as many claimed it provided better control than the controller. Many tape operators even showed up with their own takeup reels, with knobs mounted on them.*

Engineering the "One-Inch" VTR

Figure 5.12 This format was called helical wrap because now the tape was physically wrapped around the heads (scanning drum, or simply the scanner, as it was known). VTRs using this type of tape



path first appeared in the early '60s. Variants of this wrap are still used by the VTRs currently in production today. Some well-known formats get their name from how the wrap looks from above around

The Time Base Corrector

The TBC was another item that made VTRs manageable on the road. All broadcast VTRs need one. VTRs are electromechanical devices. They don't play video out at a constant rate. A VTR without a TBC would output video that would be slightly, and constantly, out of time with reference video, either slightly ahead or slightly behind. VTRs couldn't be used with other sources in effects. No color monitor could display the correct color either, as chroma timing is a couple of magnitudes tighter than monochrome timing. You might wonder how your home VCR provides stable color without having a TBC in it. The home VCR separates the color signal and uses a double heterodyning process to make the color stable while letting the monochrome continue to bounce around in time. The "fuzziness" of your VCR in great part is the monochrome jitter mixed with stable color.

The TBC takes video that is varying in time, converts it to digital if needed, stores it in memory and then reads it out at a stable rate locked in time to the house reference (which is converted from digital video back to analog if required). Today, on digital trucks those analog to digital to analog steps don't need to be performed.

The TBC was introduced in the early '70s. Memory was expensive, so early TBCs could only cope with time base errors of about a line. As technology brought the price, and the size of memory, down the correction window got larger. When it got to be a video frame in size, the TBC was able to wear a new hat — that of the frame store. Computer technology eventually taught the frame store new tricks, and it morphed into the digital video effects device. The TBC was the first "digital island" in an analog sea in mobile and fixed television facilities.

the scanner. The M2 format looked like a cursive M. The wrap shown here looks like the Greek symbol "Omega," hence this wrap's name.

The helical wrap allowed VTRs to do something similar to what the HR-100 did – lay a whole video field (not a frame like the HR-100) as one continuous track diagonally across the tape. This diagonal, or slant track, was long enough to lay a whole field down each pass across the tape. The two-inch quad only laid 17 horizontal lines down per pass. The slant track was the first step to VTRs doing slow motion. It was a required attribute, but not a sufficient one by itself. A couple more technologies need to be perfected first.

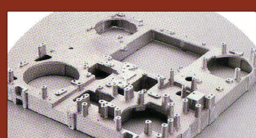


Figure 5.13 The first was precision computer-controlled milling. This base casting is from a Sony BVH-2000 Type C one-inch VTR. Long wraps meant that tolerances must be much closer than before. Anything that made the tape path vary from one machine to other would make interchange (the ability to make a recording on one machine and play it back on another) more difficult. Many early helical VTRs couldn't always play back recordings from other VTRs of the same line.

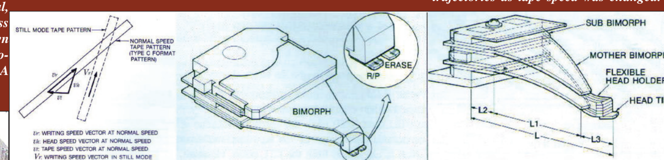


Figure 5.14 The problem with playing tapes at speeds different from the speed they were recorded at is one of geometry. When a tape is played slower than the speed at which the video track was laid down, the head takes a different trajectory across the tape, as the photo at left indicates. The head won't "track" down the recorded track correctly. A method was needed to make the head flex to follow the new track angle. (Source: Sony)

Both Ampex and Sony came up with solutions to this problem. Sony called their solution Dynamic Tracking. Ampex called theirs Automatic Scan Tracking. These were based on heads built out of piezoelectric wafers. The heads could be made to flex up or down based on voltages applied to them. These voltages weren't low; they were often over 500V. In this manner, the head could be deflected to follow a track that required changing trajectories as tape speed was changed.

This added a fourth servo to the VTR. The head was made to flex based on how much RF (recorded information) it received off tape. The day of the VTR "slo-mo" was now at hand.

Quads Leave the Scene

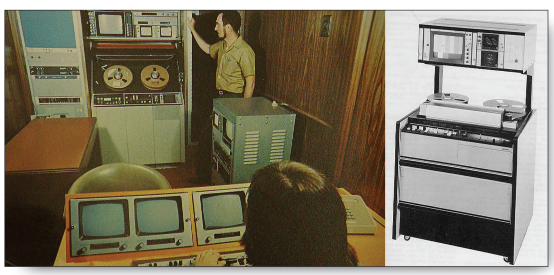


Figure 5.15 At *left is RCA's last model quad on a truck in the early 1970s, the TR-600. Ampex brought one more version out in the mid-70s. This VTR found its way onto a number of trucks, large and small. Its architecture was such that the tape transport could be separated from the rest of the electronics. This meant that this quad could actually be put on a table. Far right: the AVR-2.*

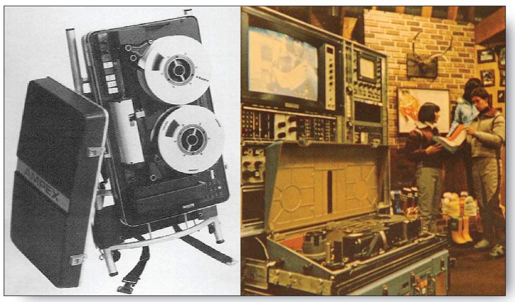


Figure 5.16 *It's interesting to note that the first portable VTRs were quads. At left is the Ampex VR-3000. It could be strapped to a back but had an additional electronics pack that also had to be carried. The RCA TRT-10 on the right had no illusions about being carried about by humans, but it was small enough to make the portable production cart a reality.*

Figure 5.17 *Evolution of tape machines on a network truck through the late '70s and into the '80s. The left photo shows a '70s the truck that had an Ampex HS-100 "slo-mo" at the rear of the truck, two AVR-2s up front and an early ¾-inch Umatic VTR that was normally used only for "air checks." The center photo shows the frame of a one-inch machine next to the disk "slo-mo" unit. The right photo shows the same truck in the '80s with Type C VTRs, Ampex VPR-2s in this case. Not only were Type C VTRs taking over, but the total number of VTRs onboard was increasing. (Source: A.F. Associates)*

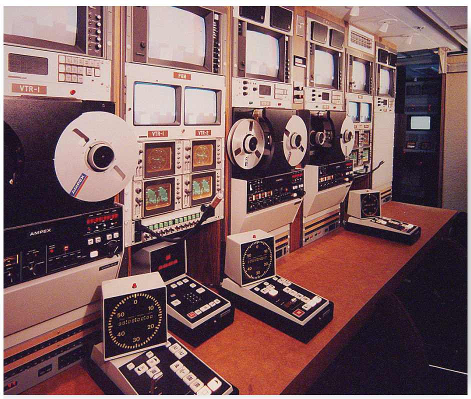


Figure 5.18 Two mainstay one-inch VTRs that were used throughout the '80s and into the '90s: Sony's BVH-2000 onboard a CBS truck (left), and Ampex VPR-2s on the right, with their "slo-mo" controllers sitting on the desk in an ABC truck. TBCs for these machines were generally separate boxes, such as can be seen below each BVH-2000 and slightly protruding from the racks. The tops of the TBCs for the VPR-2s are peaking out behind the countertop and directly below the VTR. (Source: A.F. Associates)

Figure 5.19 Sony and Ampex, along with Nagra, offered portable one-inch VTRs. From the mid-70s on there were ¾-inch Umatic portables, but the quality was far from what the one-inch format could provide. (Source: Tim Stoffel)

Figure 5.20 As the 1980s came to a close, the one-inch VTR was being nudged out of the way by ½-inch tape formats. ABC pioneered the migration to the Sony Betacam format. (Source: A.F. Associates)

Here we've seen the VTR push disk-based recording back off trucks, but in the next section disk-based recording will make a big comeback. Also, in this section we have seen how advances in technology begat additional tape formats, a trend that accelerates in the next section. ■