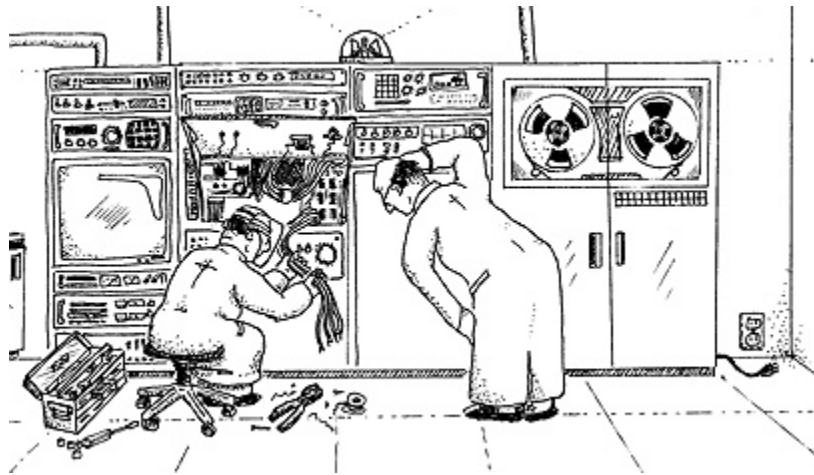


Fun with Magnetic Tape

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The Legacy of Magnetic Tape:

Mass storage, in the form of magnetic tape, has been a feature of the electronic digital computer since the first commercial machine (UNIVAC) was produced in 1950. Even now, despite the availability of low-cost removable media, magnetic tape is still frequently used as both a backup medium and a data interchange format. Optical media has largely replaced magnetic tape as a software distribution format, but the low-cost-per-bit and reusable nature of magnetic tape has allowed it to persist into the first two decades of the 21st century.

As an element of popular culture, the erratic back-and-forth movement of reels mounted on a tape drive became the visual shorthand for data processing in movies and television programs. Even when input and output were dominated by the punch card and green-bar printout, the spinning tapes symbolized “action” on the part of the computer, as intermediate results were stored and retrieved from magnetic tape. When total memory was measured in scant kilobytes of core, magnetic tape provided a backing store where program overlays, subroutines, and library functions waited to be called. An early maxim of “sneaker net” data interchange cautioned to “Never underestimate the bandwidth of a station wagon full of tapes hurtling down the highway.” (Tanenbaum)

Although normally associated with mainframe data storage, “magtape” was equally vital as a communications tool in the data processing environments of the 1960’s. Small, dedicated computers were often used to “SPOOL” (an acronym for “Simultaneous Peripheral

Operations Online”) incoming and outgoing data onto magnetic tapes to maximize throughput in the central computer and eliminate the wait states associated with slow peripherals like card readers and printers. Special purpose machines available for use with the first UNIVAC mainframes included card-to-tape converters and tape-to-print machines. The venerable IBM 1401 was often used as a “front end” for larger machines like the IBM 7090, these front-end machines were later replaced by dedicated I/O channels that allowed for processing concurrent with I/O.

By the 1970’s, companies like Mohawk Data Sciences had eliminated the keypunching step and introduced machines like the MDS System 2400 that provided both a buffered key-to-tape and a tape-to-printer subsystem. The Edinboro State College library used an MDS 2400 to collect circulation data on a reel of 9-track tape, this tape was dumped to the Univac 90/60 mainframe each night and processed. Output was likewise written to magnetic tape and returned to the library, where reports could be printed offline for use by the library staff.

The ability to collect data on magnetic tape for subsequent processing at another location enabled the large telephone companies in the United States to automate the billing associated with toll calls and eliminate human operators from the smaller central-office exchanges: computerized switch gear in the central office recorded toll calls on magnetic tape – in my own hometown, a single reel of magnetic tape could store an entire month of toll billing. This was shipped several hundred miles to the business office where the bills were printed and mailed.

Even today, large projects like SETI@home use a similar approach to overcome bandwidth limitations: data recorded by the radio telescope in Arecibo, Puerto Rico is stored on tapes which are then shipped to Berkeley, California for processing. In the field of practical geology, seismic surveys often record multi-terabyte files onto magnetic tape and transport those files to supercomputer centers where months, if not years, of processing are needed to create detailed maps of the subterranean geological features.

Early minicomputers like the LINC (Laboratory INstrument Computer), designed in 1962 by Charles Molnar and Wesley Clark for the National Institutes of Health (NIH), depended upon a specialized block-addressable “random access” tape system as its primary mass storage. Unlike traditional magnetic tape with very high data capacity and strictly sequential access, LINCtape was limited to around 400K but could reliably rewrite individual locations on the tape in a random fashion. Worst-case seek times were on the order of a minute – slow by modern standards but fairly quick considering the essentially linear nature of the tape. The LINC used its tape system in much the same way that later microcomputers used a floppy disk. Digital Equipment Corporation later adapted the design of the LINCtape and marketed their version as the DECTape.

By the middle-1970's, the nascent microcomputer market called for a low-cost data storage system and, once again, magnetic tape was the solution. This time, low-cost audio tape recorders were adapted as an entry-level storage device for S-100 systems like the Altair, the KIM-1, and the Apple. Although quickly eclipsed by low-cost floppy disk systems, several generations of home-computer made use of the ubiquitous compact cassette. A plethora of competing standards made data interchange difficult, but cassette tape storage remained popular among users of small computers throughout the late 1980's – particularly in the lower end consumer PC's.

The 1980's saw a major shift in the marketing and use of small computers. Early systems had been largely purchased by computer hobbyists who were expected to be somewhat technologically proficient; many wrote their own software and built their own hardware. Thus, popular systems tended to be “open” and well-documented. Starting with the IBM-PC and Apple Macintosh, microcomputers were becoming more like appliances and less like sophisticated toys. Turnkey systems were the order of the day, with business users expecting a useful system that didn't require as steep a learning curve. These systems were likely to incorporate a hard disk for program and data storage but generally required a backup medium with greater capacity than a floppy disk. Recordable CD drives were not yet available, so the emphasis was on tape backup solutions. A variety of small tape formats were marketed with capacities ranging from a few megabytes to several gigabytes.

In many ways, the “heyday” of small tape systems was the early 1990's, with formats ranging from ½” open-reel 9-track tape on 10 ½” reels to small 4 mm micro-streamer cassettes used to backup both file servers and individual workstations. By late 1995, CD-R drives were becoming cost-competitive to tape drives having a capacity less than 1 GB. Other viable alternatives to tape drives for backup in the late 1990's included Zip Disks with capacities ranging from 100 MB to 250 MB, the “superdisk” floppy with a capacity in the 125 MB range, and portable hard drives. For small files and data interchange purposes, the high-density floppy disk had already displaced magnetic tape.

By the year 2000, fears of a catastrophic Y2K bug had prompted many users to upgrade or replace legacy systems, including many that were dependent upon magnetic tape for backup. The decentralization of data processing and growth of the Internet also decreased the need for file-interchange using physical media. The Apple iMac was one of the first systems to ship without even a floppy disk drives. Other manufacturers followed suit as the introduction of flash memory allowed for high-capacity USB “jump drives” that made the floppy disk largely obsolete.

Although tape is now considerably less ubiquitous than it was even a decade ago, it still serves as the backup medium of choice for large servers, mainframe computers, and as a data interchange format for files too large to store on a DVD-R. In terms of media cost, it is

still slightly cheaper and somewhat more durable than backup onto removable or portable hard drives.

Some Notable Tape Formats:

The first magnetic tape format, and probably the rarest one still known to contain significant historical data, is the Uniservo tape format used by the early UNIVAC mainframes.