The Type-C Format—A Moving Target

By William F. Carpenter

The SMPTE 1-in. Type-C videotape recording format adopted five years ago has resulted in a family of videotape recorders that have been widely accepted by both broadcasters and production studios. This article reviews the changes in features and performance of the various Type-C format VTRs from the first units available through the most recent developments in both studio and portable VTRs. The article informs the VTR user of the state of the art of the Type-C format and partially explains the effects that this "moving target" has had on future digital developments.

When the SMPTE 1-in. Type-C format was agreed upon in 1978, there were doubts in the minds of many as to whether it would ever replace the quadruplex VTRs that were in use worldwide. Most VTR users could understand the projected economies of this new format, specifically in reduced tape cost and the resulting reduced space required for archival storage of the tape. Also, the performance features of picture in shuttle and still frame provided by the one-field/scan format held a future of increased productivity in the editing area. In addition to these basic improvements over quadruplex in both performance and economy, there was intrinsic value to the mobile production user of reduced size, weight, and power, all basic concerns in the growing field production environment.

This article traces the Type-C format from its meager beginnings through the current generation of products and identifies many of the important milestones along this path in both studio and portable VTRs.

First Generation Type-C Products

In the beginning, once the SMPTE Type-C format had been agreed upon, two VTR products aimed at the educational and industrial marketplace emerged. These two machines, the Ampex VPR-2 and the Sony BVH-1000C, were the pioneering products in this helical revolution.

The application of these machines in the broadcast/production marketplace soon brought requests from users for additional features. Many of these feature changes were requested by production-oriented users as a result of the inroads these machines were making into the editing environment.

Simple two-machine editing employing the backspace techniques originally proven in the ¾-in. formats proved to be faster and more convenient than the previous quadruplex editing methods. The accuracy of the tape timers, when updated by control track combined with the picture in shuttle and still frame capabilities, made the production very similar to film editing. The speed of decision-making was greatly increased by eliminating the lengthy on-the-fly "black-video-black" or "video-black-video" type of rehearsals that were commonplace with quadruplex VTRs.

In addition, a scan-tracking system employing a moving head brought a new dimension to sports broadcasting. The capability of one machine in a mobile van to be used as an isolated recording device and to be available immediately for instant slow motion replay has increased enjoyment for the sports viewing public worldwide.

These capabilities were of value for teleproduction users also, since now variable-speed effects could be used in any video production without a videodisk recorder. Some of the features requested during this period included spot erase of the various audio tracks, reverse slow motion, and built-in time-code generators and readers.

At this time, two additional manufacturers joined the ranks of Type-C format producers — Hitachi and NEC. Their machines included the feature benefits of the previously mentioned VTRs and added some innovations of their own, such as audio confidence and air guiding in the scanner area.

Development of Portable Type-C VTRs

Similar developments were taking place at the same time with portable Type-C format VTRs. Prior to their introduction, the portable production requirements were handled by the Ampex VR-3000 in the quadruplex format and by the various ¾-in. machines heavily used in ENG applications. Separation between these two formats was great, both in picture performance and features. On one hand, there was the accepted quadruplex picture quality, but combined with the complexity and weight of the quad format. On the ¾-in. helical side, there was the simplicity of cassette loading and lighter weight, but the performance with the color-under system lacked the picture quality required by a large portion of the teleproductio marketplace.

The three Type-C format portables, all of which appeared in the marketplace within a 9-month period, ranged in features from basic acquisition to full-featured field production units including cue-controlled editing and color video confidence replay. These machines were immediately pressed into service by the growing number of mobile teleproduction users of the Type-C format, but the weight of these units still limited their true portability as compared to either ¾-in. or film production.

The weight reduction in the change of formats from the previously used quadruplex VR-3000 was between 5% and 15%, depending on the features of the Type-C format portable. This meager weight reduction was related to the fact that the record time had been increased from 20 min to 1 hour with the associated increased battery capacity. These units, though labeled "portable" by all manufacturers, were carried in small vehicles or handcarts for field production use.

Introduction of Second Generation Products

At the 1980 NAB show, the first of the second generation of Type-C format VTRs was introduced — RCA's TR-800. This product could truly be called second generation since it in-

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cluded a new tape transport design that would handle 2-hour reels and had a microprocessor-based control system. It also featured an increased scan-tracking range from −1 to +3 times play speed and a sophisticated built-in time-code editing system. Though this machine was the first Type-C format product produced, RCA had gained considerable experience by marketing private labeled products since the start of the Type-C format revolution.

At this time, feature additions were made in the majority of the first generation machines with B models or evolutionary model number changes to identify the later versions. One of the additional features required by an expanding portion of the marketplace was increased record/play time, and some manufacturers modified their basic machines to include 3-hour tape capacity in unique console-sized versions.

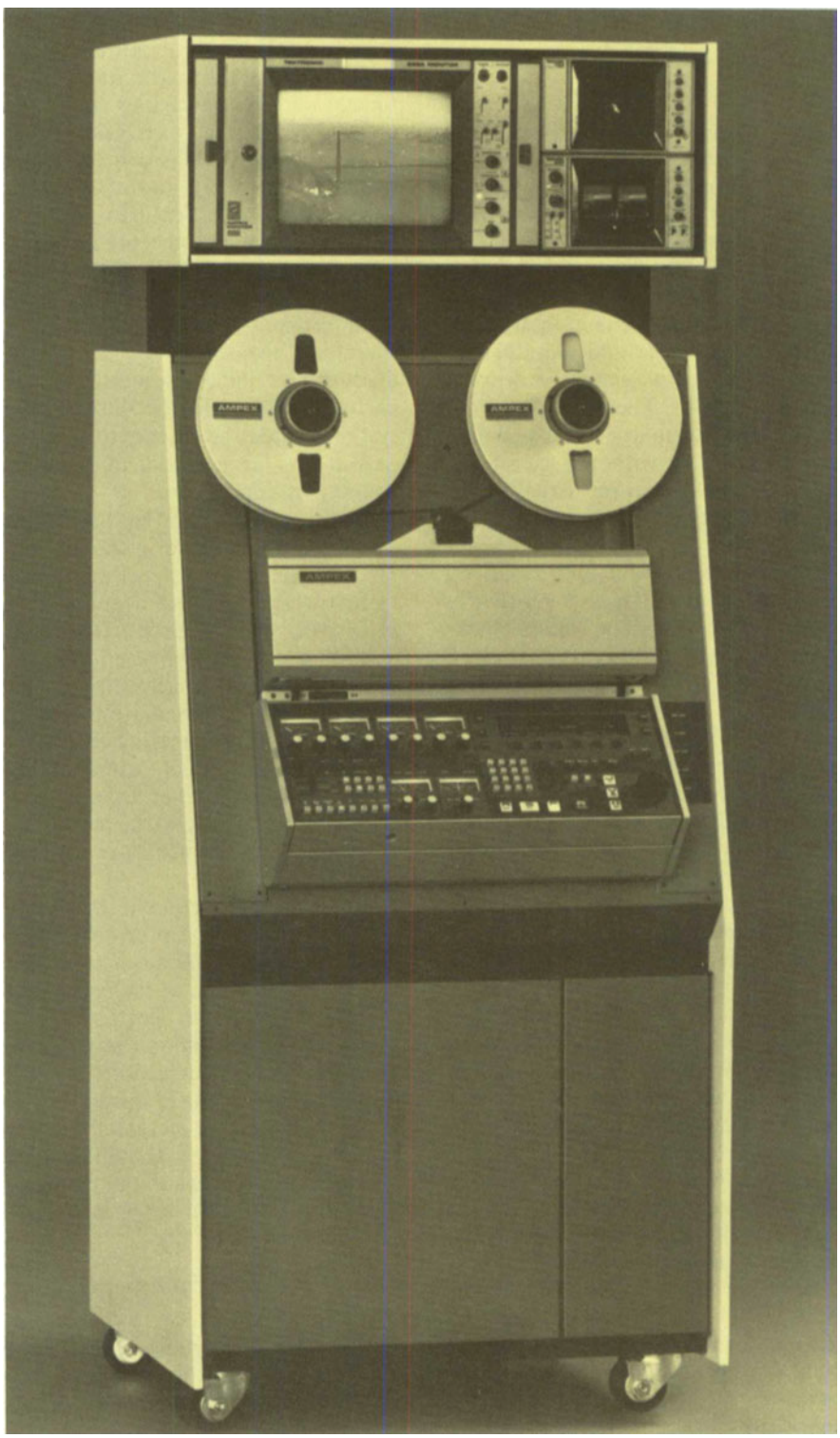

Figure 1. Ampex VPR-3 studio tape recorder.

At the 1982 NAB show, two second generation Type-C format VTRs with some striking similarities were added to the marketplace. One of these products, the Sony BVH-2000, included the increased 2-hour tape capacity and microprocessor-based servo system and the increased scan-tracking range of the TR-800. In addition, three control panels were available to allow this VTR to be applied over a broader range of user requirements. It is interesting to note that all of these VTRs were aimed at the overall broadcast/production marketplace, with very similar features and associated cost.

The other second generation VTR introduced at NAB 1982 was the Ampex VPR-80. This product was also similar to the previously mentioned second generation VTRs since it included the new transport with 2-hour tape capacity and microprocessor-based servo and control systems.

However, at this point the similarity changed since, rather than being designed for the same marketplace as all of the previous studio VTRs, this recorder was aimed at a different segment. Its goal was to provide a no-frills, cost-effective package for those teleproduction customers desiring to move up from the ¾-in. machines or a general-purpose machine for the day-to-day needs of the broadcaster. This machine included extensive editing capabilities and built-in diagnostics similar to the other second generation VTRs. But the variable speed mode was limited to a range from 0 to +1½ times normal speed, which had been proven adequate for typical playback-to-air sports applications but not for the high end of the teleproduction marketplace.

To summarize the status of the Type-C VTRs from their introduction in early 1978 through 1982, in a period of slightly more than four years, five manufacturers produced seven different studio VTRs plus their three-hour derivatives and three different portable VTRs. These products encompassed two generations with the second one consisting of evolutionary changes based on customer requests and comments on the original products. This rapid development provided a "moving target" for other digital developments.

Third Generation Products

Later in 1982, at the International

Broadcasting Convention (IBC), two third generation Type-C format products were introduced which further increased the "target range" to be reviewed by any potential digital VTR manufacturer. The first of these products was the Ampex VPR-3 (Fig. 1) studio videotape recorder, which can be classed as third generation since it included some revolutionary engineering concepts previously unavailable in a Type-C format VTR. The first and most obvious revolutionary change was in the area of tape handling. The VPR-3 includes a combination of air and roller guides to virtually eliminate the friction buildup normally found in the tape path of a Type-C format videotape recorder (Fig. 2). These guides are used in all tape movement modes to provide fast, gentle, precise tape handling without damage to the valuable master tape.

The next revolutionary change to the transport was the elimination of the pinch roller and the use of a vacuum capstan which controls tape speed in all modes of operation. This concept, which has been proven in thousands of broadcast VTR transports, allows the tape to be accelerated to its full shuttle speed from play speed without transfer of the controlling elements. Since the tape is under capstan control at all times, the addition of a high-resolution tachometer to the capstan assembly allows all servo systems to sense precise tape speed and direction at all times.

The results of this revolutionary third generation tape transport can be seen in the typical acceleration and cue profile graphs. The acceleration graph (Fig. 3) shows that, with the 1-hour tape reels normally used in the teleproduction environment, the machine is up to the full 50 times play speed shuttle velocity in less than 1 sec. The typical cue profile graph indicates that the machine can cue back to the start of a 30-sec segment and roll in less than 2 sec.

In addition, the VPR-3, through the use of a field-based color framing system senses on which field the tape is parked at all times, and combined with the fast acceleration of the capstan system, is up to operational speed in one field. This results in a fully synchronous operation in which the machine will play back synchronously with the facility in a maximum of four fields on NTSC or eight fields in PAL. That is, if the machine is parked on Field 1 on NTSC and PLAY is pressed, it waits until the next Field 1 appears on the reference signal, starts

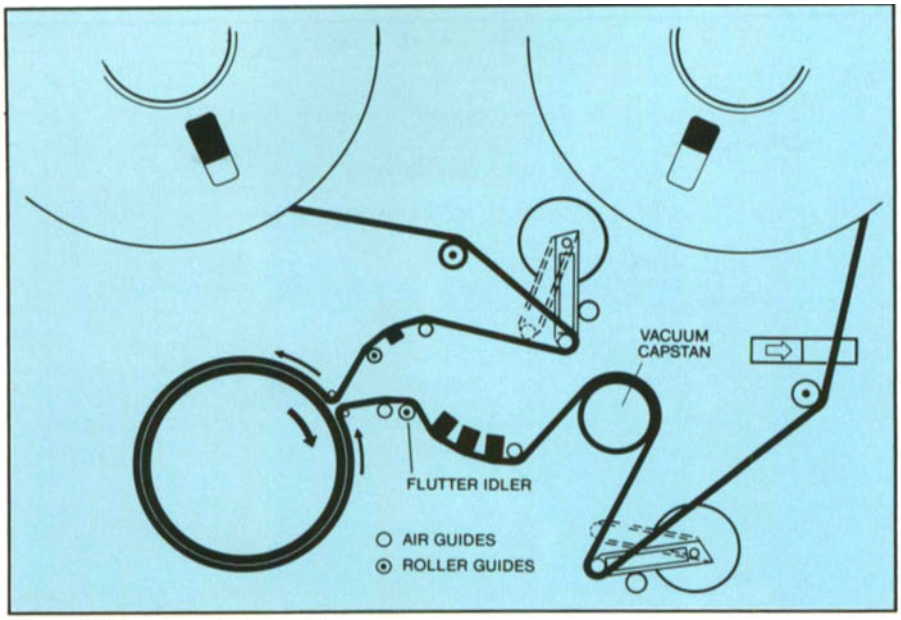

Figure 2. VPR-3 air and roller guides.

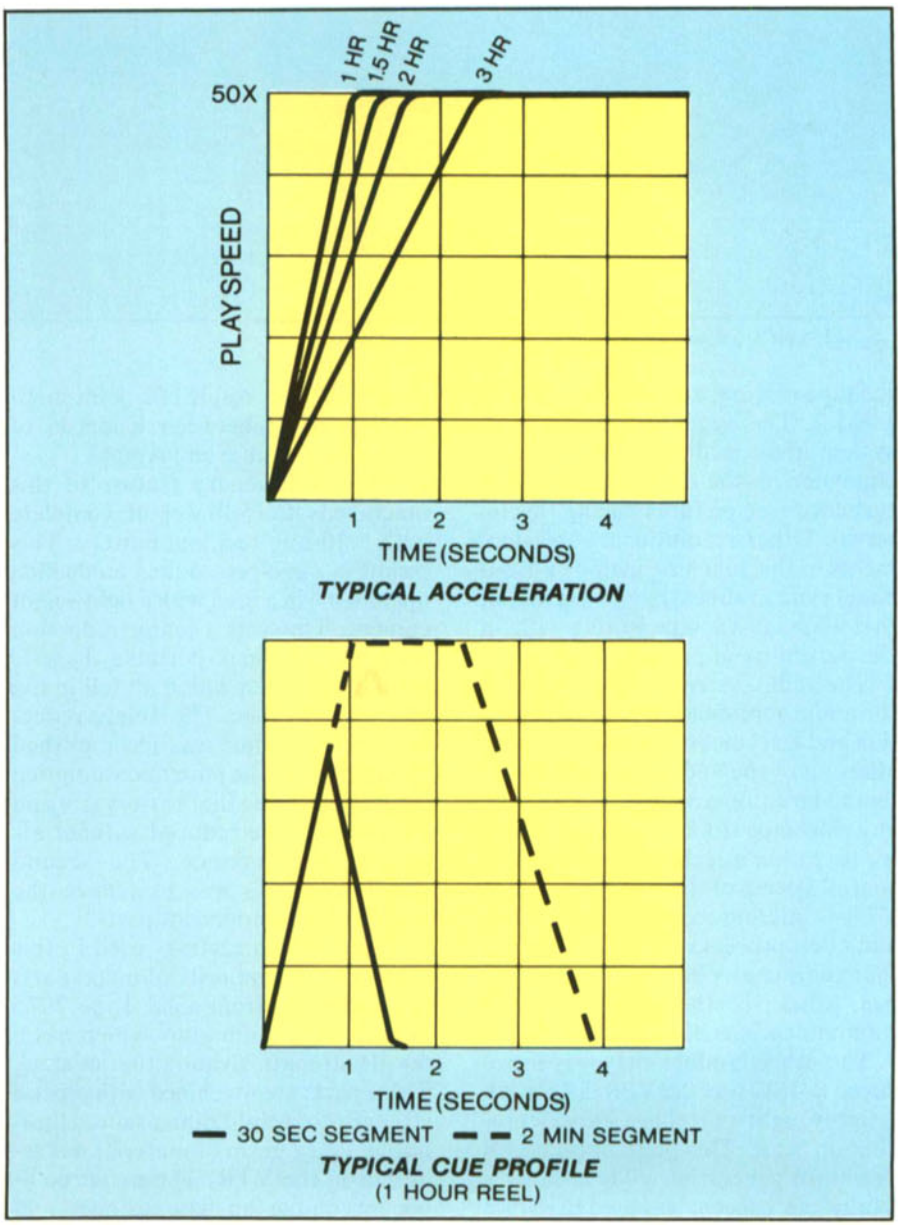

Figure 3. Typical cue profiles.

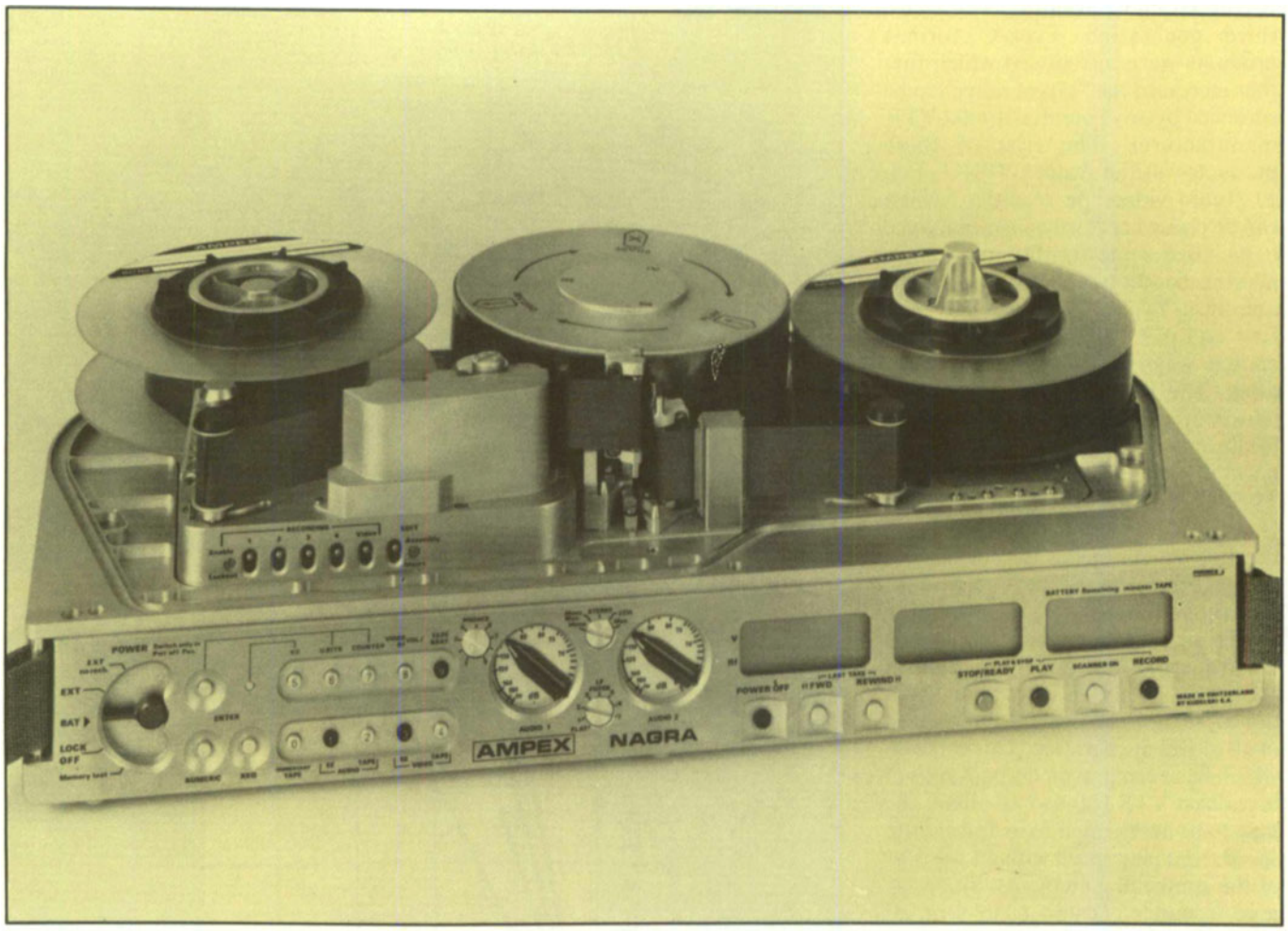

Figure 4. VPR-5, a lightweight portable field teleproduction VTR.

the tape moving, and is up to speed by Field 2. The dynamic scan-tracking system that is directed by the tachometer on the capstan allows disturbance-free pictures during this interval. Other revolutionary developments in this machine include a front panel sync to subcarrier phase meter, that allows faster tape editing without the possibility of picture shifts.

The audio system on this VTR uses the audio confidence head and distortion and level measurement circuits to allow all of the audio record parameters to be automatically optimized on any videotape stock. The video system is also automatically optimized. The control system of this third generation VTR is microprocessor-based. A second microprocessor is used to control four additional VPR-3s from the control panel via the proposed serial communications bus concept.

The other product that was introduced at IBC was the VPR-5 (Fig. 4), a lightweight portable field teleproduction VTR. This product is classed as a third generation VTR because a totally new concept was used to reduce both weight and power consumption. This VTR is a result of a joint engineering effort between Kudelski of Nagra audio fame and Ampex.

The revolutionary feature of this machine is its 15-lb weight, complete with a 20-min reel and battery. This results in a one-person field production operation when used with a lightweight camera. This was a major reduction from the previous portable Type-C format machines which all fell in the 45- to 55-lb range. The weight reduction in this product was accomplished by attention to the power consumption in all circuitry, so that battery size and weight could be reduced without affecting performance. The second major emphasis was to reduce the weight of all component parts.

There are no castings used in this VTR, but the majority of metal parts are machined from solid Type 7075 aircraft aluminum alloy which has a tensile strength rivaling that of steel. These parts are machined with precise strength-to-weight dimensions, eliminating every gram of material not required in the VTR. The major components on the top plate, scanner, and reel motors are designed so that they do not protrude below the top plate, which allows the maximum space for the electronics package.

The majority of the electronics are contained in small PWAs that contain the small-outline component packages. Since these are leadless components, automated manufacturing techniques and vapor phase soldering were used and resulted in extremely lightweight and highly reliable circuit modules. This product, as were the other second and third generation VTRs, is microprocessor based; the microprocessor is part of the intelligent power control system and shuts off various components when they are not needed. This increases battery life. The VPR-5 also includes cue-based insert and assemble editing control. The unit also can be used with 1-hour reels in an unenclosed bench-type operation.

Conclusion

Since its adoption in 1978, use of the Type-C format has expanded greatly. It is now used in 12 VTRs of 3 different generations. It provides an even larger target for digital formats of the future.