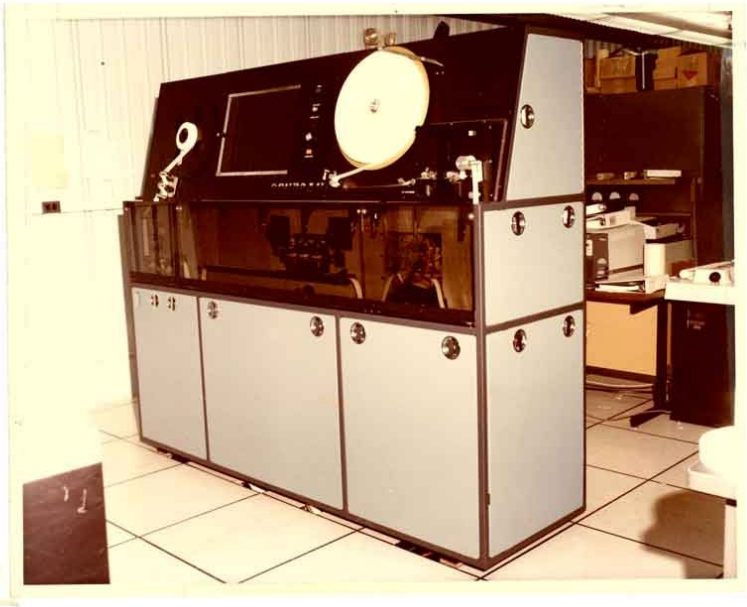
Tale of the Tape

Key tape has been a part of NSA communications security (COMSEC, now Information Assurance) for decades. The key tape era is now passing as the Information Assurance Directorate (IAD) moves toward electronic means of key distribution and the last of the unique rolls of Paper-Mylar-Paper-tape leave the Cryptographic Assurance Operations (I31) production line. A mainstay through the years, key tape has provided cryptologic key to a diverse set of communications systems such as GOLDWINE, AFSATCOM, J-TIDS, KG-81 and VINSON/BANCROFT.

The development of the Punch, Verification and Print (PVP) system serves as one example of the innovation and invention necessary for effective COMSEC/IA. In the late 1970s, COMSEC engineers were challenged to develop a high speed, real time system capable of mass producing key tape.



At the time Intel's new 8080 microprocessor was not commercially available but was rumored to soon be released. Eventually the 8080 microprocessor would play a crucial role in monitoring each of the required functions of the system. However, until the new microprocessors were available, the PVP's software development engineer and Crypto software programmer had to be content with writing the main system software for the DEC PDP-11 computer that would import cryptologic key and oversee the entire tape production process. Written in assembly language, this task was daunting and would be considered the equivalent of travelling from Baltimore to Los Angeles on hands and knees by today's programmers.

Throughout PVP system development, many other leading edge engineering challenges were conquered by NSA's COMSEC engineers.Some of those challenges are discussed below:

Each 5,000 foot roll of Paper-Mylar-Paper-tape moving through the production line at one foot per second represented the raw material on which the COMSEC key would be punched and printed. In the day, keeping the punch and print operations moving with the necessary speed and precision presented a serious engineering challenge.

Borrowing from the technology of magnetic tape drives, the development team came up with vacuum wells which were incorporated into the system to physically regulate the flow of the unique Paper-Mylar-Paper-tape. In fact the Paper-Mylar-Paper-tape itself was specially produced by Emerald Technologies and ROI/TIKA Tape specifically for NSA and consisted of a layer of Mylar sandwiched between two layers of paper tape. This yielded a product that was so durable it could reliably withstand the harshest of operational environments ranging from the tropics to the arctic.

The 1" width of the paper tape required three offset dot matrix print heads whose operation had to be synchronized to the speed of the tape flowing through the system and aligned such that the final printed identification data read as if printed by a single print head. Introduction of the newly arrived microprocessors that monitored, controlled and verified printing in coordination with the PDP-11 presented a solution to this challenge. The microprocessors provided the improvements in processing speed necessary to keep up with tape production speeds. NSA's use of the microprocessors as control devices was beyond the state of the art for the time, a fact that was later independently confirmed at Stanford University.

Long before toner cartridges became the standard ink dispenser in printers, ribbons were stamped by the print heads to place ink on paper. At some point during any print operation the ribbon had to reverse direction to maximize print ribbon integrity. However, the PVP print heads moved so fast that in the time it took the print ribbon to reverse course the ink on the ribbon would be exhausted and characters would fail to print on the tape. This situation led to the further development of code which could anticipate the end of a ribbon and launch the reversal process in time to avoid destroying a ribbon and stopping production.

Ease of operation and minimization of downtime are critical concerns of any production line. Key tape production, nor the PVP that controlled production, was no exception.During early design reviews it was discovered that many equipment operators could not type, a fact that would greatly slow production if they had to enter the industry standard production control commands through a computer console. With this knowledge in hand, computer programs were written to detect and alert operators of production anomalies by marking the tape accordingly and continuing production without direct human intervention (i.e., noting where the error occurred and automatically repunching/reprinting the erroneous segment of tape). With the innovation of control software into the key tape system, the PVP could be controlled with a simple Stop/Go button. Maintenance was improved by embedding the 8080 microprocessors within the PVP to independently monitor every function and provide maintainers a quick assessment of any malfunctioning process (much like today's automobile mechanics relay on diagnostic tools to tell them what part of a car needs attention). Both of these innovations were highly dependent on the processor speeds achieved by the new microelectronics.

For decades the protection of many of the nation's military and strategic secrets have depended upon a cryptologic product known as key tape. With an era coming to a close, it's easy to see how the foresight that introduced early microelectronics into a

leading edge production environment has gone far to build NSAs customer’s confidence in NSA’s COMSEC products.