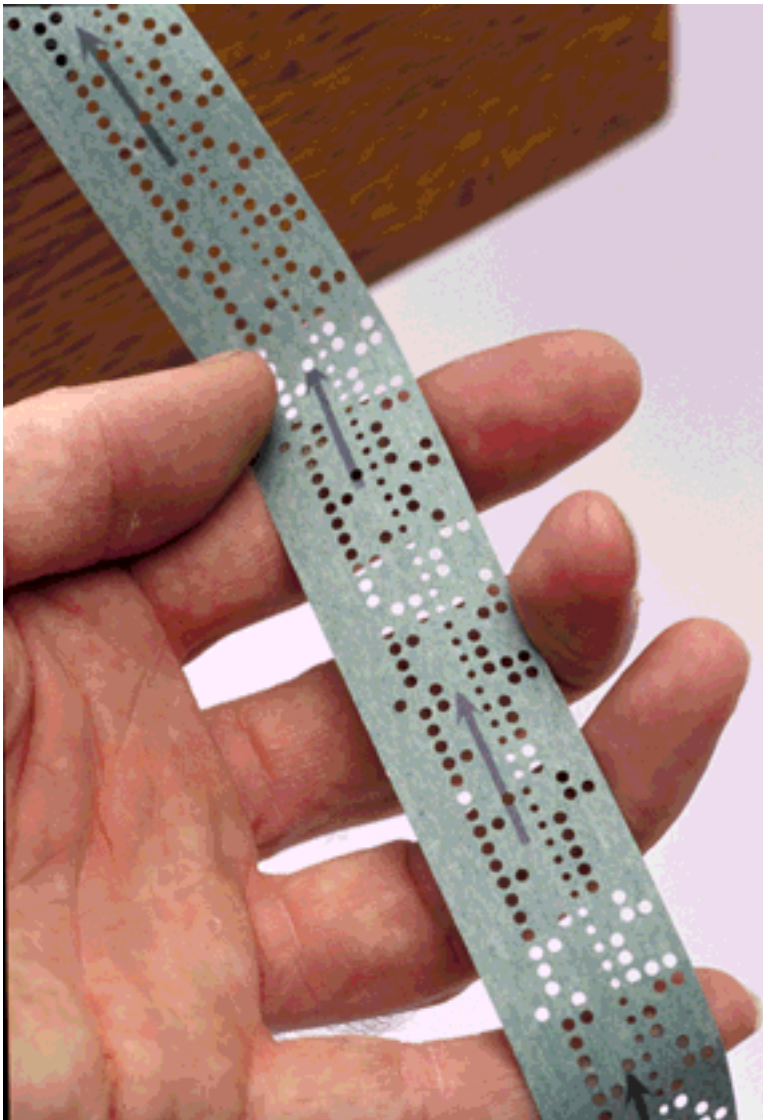


Paper tape

Paper tape is a data storage medium from a past century.



It's roots are in mid-19th-century telegraphy. The cliché "dit dit dah dah" sound of audible telegraphy is really that of simple point-to-point radio Morse Code telegraphy, such as amateur radio or, once upon a time, ships at sea. Telegraphs, as in telegrams, business and personal messages and all that, started out as visible marks on long paper strips that were decoded by a telegraph operator, and written or typed out for the message recipient. By the start of the 20th century automatic equipment inked letters directly onto the paper strips, which the operator merely cut up and glued onto the telegraph form; for an example machine of this type, see the description of my [Western Union Simplex Printer 2B](#) that is now part of the Story Teller system.

Initially marks were made on the tape with ink or scratches or

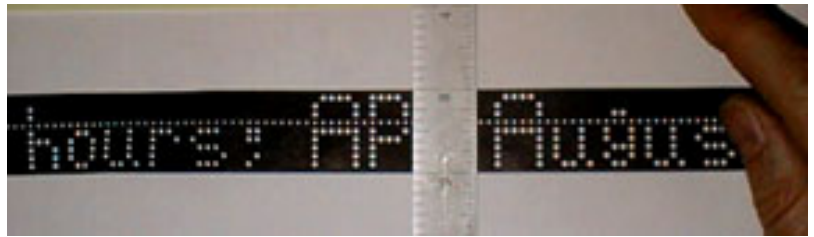
indentations, but it quickly gave way to perforations, which machinery was able to make, and read mechanically, in the rapid development of automatic equipment. (An [example of an ancient tape](#) can be seen in my [History of Character Codes](#).)

100 years ago there were many different kinds of perforated tape systems, but it quickly boiled down to one format: six holes across the width of 11/16" wide paper tape. Five holes were for data, the sixth was for a sprocket/gear the dragged the tape through the mechanism. ("Data" is a modern construct; at the time each row of five holes was just called a "character".) This is generally called "5-level" tape. (Sorry, I have only unpunched 5-level tape, since I don't use it.)

Some time in the 1950's the growing need for a larger symbol set (eg. more holes across the



tape) caused the introduction of 8-level tape; it has exactly the same dimensions of 5-level tape but on the "most significant" edge of the strip, three holes were added and the width increased to 1 inch. 8-level tape readers can read 5-level tape; with slight modification an 8-level punch can create 5-level tapes. This is called "backwards compatibility", once common in the electronics/data world, now seemingly abandoned in the greedy and short-sighted marketplace.



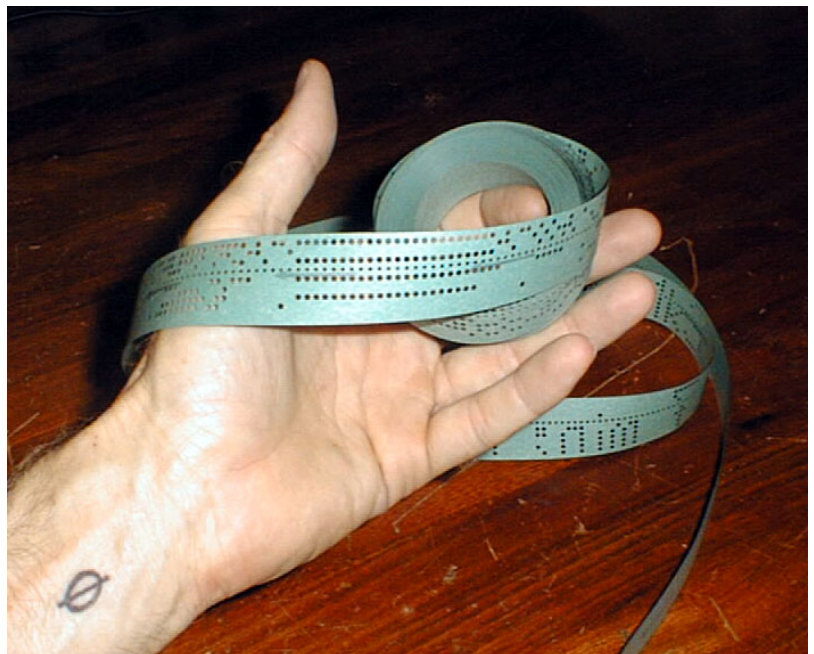
(I hope I don't confuse you with the "human readable" hole patterns on the tapes in some of these photos; that is NOT how data is stored. Those are punched for the convenience of the person handling the tapes, as a label to identify the tapes, it is arranged such that the machinery ignores it. Actual data appears as random-looking rows of holes, as in the small loop of tape in my hand above.)

While it's not exactly practical for general data storage today (storing Microsoft Word 5.0 for the Macintosh on paper tape would take 340,000 feet of tape...) it is aesthetically interesting and pleasing to work with (until you drop a few hundred feet into a tangle on the floor). And in carefully-tuned modern systems (with data- and symbolic-compression) it becomes quite workable, and you can feel the sort of visceral gestalt of a tape-driven data system.



Half the pleasure of the Story Teller system is grokking it "in parallel", as mechanical and electronic devices working in concert; even without really knowing what's going on, by watching carefully you can vaguely follow the "data" flow off the tape, and to the peripheral devices.

Perf tape comes in many different materials. Most common is paper, plain or oiled. Paper is cheap and plentiful, though it doesn't last long; it gets fuzzy and ratty after only a few dozen uses. Really old





mechanical punches need oiled tape to lubricate the punch dies, most modern stuff (post-1960) will take plain paper just fine. (Oiled tape leaves messy stains on everything.) It comes in many colors, which is of no significance for the machinery, except that some simple readers (like my Model 3) require an opaque tape, since the sensing of holes is done optically. And it's cheap; a 1000-foot roll of 1", plain black tape costs \$5.00 in September, 1999.

Of higher quality (and greater expense) is mylar tape, or laminates (the greenish stuff in the photo to the right). Mylar is a very stable, tough plastic that will last many hundreds, or thousands, of reads, depending on how hard the reader is on the tape. It requires a "mylar-capable" punch, because it's much harder than paper, and thinner and smoother. Laminates are generally paper/mylar/paper sandwiches, though the mylar is much thinner the resulting tape is far, far stronger than paper tape and is usually compatible with non-mylar-capable punches. Both mylar and laminate tapes are expensive; a 1000-foot roll of 1" mylar tape is \$54.00; laminate \$52.00 per roll. Since I'm a good scrounge, I have a few dozen rolls of both types, old surplus, which I use for performances like the Story Teller system.

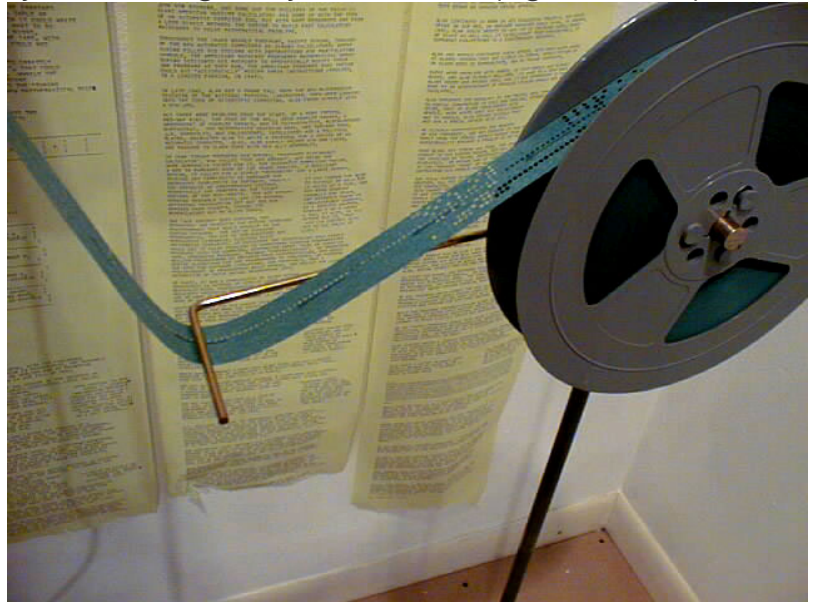
(An aside: perforated tape may be the only truly archival data storage medium we humans have ever come up with so far, other than handwriting of course. The encoding is extremely simple, and a "Rosetta stone" of letters and their hole-pattern equivalents (a variation on the proverbial "ASCII chart") would be adequate. The sole advantage of course is that it could be read by machinery, as well as be hand-decoded. Half-century old tapes remain readable, as long as the paper is preserved. (Though one could argue that the effort for even a large, complex and let's assume valuable document, the time/effort saved by creating a tape-reading machine wouldn't be justified; even a tedious hand entry of equivalent ink-on-paper would have to be done only once. Only a truly huge library of tapes vs. printed pages would arguably be worthwhile.)



Usable tape readers are hard to find today; "usable" means under 50 pounds/25kg, and with a non-lethal electrical interface, and a footprint smaller than a microwave oven. I ended up making my own, the first one is my Model 3 Tape Reader, shown here with a tape under the read head, with the cover lifted, as installed at the OUT WEST show at Plan B in Santa Fe. (Note the "forgery" business is more obvious to the trained eye in this

photo; that's a solid state optical head, with stepper drive, inside that mid-century phenolic, brass and shellacked oak.)

Of course no real-life paper tape system consists of just a tape and a reader. You need a raft of support equipment and supplies, like take-apart reels for the long stuff (the Alan Turing story requires 650 feet of tape). Winding up more than a few dozen feet of tape with your fingers is insane (of course I've done that). For long tapes, like the Turing story, there is a supply reel and gravity tensioner, (right, below), and a motorized take-up reel with slack sensor. When the tape is played out, the loose end flapping on the take-up reel, you need to rewind it -- I use a cut-down tape editor (more later) that takes about a minute to rewind the



Turing story tape.



Paper tapes break, and you shouldn't be surprised that there's a whole technology devoted to tape repair. There are patches, self-adhesive tape with all-possible holes punched, with which you tape the torn/cut ends together. And the very data on the tape itself is formatted such that a torn section causes only the loss of the cut/damaged tape, rather than the entire tape contents (the Story Teller system uses variable

length records, generally 40 characters long).

And there are tape editors -- be thankful you never have had to do this. It looks like an old manual film editor; two reels with cranks, and a little splicing block to hold the tape while you cut it and apply the perforated patch. I sawed mine down into a winder only; if I break a tape I punch a new one, courtesy of 1999 multi-giga-byte disk drives and my modern (sic) tape punch.

To the right are my two modern



(late 1980's) tape punch/readers, incredibly lucky finds, both. The one on the left is a GNT-4601 with an ASCII code EPROM; I paid C \$25.00 for it new-old-stock (then US\$200 for the ASCII EPROM). The one on the right is a DSI NC2400, for which I paid US\$50. Both are mylar-capable. Though they take a standard RS-232 serial interface, Microsoft doesn't provide one; the handshake lines are not supported properly (neither is the generic serial printer), so I have to use an old FidoNet-style FOSSIL interface to repair the serial drivers in Win98.



Western Numerical Controls, by the way, sells paper tape supplies and equipment, and are a pleasant company to do business with.



WPS HOME