Chapter Thirteen

POSTNET Barcodes: Enablers of Letter / Flat Mail Postal Automation, 1982 - 2013

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Introduction - Postal Automation Background

POSTNET barcodes served as an essential component of the United States Postal Service (USPS) letter and flat mail postal automation program for more than 30 years. These barcodes provide a source of valuable routing information to philatelists. Like most postal artifacts, POSTNET barcodes also offer their fair share of interesting errors, freaks, oddities, and other challenges for study by interested collectors. With approximately 40% of the world mail volume, the USPS has understandably been highly motivated to find means to speed the delivery of mail while controlling costs in a labor intensive business. In 1990, the USPS estimated costs of manual sortation of mail at $30 per 1,000 while the cost of automated sortation was estimated at $1.50 per 1,000 mail pieces.

Hand sorting of mail dates back to the origins of mail but is a labor intensive process. The clerks can only conveniently access a limited number of destination "pigeon hole" mail slots as they sort. While this is a manageable process with a limited number of destinations (such as the apartments in a small apartment building), sorting outgoing mail for every delivery point (over 152,000,000 in 2013) in the United States is a daunting undertaking that requires many stages (passes) of sortation.

Finally, manual sortation requires extensive memorization. For example, a postal clerk sorting mail for a typical 600 address delivery route must memorize the sequence and location of the mail sortation pigeon holes for all the addresses. As new houses and roads are built, the routes must be reconfigured, new routes memorized, and the sorting bins relabeled. Automating this process allows the use of more sortation bins (beyond arm's reach), dramatically reduces the sorting time, and allows rapid remapping as delivery routes are reconfigured.

Precursor Barcodes

A trial of the experimental Letter Mail Code Sort System (LMCSS) barcoding system was conducted in 1972 in Cincinnati, OH. The short two-part barcodes are very distinctive and are rarely seen on commercial mailings (Cincinnati Bell mailed some envelopes) or personal mail. Most known examples are philatelic covers with a nice postal automation cachet by Alfred "Tag" Boerger (Figure 1). Occasionally business reply envelopes or preprinted barcoded courtesy reply envelopes are seen in dealer boxes from the few billers that provided barcoded courtesy reply envelopes to their customers for bill payment. The barcode symbology was discussed in contemporary papers (Stark, 1972, Paul, 1973). The experiment was short lived and the barcodes are not easily read (Paul takes 16 pages to explain how to decode the barcodes) so I'll leave it to interested readers to explore them independently.

Introducing POSTNET Barcodes

In an effort to encourage mailers to apply barcodes, the USPS adopted their novel POSTNET (acronym for "POSTal Numeric Encoding Technique") barcode. This barcode symbology could be created and printed by mailers using the primitive printers of the time such as impact printers and dot matrix printers (Appendix A).

The USPS deliberately selected a barcode symbology which maximized the ability of mailers to produce barcodes –

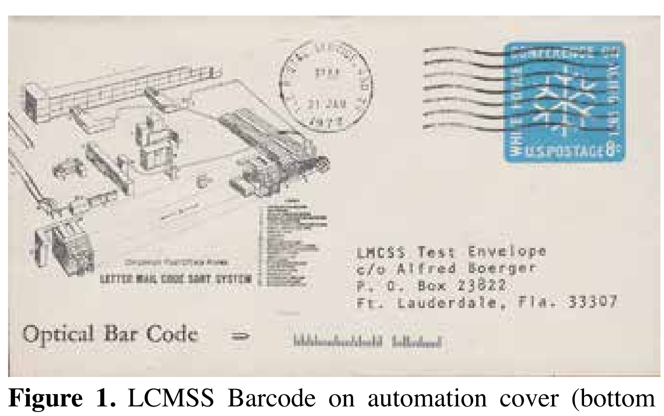

Figure 1. LCMSS Barcode on automation cover (bottom center).

Figure 3. Five digit ZIP coded envelope with matching POSTNET barcode: 61820.

even though the USPS incurred the cost of buying expensive barcode readers to read the tall / short barcodes downstream. In contrast, the ubiquitous wide / narrow Universal Product Code (UPC) barcodes (Figure 2) used at the grocery store require high quality printers to produce (which the mass marketers are happy to incorporate into their colorful packaged goods labels) but they can be scanned by inexpensive laser scanners at the thousands of retail outlets.

16oz Strawberries
7 15756 20002 3

Figure 2. Universal Product Code (UPC) for strawberries at the grocery store.

The USPS also opted for simplicity in the barcode data itself. The initial POSTNET "A Field" barcode simply represented the current 5 digits of the ZIP code (Figure 3). The USPS Optical Character Reader (OCR) machines or keyboarding clerks could relatively easily read the free standing ZIP code at the end of the destination address and enter those digits to generate the barcode. There are only 10 different possible digits to decipher and, unlike letters which may be connected together in handwritten script, numbers are normally written as separate characters.

The OCR system was designed to search the envelope for an address block (which required about half the processing time) and then start reading up from the bottom looking for a numeric string – the ZIP code. This system depended upon the sender writing the correct ZIP code and the OCR correctly reading those digits. There was a potential to misdirect mail if the characters were read incorrectly. Reading the city and state to cross check the ZIP code was a much preferable solution which was implemented as the quality of OCR technology improved.

My interest in POSTNET barcodes was sparked by a brief article (Boughner, 1983) in *Linn's Stamp News* describing the newly deployed barcodes. Within 5 years, I'd conducted an extensive study of POSTNET barcode errors, published a number of papers, won a Vermeil medal for my exhibit at Milcopex, and was on a path towards a career change from biology into postal automation (Quine, 1989b).

Understanding, Decoding, and Analyzing POSTNET Barcodes

The POSTNET code symbology is readily accessible to interested philatelists. The code starts and ends with a tall bar (like bookends on a bookshelf). Each digit of the ZIP code is coded by 5 bars of which 2 are always tall and 3

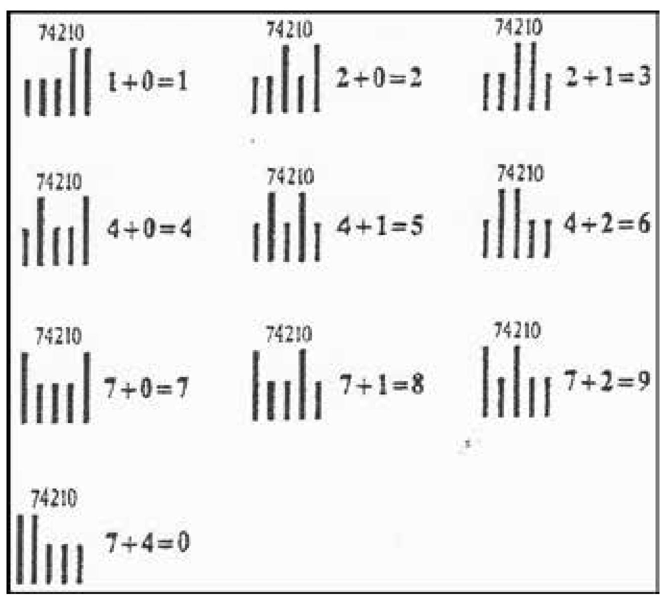

Figure 4. POSTNET barcode patterns used to represent numbers in a ZIP code. Every digit is coded with 5 bars (2 tall and 3 short). The tall bars define what value is coded. "0" is arbitrarily defined as a special case. The weighting factors (7, 4, 2, 1, 0) are shown above the bars for reference (Wawrukiewicz, 2011).

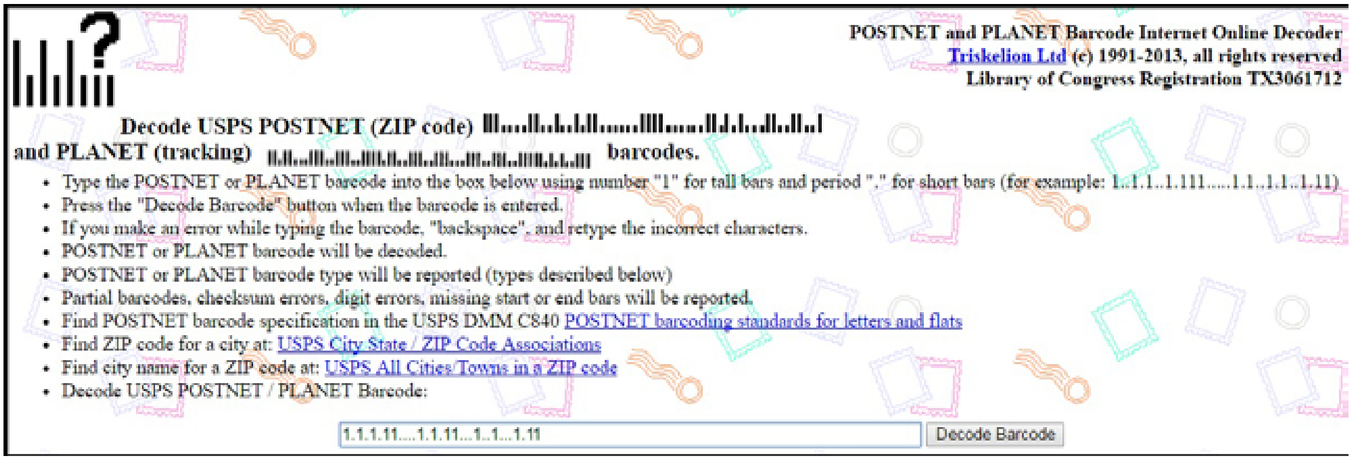

Figure 5. Online POSTNET Barcode Decoder developed 15 years ago. POSTNET and PLANET barcodes are briefly described at the top. Barcode patterns are entered manually at the bottom with “1” for tall bars and “.” for short bars. This illustrates the decoding of the POSTNET barcode in Figures 6 and 8.

Figure 6. Example POSTNET barcode for decoding: 50508.

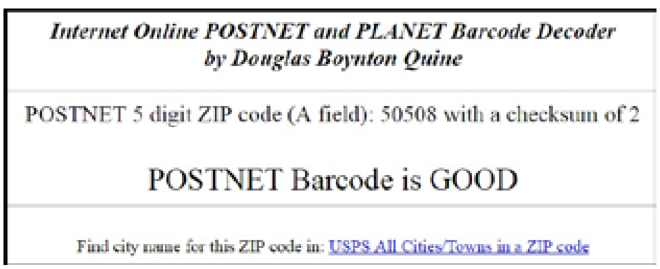

Figure 7. Online POSTNET Barcode Decoder – Decoding results for POSTNET barcode (Figures 5 and 6). “POSTNET barcode is GOOD” means that a complete barcode was successfully entered. Data entry errors, incomplete, or impossible barcodes will be reported as “BAD”. Obviously, the decoder cannot evaluate whether the barcode is the correct one for the address. The “checksum” is explained below.

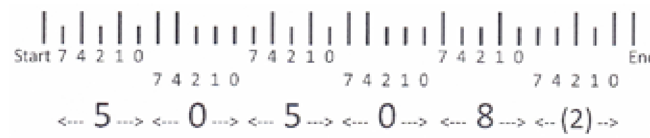

Figure 8. Decoding a 5 digit (32 bar) POSTNET barcode
Top: POSTNET Barcode: 50508 (2)
Middle: bar definitions
Bottom: decoded barcode digits and checksum

are always short (a 2 of 5 barcode). You may memorize or reference the barcode patterns in Figure 4 to read the “digits” of the ZIP code.

For philatelists interested in barcodes, I recommend using my free online tool (www.quine.org/postnetj.html). It was created of necessity as I worked my way through a barcode study of 20,000 envelopes. The bottom line in Figure 5 shows the data entry of the barcode illustrated in Figure 6 with “1” typed to represent each tall bar and “.” typed to represent each short bar. Figure 7 shows the decoded “good” results. When “bad” barcodes are identified, it is always worth repeating the decode to be sure before concluding that another interesting error has been identified.

Naturally some readers will want to understand how the barcode works, but this is not necessary for understanding the prior two paragraphs. The encoding mechanism is shown in Figure 4. We are all familiar with the concept of the units, tens, hundreds, and thousands places in our decimal system. The POSTNET barcode is a little different. It uses a “zero” place, a “one” place, a “two” place, a “four” place, and a “seven” place. Only the tall bars are counted (the short bars are just placeholders). Tall bars are weighted by position (Figure 4) and added together (“74210” is printed above each pattern for reference). Mathematically, the unconventional selection of 0, 1, 2, 4, and 7 (coding 0 and 7 rather than the 8 in binary) as the weighting factors is elegant and deliberate. It means all ZIP code digits can be represented by a combination of 2 tall and 3 short bars (zero is “arbitrarily” encoded by 4 + 7).

After all digits of the ZIP code have been encoded, an additional 6th “checksum” digit is added for error correction. This is computed by adding up all the numbers in the ZIP code and determining how much more is needed to reach a multiple of 10. For example, the ZIP code 77777 digits add up to 35 so an additional 5 (the checksum) is needed to reach 40 which is a multiple of 10. In contrast, the ZIP code 50508 adds up to 18 so an additional 2 (the checksum) is needed to reach the next higher multiple of 10 – namely 20. In this chapter, the checksum digit follows the POSTNET digits in parentheses.

To help interested readers manually decode POSTNET barcodes, Figure 8 shows a sample POSTNET barcode with the bar labels, weighting factors, and decoded values below.

The 2 of 5 tall rule has important implications for error correction and quality control. If each set of 5 bars between the start and stop bar has 2 of 5 bars tall then we know they

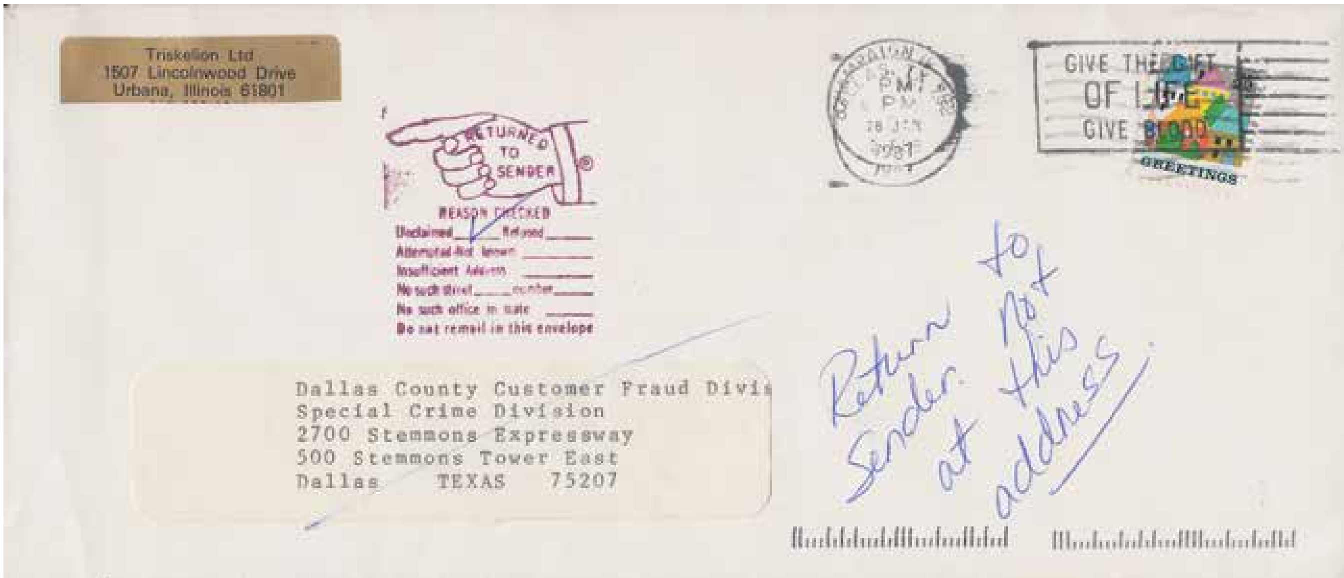

Figure 9. 5 digit A field barcode: 75207 (9), upgraded with a B Field: 07-2107 (3). The B field repeats (or corrects if necessary) the last 2 digits of the 5 digit ZIP code and then adds the +4. It was created as MLOCR technology improved. Such examples as this are not commonly found.

are "intact." If, on the other hand, we have a cluster with 1 or 3 tall bars, we know that an extraneous mark or a printing defect has added or removed a bar. This, then, enables us to recover many defective barcodes. Consider the barcode which decodes as 11*11 (5). [My convention is to represent unknown digits as "*" and to report the checksum in parentheses.] From this decoded barcode I know that the middle digit had an invalid cluster (perhaps a stray line added an extra tall bar). Ignoring the middle digit, I can compute what it should be using the checksum. The readable ZIP code digits add up to 4 plus the checksum of 5 equals 9. We need "1" more to get a multiple of 10 and therefore the unreadable digit must be a 1. Using this technique, you can always recover a single bad digit; sometimes you can recover 2 missing digits (Quine, 1988a).

All of the POSTNET barcodes can be decoded by ignoring the first tall bar and then reading the clusters of 5 bars from left to right. However, the process is slow and manual decoding errors are inevitable. That's why I use my online tool for decoding POSTNET barcodes.

From 5 to 9 digit POSTNET: Real time Postal Automation Evolution

The original "A Field" POSTNET barcodes represented a 5 digit ZIP code (Table 1 using a traditional example barcode 12345). Eventually OCR technology improved and the full address could be read with multi-line optical character reader (MLOCR) technology. This meant that the ZIP+4 (9 digit ZIP code) could be generated from the address information and verified against the printed ZIP+4 (if available). Typically, the MLOCR would locate the address block and then sequentially recover the ZIP code (lower right), state and city (to the left). On the next line up typically a street number and name would be decoded. This expanded the POSTNET code (C field, Table 1) to represent the 9 digit ZIP code (e.g. 12345-6789 plus a checksum). The POSTNET barcodes simply expanded from 32 bars to 52 bars wide with the same spacing. During the OCR upgrade and transition, many 5 digit POSTNET codes continued to be produced. A modification was therefore deployed at the MLOCR-enhanced sites to append a code (B field, Table 1, e.g. 45-6789) which corrected the frequently incomplete zone numbers ("45") and then added the +4 digits ("6789") to a pre-existing 5 digit "A field" POSTNET barcode. Figure 9 shows an example on live mail in which the original 5 digit ZIP (75207) has been upgraded with a "B Field" (07-2107) to produce a 9 digit ZIP+4 result.

Table 1 - POSTNET Barcode Types
A Field = 5 digit ZIP (e.g. 12345)
C Field = 9 digit ZIP (e.g. 12345-6789)
C' Field = 11 digit ZIP (e.g. 12345-6789-01)
B Field = adds 6 digits (e.g. 45-6789) to A field making 9 digit ZIP
B' Field = adds 8 digits (e.g. 45-6789-01) to A field making 11 digit ZIP

The developing ZIP codes and associated POSTNET coding as OCR reading improved.

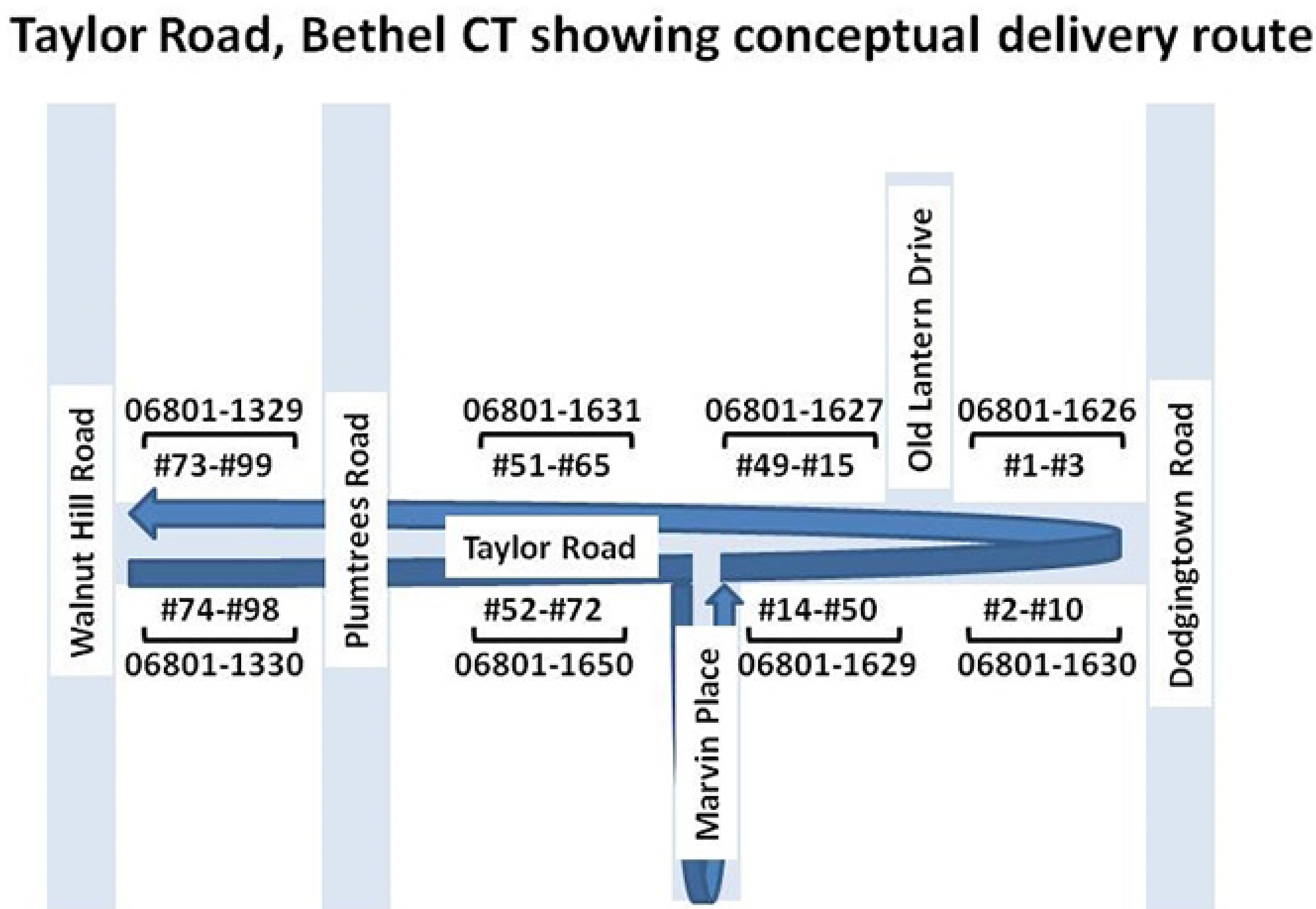

Figure 10. ZIP+4 map of a neighborhood showing block faces and a conceptual delivery route.

While most people don't think about it, the ZIP+4 still represents incomplete address information. It only encodes the "block face" of a typical residence address (Figure 10). In short, a "block face" is one side of a block, in other words, the even side of the 52-72 block of Taylor Road in Bethel, CT. Across the street, is the odd numbered 51-65 block of Taylor Road. In USPS jargon, the block faces are called "sector-segments" and they are the +4 digits (digits 6 through 9) of our familiar 9 digit ZIP codes. Despite the highly organized name, "sector segments" are typically assigned "randomly". Figure 10 illustrates the assigned ZIP+4 codes on Taylor Rd. Note that the adjacent ZIP+4 codes often bear no obvious numerical relationships to each other. From an operational viewpoint, using ZIP+4 codes to sort mail means that all mail within a ZIP+4 block face will be jumbled together. The mail is not sequenced by delivery point (house).

Carrier Route Sequencing

Sequencing mail requires sorting in mailbox order – and that requires an 11 digit ZIP code which identifies which house a letter is destined for. [For the sake of simplicity, I'm illustrating detached single family home addresses; a similar pattern is used within apartment buildings which may be assigned one or more internal sector-segments.] Since each block face is within a specific hundred range (100's or 200's), taking the last 2 digits of the street number and appending it to the ZIP+4 code will uniquely define a house – a mail slot. This is exactly what the final iteration of the POSTNET code does. The C' (C prime, Table 1) POSTNET represents the 11 digit ZIP code plus a checksum for a total of 12 digits encoded in 62 bars. Again, during the OCR upgrade and transition, obsolete 5 digit POSTNET codes continued to be produced. A modification was therefore deployed at the enhanced OCR sites to append a code (B prime field, Table 1) which corrected the frequently incomplete zone numbers (digits 4 and 5) and then added the +4 ZIP code digits and the delivery point codes (digits 10 and 11).

Although few residents of the United States know it, their house is identified as an 11 digit ZIP code location. For example, according to the (Figure 10) ZIP+4 map, 59 Taylor Road has the ZIP+4 of 06801-1631. The 11 digit POSTNET representation of this address (adding the last 2 digits of the street number) therefore would be 06801-1631-59. When the Delivery Barcode Sorter (which I helped develop in the early 1990's) sequences mail by the Delivery Point Barcode, each mailbox is placed in the proper sequence in the tray of mail provided to the letter carrier. In a suburban neighborhood, the letter carrier may start at 98 Taylor Road and (Figure

10 following the dark blue arrow) walk down the even side of the street, take a side trip down the Marvin Place cul de sac, continue to 2 Taylor Road at the beginning of the road, cross the street to 1 Taylor Road, and then complete the route ascending the odd numbers. *Note that "adjacent" street numbers 98 and 99 can be at opposite ends of the delivery route. This causes no difficulty to the mail sorting machine which is simply instructed to sort mail to the addresses in the order in which they are delivered (again, see the carrier path in Figure 10).* Note that new sorts are developed as new houses or roads are built. The "radix sort" used by the USPS is discussed in more detail in Appendix B.

POSTNET clear zones and Address Block POSTNET Barcodes

Originally, POSTNET barcodes were relegated to the lower right corner of a letter. The mandatory "clear zone" is defined by the USPS in the *Domestic Mail Manual (DMM),* and picture postcard publishers often outline the region to discourage writers from writing in the space and interfering with the readability of the barcodes. One of my favorite covers is a USPS mailed standard whose address placement violated the very standard that it was promulgating (Figure 11 outside and Figure 12 inside). As reader technology improved, the USPS moved from fixed position barcode readers to image processor based Wide Area Bar Code Readers (WABCR) that could search an envelope, find, and decode the POSTNET code. This was a tremendous boon for mailers because it enabled them to print an address block with an address and barcode (computed from the associated address) in a single operation to earn the "work sharing" discount discussed in the next section. The clear zone requirement remained in the lower right corner of the envelope to allow the USPS to overrule or upgrade the mailer affixed POSTNET if necessary.

In later years, as technology improved, POSTNET barcodes were also implemented on flats such as magazines and large (over 6.125" x 11.5" x 0.25") envelopes. Because these mailpieces are addressed in both portrait and landscape orientations in a wide diversity of positions, the flats barcode readers had to be omnidirectional (able to read barcodes in any orientation) everywhere on the mailpiece. It was an interesting challenge to help develop these barcode readers early in my postal automation career. Flats mail automation has lagged that of letter mail because the challenges of handling the diversity (and lower volumes) of flats mail required advances in materials handling and sorter technology. Ultimately, flats mail followed much the same path as letter mail automation except that it benefited from the lessons learned on letters, and therefore commenced at a more mature point in the automation progression.

Work sharing Postal Discounts

Enlisting mass mailers in the barcoding and sorting processes offered many benefits to the USPS. When mailers create millions of mail pieces such as credit card statements or utility bills, they have the potential to group (presort) the mail by destination ZIP code. If this mail is drop shipped to the destination or handed to the USPS as a package then the USPS avoids all the outgoing mail sortation expenses (and potentially some shipping costs) getting the mail to the destination post office. If the mail is prebarcoded by the mailer, then it can be merged with other mail on the final Delivery Barcode Sorter for delivery sequence sortation by barcode for local delivery. Since this mail bypasses the facing (orientation) and cancellation processes before the Optical Character Readers, this mail will not be cancelled or barcoded by the USPS. Such presorted mail therefore must be prebarcoded, appropriately presorted by ZIP code, and have postage evidenced by means of a postage meter, permit mailing imprint, or precancelled stamps which do not require cancellation. In

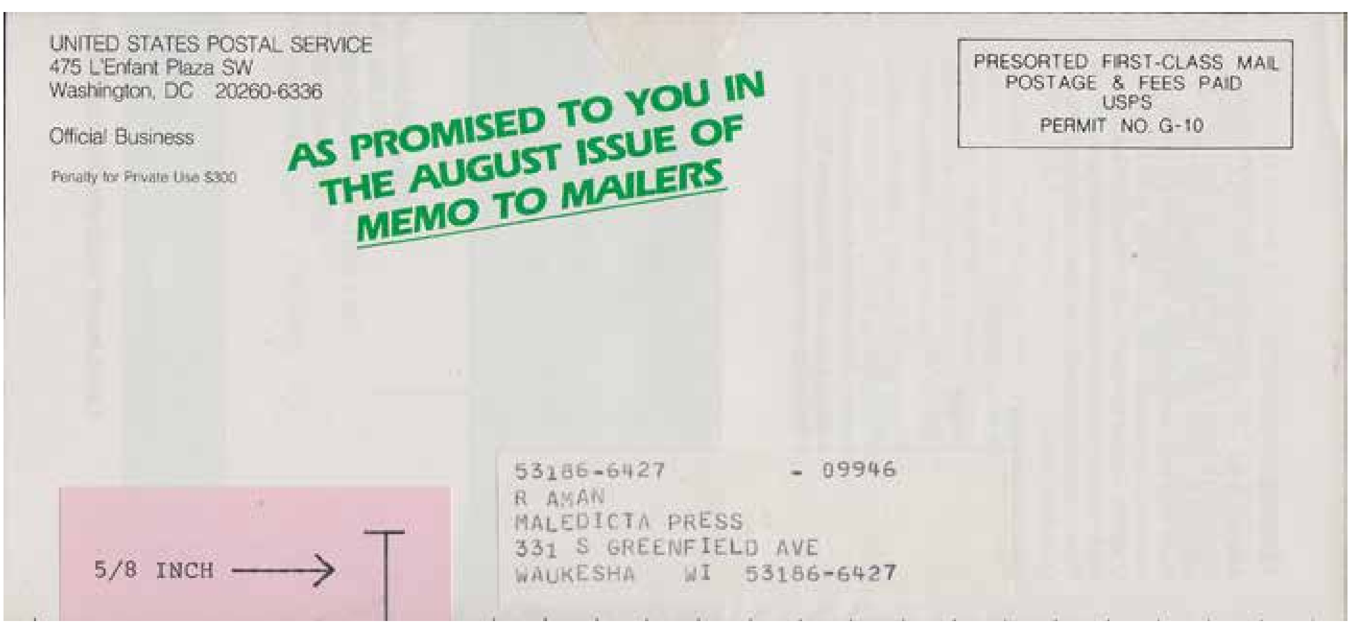

Figure 11. USPS fails the standard it advocates by printing 2 lines of the address in the 5/8" "clear zone."

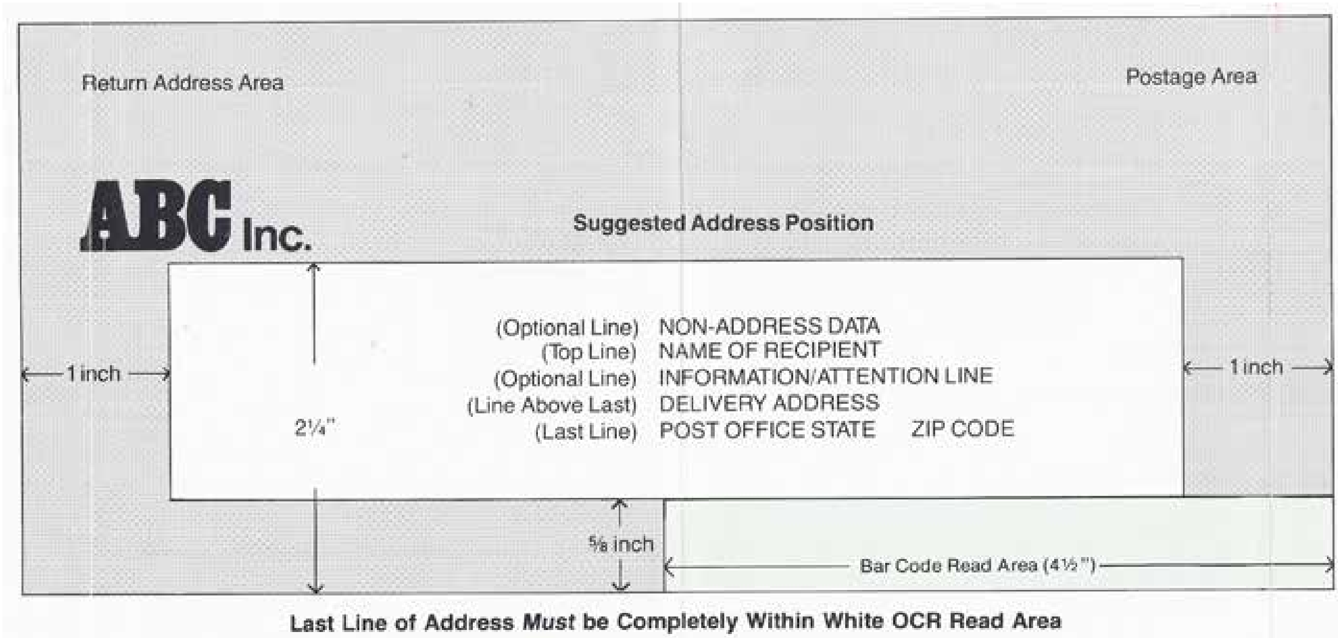

Figure 12. USPS standard defining the mandatory 5/8" bottom clear zone which is ignored on the cover.

exchange for the considerable equipment and labor investments by presort mailers, the USPS offers substantial presort postage "work sharing" discounts.

The USPS defined very detailed color contrast and dimensional specifications in the *DMM* to ensure its readers could read the barcodes created by the mailers. The barcodes were also spot checked when the mail was presented at USPS bulk mailing centers for acceptance. While the USPS always prints their barcodes in black ink, the printing standard only requires a high contrast ratio at the red end of the spectrum. This meant that green, blue, purple, brown, and black colored barcodes could be used but not red (Figure 13), orange, or yellow. Nevertheless, over the years I have accumulated a full rainbow of preprinted barcoded envelopes from a variety of mailers. Human readers can visualize the functional specification by viewing barcoded envelopes through a red filter. If the barcode is red on a white envelope, it appears invisible against the apparently red envelope and is not allowed. Likewise even a black barcode can disappear on a dark green envelope which appears black through a red filter.

The use of barcodes to automate the mail makes a lot of sense. While a battery of clerks or extremely advanced technology is required to find and read (decode) addresses, the standardized POSTNET barcode can be quickly found and decoded with high reliability at a relatively low cost. The average letter passes through 6 stages (passes) of sortation before delivery. With OCR reading and then POSTNET barcoding of letters on the first sortation pass, all subsequent sortation passes benefit from full barcode sorter automation with tremendous cost savings and improvements in throughput. The automation equipment is fast and reduces the number of missorted mail pieces (improved accuracy) because the machines don't get fatigued or distracted. Automated equipment permits rapid software updates across the system with addresses for new buildings and carrier route changes rather than the painstaking process of retraining the sortation clerks. Reduction in rework time and costs associated with missorted mail also drive more timely mail delivery and improved customer satisfaction.

Distinguishing USPS and Mailer / Presort POSTNET Barcodes

A. Mailer Applied POSTNET Barcodes

The easiest way to identify mailer applied POSTNET barcodes is to compare the location and print of the POSTNET barcode and the destination address. Obviously the address and POSTNET barcode in the address block behind the glassine of a window envelope must have been printed by the mail-

Figure 13. Red POSTNET barcode on preprinted business reply card violates the USPS color specifications.

Figure 14. Enlarged POSTNET barcode fragment from Figure 3 showing individual dots of ink (3 for short bars and 8 for tall bars) from USPS inkjet barcode printer.

er before it was handed off to the USPS. Likewise, address blocks with combined addresses and POSTNET barcodes aligned and printed with the same technology (like magazine labels) must be mailer generated. POSTNET barcodes in the lower right POSTNET "clear zone" of the envelope will have been applied by a subsequent downstream operation either by a work sharing Presort Bureau or the USPS.

B. POSTNET print technologies

The technologies used to print the POSTNET barcodes can generally be used to identify the source of the barcodes. The USPS uses very high speed continuous flow inkjet printers to print the POSTNET codes as the envelope speeds down the MLOCR track. These printers are best visualized as high speed paintball guns that continuously shoot dots (pellets) of black ink. Most of the time, the dots are shot into a gutter which recycles the ink. When it is time to print something, the ink dots are deflected upwards onto the envelope. The individual ink dots that comprise the bars can be seen with the naked eye and counted with a magnifying glass. Typically, the USPS printed tall bars are 8 slightly overlapping dots tall and the short bars are 3 dots tall (Figure 14). The inkjet printer moves the ink dot stream up and down electronically to "paint" the vertical bars. Since the envelopes are speeding by, the printer actually draws an upwards diagonal in the air which, when combined with the sideways movement of the envelope, results in a vertical line. Of course, the speed compensation is not necessarily precise and therefore the lines may be slanted. Misadjustment can also result in ink splatter around the dots (Figure 24 below) and, in extreme cases, a continuous black line (Figure 15) if the inkjet was not successfully directed down into the ink recycling gutter between barcode bars.

Businesses generally do not use high speed continuous flow inkjet printers because they are of lower quality and means that the associated communication (business letter, invoice) ends up with low quality print. Magazine address labels are one of the few cases in which POSTNET barcodes are preprinted by mailers using high speed continuous inkjet printers (and the matching address text print makes it obvious that it was mailer generated).

Businesses started printing POSTNET with dot matrix impact printers (small home printers or large industrial dot matrix "line" printers). Although these technologies also produced dotted bars, their dry ribbon ink was not susceptible to the slanted bar problem, ink splattering, or the black line across the envelope problem (Figure 15). Another technology used by presort mailers was fully formed character impact printing (like a typewriter). Small business systems used a daisy wheel of characters (including the 4 special characters

Figure 15. Solid black line associated with misadjusted POSTNET barcode printer.

used to print paired POSTNET bars, (Appendix A, Figure 41)). Larger businesses used fully formed characters on line printers. Both of these approaches also used dry inked ribbons but of course produced solid rather than dotted bars. Under ideal conditions, the bars would have square corners and be evenly black. Finally, laser print technology has brought extremely high resolution to POSTNET barcode printing. Laser print technology is now available to large and small businesses as an integrated component of the address printing process; the resulting POSTNET codes can be very sharp and black.

C. Text Associated with POSTNET Barcodes

The final clue distinguishing USPS and mailer / presort bureau applied POSTNET barcodes is the text (if any) to the left of the POSTNET barcodes. By 1993, I saw envelopes with USPS printed text ZIP+4 to the left of the POSTNET code (e.g. 87194-7822). The characters separating the two portions of the ZIP code vary between several characters including -, +, >, =, /, @, and $ (Figure 16 shows a ">"). Apparently the special characters within the ZIP code indicate which MLOCR software component successfully completed the address look-up. This is helpful to the USPS for diagnostic purposes. I also saw the ZIP+4 code with the carrier route number to the left of the POSTNET barcode such as "06810>4148 46" (Figure 16). While this might appear to be an 11 digit delivery point ZIP code, the last two characters are not the final digits of the street number but rather the carrier route number. The letter carrier does not need to have the last two digits of the street number repeated; they are clearly visible in the address. The carrier route number, however, may be useful for missorted mail because it enables the letter carrier to readily determine whose route that mail belongs to.

In contrast, as of the late 1990's, the presort mailer applied POSTNET barcodes are associated with text in the general format of "AXXXMP3 40218." The first character codes the version (product month designator) of the USPS Coding Accuracy Support System (CASS) licensed address database used to produce the barcodes. The next three characters are the system identifier which identify a specific serial numbered machine at the licensed presort bureau. This allows the USPS to trace any errors back to the offending work sharing MLOCR machine. The next character is the manufacturer

Figure 16. Human readable text 06810>4148 46 to left of USPS printed POSTNET barcode representing the 5 digit ZIP, ">" symbol, +4 digits, and the carrier route number.

code (model), and the last 2 characters indicate the discount rate being claimed for the mailing. Finally the 5 digit human readable ZIP code is printed followed by the POSTNET barcode. Since the USPS is paying the mailers or presort bureaus for the presort "work sharing", USPS is very diligent in regulating the process, requiring the use of timely databases, and ensuring that the desired value is delivered. The last thing the USPS wants is to receive a batch of incorrectly coded letters which get missorted and misdelivered while earning the mailer a cash discount! When presorted mail is provided to the USPS for acceptance, presort mailers must comply with the required minimum numbers of pieces and ZIP presort densities to qualify for the discount. The USPS also audits a random sample of the mail pieces. They use an Automated Barcode Evaluator (ABE) or Mail Evaluation Readability Lookup INstrument (MERLIN after 1999) system to ensure that the correct POSTNET codes have been applied. Sequential numbers are printed on the selected pieces for reference and review purposes. These large dot-matrix printed numbers may be noticed in the top middle of a small fraction of presort processed pieces. The effort, however, is worth it. I've seen presort MLOCR systems that saved the mailer over $2,000 an hour in postage as they ran.

Forwarding Mail - *FASTForward*

Once the MLOCR systems were capable of reading the full address printed on an envelope, an opportunity presented for real-time address correction and forwarding as work sharing CASS certified MLOCR systems processed mail. If a change of address was filed for a particular address, the USPS would flag that address in the USPS address database. Whenever an OCR looked up that flagged address, it would be instructed to continue reading up the address to the personal name at the top to determine whether the letter was addressed to the current resident or a previous one. Current resident mail would be barcoded to the current address whereas mail addressed to a previous resident would be FASTForward barcoded and readdressed to the proper forwarding address. FASTForward added a one line text address above (or to the left of) the POSTNET barcode for the benefit of the receiving office letter carrier who would be delivering the letter to a new address not otherwise printed on the envelope (Figure 17). Six characters are added to the left of the new address for USPS purposes: "COA" is a visual cue to the letter carrier of an address change (the orginal address being obsolete) and for audit purposes, the three following characters identify the specific MLOCR which FASTForwarded the letter. This FASTForward OCR system upgrade actually completed the address lookup and correction in the time originally allocated for the basic OCR and POSTNET barcode printing function. Although I've seen almost no live envelopes, the FASTFor-

Figure 17. USPS sample FASTForward envelope from USPS *Postal Bulletin* 21943 (April 10, 1997). If the addressee moves, the corrected address and POSTNET barcode are printed by the MLOCR system in the lower right corner of the envelope.

Figure 18. Business reply card using USPS sample POSTNET barcode 12345-9876 (5) rather than the correct California ZIP code: 95117.

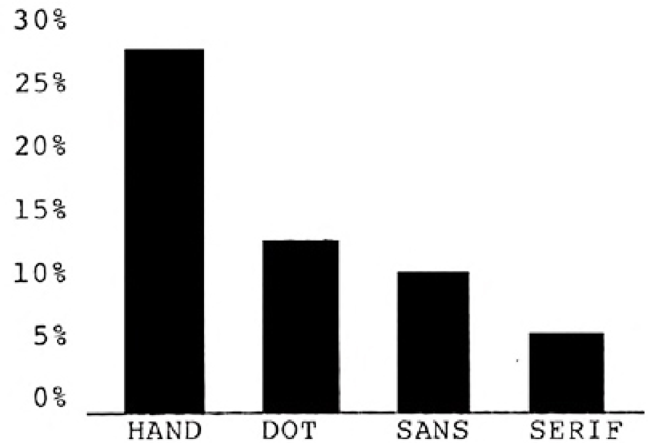

Figure 19. Read errors on early OCR POSTNET coded letters by font.

ward program began in 1995 and was live until January 27, 2013. Since the USPS gives priority to POSTNET barcodes in the lower right corner over those in the address block, envelopes that are forwarded with FASTForward do not become loop mail. I discovered this sample in the USPS Postal Bulletin archive (www.uspostalbulletins.com) created by Tony Wawrukiewicz.

POSTNET Errors and Corrections

When 500 million letters a day are processed by the USPS, it is reasonable to expect that some errors will occur in the envelope handling, OCR address reading, and POSTNET printing processes. The USPS work sharing partners also make some mistakes which slip through the bulk mail acceptance processes. As a student of postal automation, naturally I was curious to see what I could find. At the most extreme end were instances in which the mailers did not understand the purpose and use of the POSTNET barcodes. For example, I observed a packet of commercial business reply advertising cards in which one card (Figure 18) was addressed to a business in California with the preprinted USPS specimen POSTNET code 12345-9876 (which happens to be assigned to General Electric World Headquarters in Schenectady, NY). Apparently the California business didn't understand that the POSTNET code was intended to encode their ZIP code and was not simply a decorative pattern to be placed below the address. If any of these cards were successfully delivered, they probably were long delayed by their unwanted detour to Schenectady, NY. Around 1990, at Disney World's Epcot Center, General Motors handed out business reply cards at their pavilion with the POSTNET code printed upside-down (long before the readers could decode inverted barcodes). I've seen thousands of POSTNET barcode problems but they can be classified into a few major categories.

A. ***Optical Character Reader Errors***

Computers, like people, have trouble reading handwriting and find script more difficult to decode than nicely separated block letters. My studies of read errors on thousands of early envelopes revealed dramatic differences between the read rates on handwritten, dot matrix machine printed, serif font machine printed, and sans serif font machine printed addresses (Figure 19 from Quine, 1987). Examples of various machine print fonts are provided in Figure 20. Serifs are the details added to characters to improve readability; sans serif fonts are fonts without serifs.

Small towns like Bethel CT have a single ZIP code so a single line OCR can confirm the ZIP code with the town name. Single line OCR systems cannot confirm the zone (digits 4 and 5) for large cities with multiple ZIP codes like Boston (021xx) or New York (100xx). That zone information (xx) requires detailed address data from the upper lines of the address. As a result, the single line OCR systems (or MLOCR systems that could not read the handwriting) often used to drop the last two digits of the 5 digit ZIP code in

Figure 20. Examples of dot matrix, sans serif (Arial), and serif (Times Roman) machine print; serifs are the details added to the top and bottom of letters like the "E, H, and M" to improve readability.

Figure 21. Incomplete ZIP code: 53100 (1) with faint yellow Canadian fluorescent barcode.

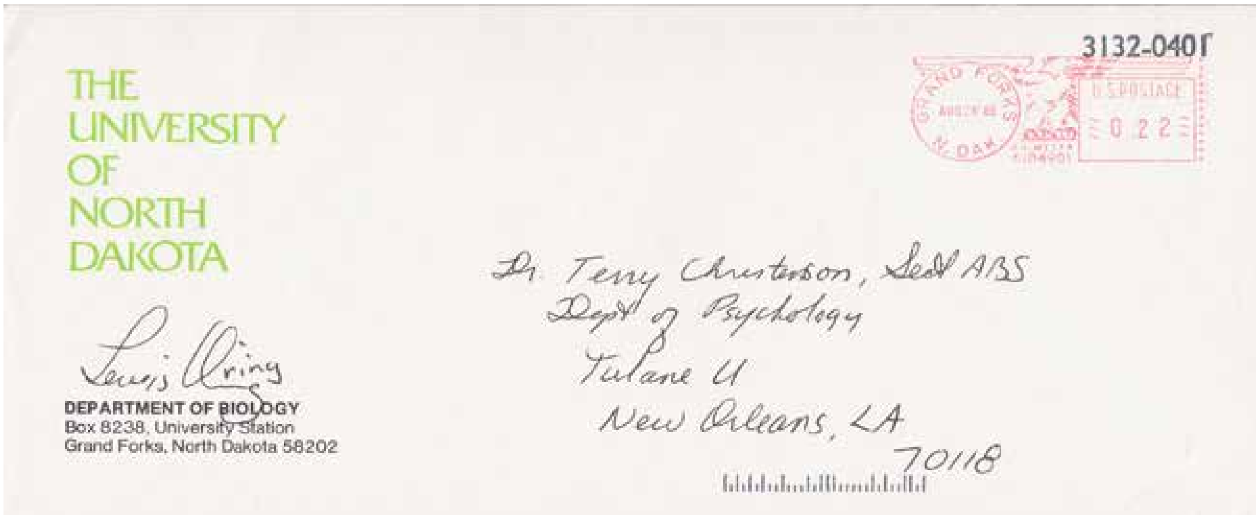

Figure 22. Return address encoded as the delivery address: 58202 (3).

cities and report just a generic ZIP code with no zone: 53100 (Figure 21).

Illegible handwritten addresses pose a special problem because sometimes the OCR can't locate and decode a delivery address at all. In such cases, there is a risk that the ever expanding search for an address block will encounter the return address. In that event, the OCR may read a preprinted return address label or letterhead and print that ZIP code as the delivery POSTNET barcode (Figure 22). This was a common issue with handwritten addresses in the early days of the POSTNET program. At that time, I found a 27% error rate on handwritten addresses (Figure 19 above). Recent technological advances in reading handwriting have resulted in very good read rates on handwritten addresses today.

Dramatic POSTNET barcode errors are associated with the OCR incorrectly parsing the address and reading the PO Box number as a ZIP code (Figure 23). As a result, the letter addressed to the Netherlands was incorrectly barcoded and delivered to the aptly named "Truth or Consequences", New Mexico 87930. There it was back stamped and then finally resent to the Netherlands.

B. POSTNET printer errors

The POSTNET barcode specification states that the bars should be printed equally spaced at a rate of 20 to 24 per inch with tall bars between 2.92 mm (0.115") and 3.45 mm (0.135") tall. That said, improper transport speed settings or

Figure 23. PO Box misread as ZIP code misdirects cover to Truth or Consequences, NM 87930 (3).

Figure 24. Poorly adjusted printer damages POSTNET barcode: 53186-6492 (6).

Figure 25. Poorly adjusted printer loses readability of tall POSTNET bars, as they are missing detail.

misadjusted continuous flow inkjet printers can cause narrow, wide, tall, short, or slanted barcodes. I've seen USPS printed POSTNET code bars printed as far apart as 15.6 per inch and as close as 38 per inch (on a double feed). I've seen tall POSTNET bars printed as short as 2.4 mm and as tall as 4.6 mm. I found about 34% of the barcodes were outside the height specifications in the first 5 years of the program before rigorous checking was implemented.

The most common issues with USPS POSTNET barcodes relate to print quality. The bars can be severely distorted (Figure 24) or even lose the upper bars (figure 25) if there are issues with the ink or barcode printer adjustments.

The MLOCR systems are supposed to check for preexisting POSTNET barcodes to avoid overprinting them with another barcode. Overprinted barcodes typically render both the original and the new barcode unreadable. That said, multiple overprinted barcodes occur. When the two barcodes are completely separate, they can be easily decoded (Figure 26). When they overlap severely, they may make an unreadable muddle (Figure 27).

Finally, in rare instances, two well aligned machines can cause the overprints to be perfectly aligned and appear to be good barcodes. However, if the two superimposed barcodes do not represent the same numbers, the patterns will be unreadable because conflicting data in multiple digits causes the barcode to violate the 2 of 5 rule (Figure 28). Such cases require careful work with a magnifying glass to read since one side of some combined bars is tall while the other side is short.

Most dramatically, sometimes apparent software glitches or inadvertent test patterns result in "impossible" POSTNET barcode patterns in which all but the first bar are short (Figure 29) or tall and short bars alternate which obviously violate the basic 2 of 5 tall rule underlying this barcoding protocol. Readers should be aware that there are some alternative uses of similar barcodes especially by the Internal Revenue

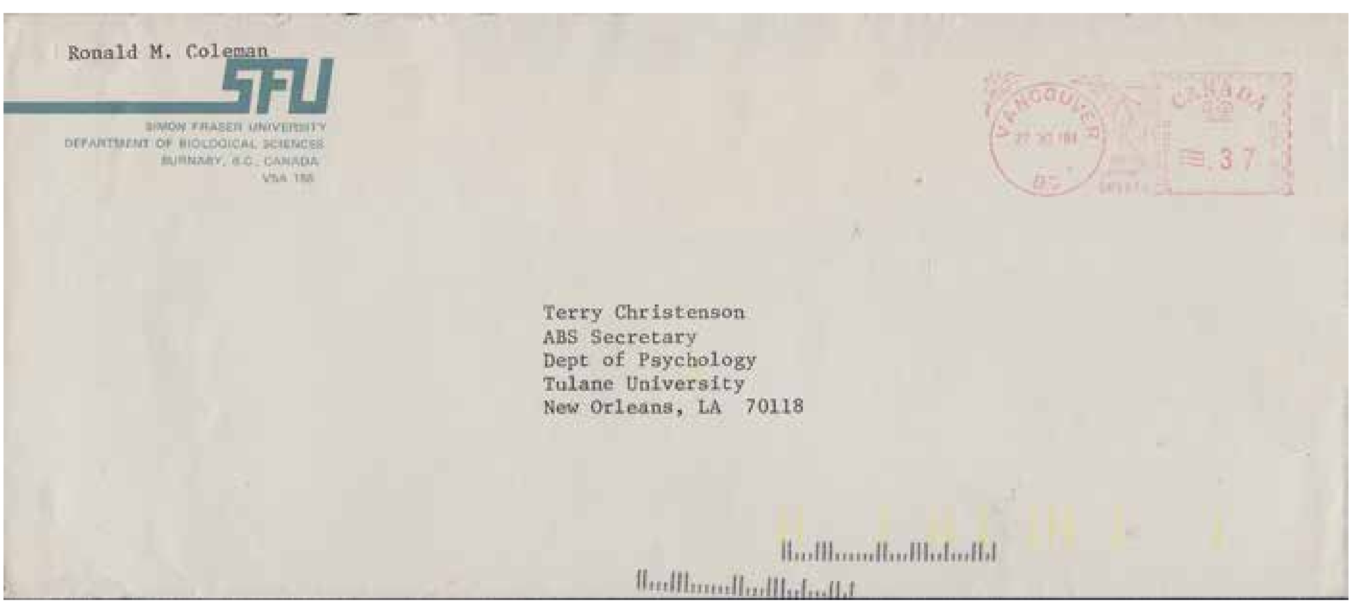

Figure 26. Two independent POSTNET barcodes: 70118 (3) (twice).

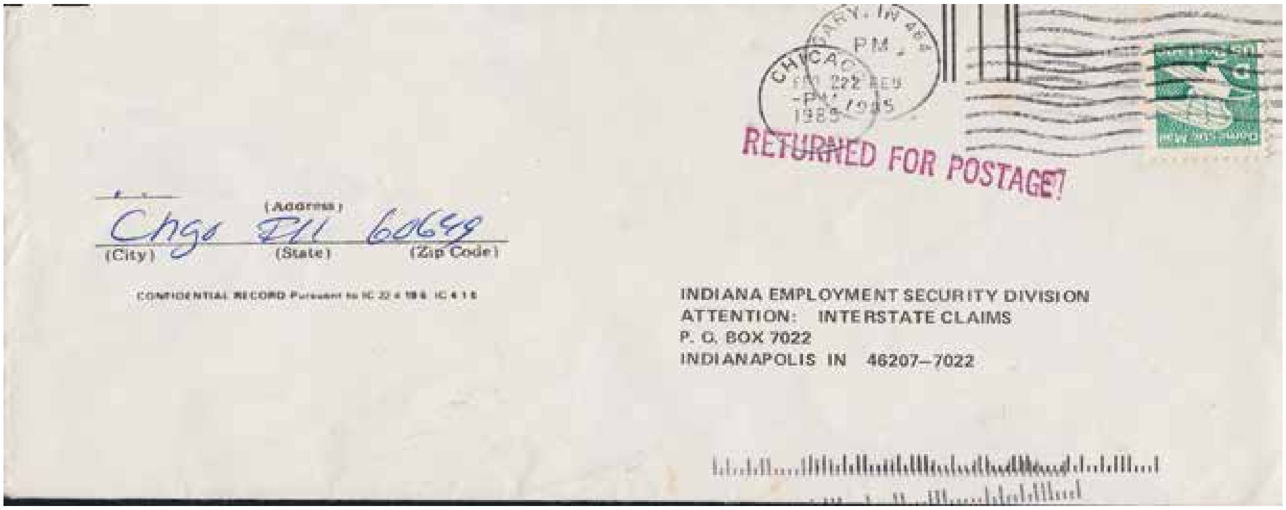

Figure 27. Multiple POSTNET barcodes: 46207-7022 (0) (3 times).

Figure 28. Unreadable hybrid barcode produced by 2 different overlaid barcodes explains detour to 61220 (9) (Rock Island) before delivery to 61820 (3) (Champaign IL).

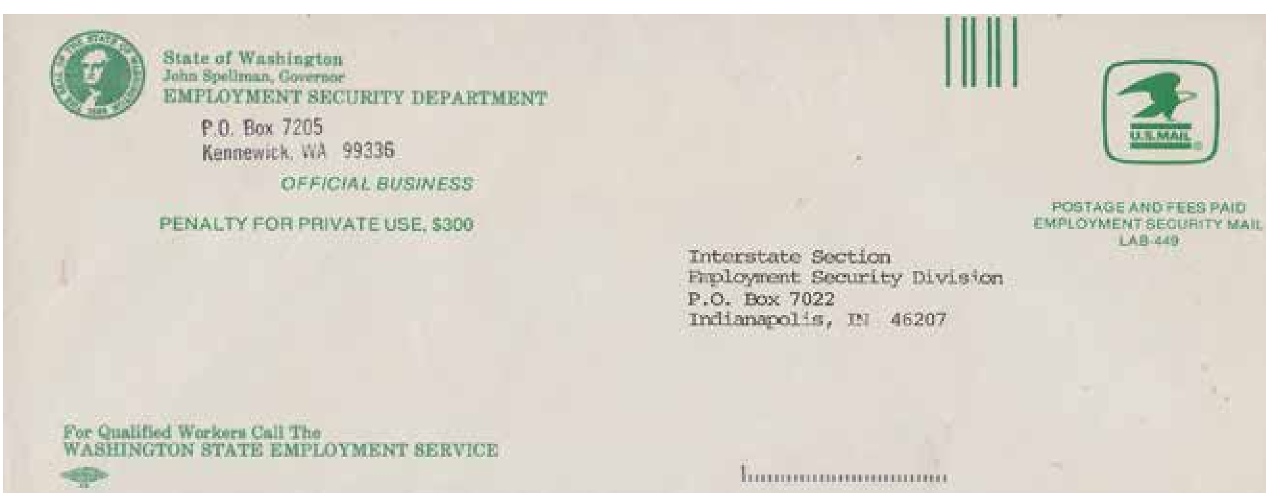

Figure 29. "Impossible" (test) POSTNET barcode with short bars.

Figure 30. POSTNET barcode at the bottom and intentionally inverted internal corporate barcode in the upper left for internal sortation purposes.

Service, AARP, Prudential Insurance, and Plain Truth (Figure 30) on cards, letters, and financial statements. These barcodes should not be mistaken for defective USPS POSTNET barcodes (Quine, 1988b, Quine, 1989a). When commercially printed (not USPS inkjet) tall – short barcodes are observed on commercial or government forms or envelopes, they may be associated with internal processes and are not USPS barcode errors encoding ZIP coded addresses. Figure 30 has a POSTNET barcode in the lower right corner and an internal Plain Truth barcode inverted in the upper left. Plain Truth can use these barcodes to double the utility of their barcode sorter. In the morning, they could feed these incoming business reply cards cards upside-down through their sorter to sort cards by whatever parameter the internal barcodes represent (perhaps specific advertising offers) to facilitate their business operations. In the evening the same barcode sorter could be used to presort outgoing USPS mail by the POSTNET barcodes to obtain postal work sharing discounts.

Additional barcode "errors" are associated with the extraordinary diversity of the mails. When POSTNET barcodes are printed on black envelopes (Figure 31) or envelopes with dense graphics in the "barcode clear zone", the barcodes are not readable. Even the advanced inkjet printer ink compositions do not stick to everything. The barcodes may smear on very glossy papers and may fail to adhere at all to some window envelopes. I attribute such issues to the mailers using non-compliant envelopes rather than to issues with the USPS printers.

C. Double Feed Errors

USPS has always recognized that some addresses may be so bad that they cannot be decoded with automated equipment and that human intervention may be required (Figure 32). An ingenious Remote Barcoding System (RBCS) was implemented whereby envelopes received a light pink fluorescent numerical identification barcode on the back if they could not be read by the MLOCR system. Those letters were out-sorted and stored until the images could be relayed to RBCS manual keying operators. The operators would then enter the address information based upon their reading of the captured image. Subsequently the letters were fed back into the MLOCR system, the tracking barcodes read, and the corresponding manually entered data called up and used to apply the POSTNET barcode. One advantage of using a fluorescent ink is that the RBCS barcodes do not require a "clear zone" on the back of the envelope; they can be printed on top of graphics and read using black light (UV).

These RBCS driven barcodes do have the potential for a dramatic failure mode which is observed from time to time

Figure 31. Black envelope with a POSTNET barcode: 75240 (2) which could not be read by the contemporary barcode reader. The barcode is faintly visible at the bottom center in the scanned image.

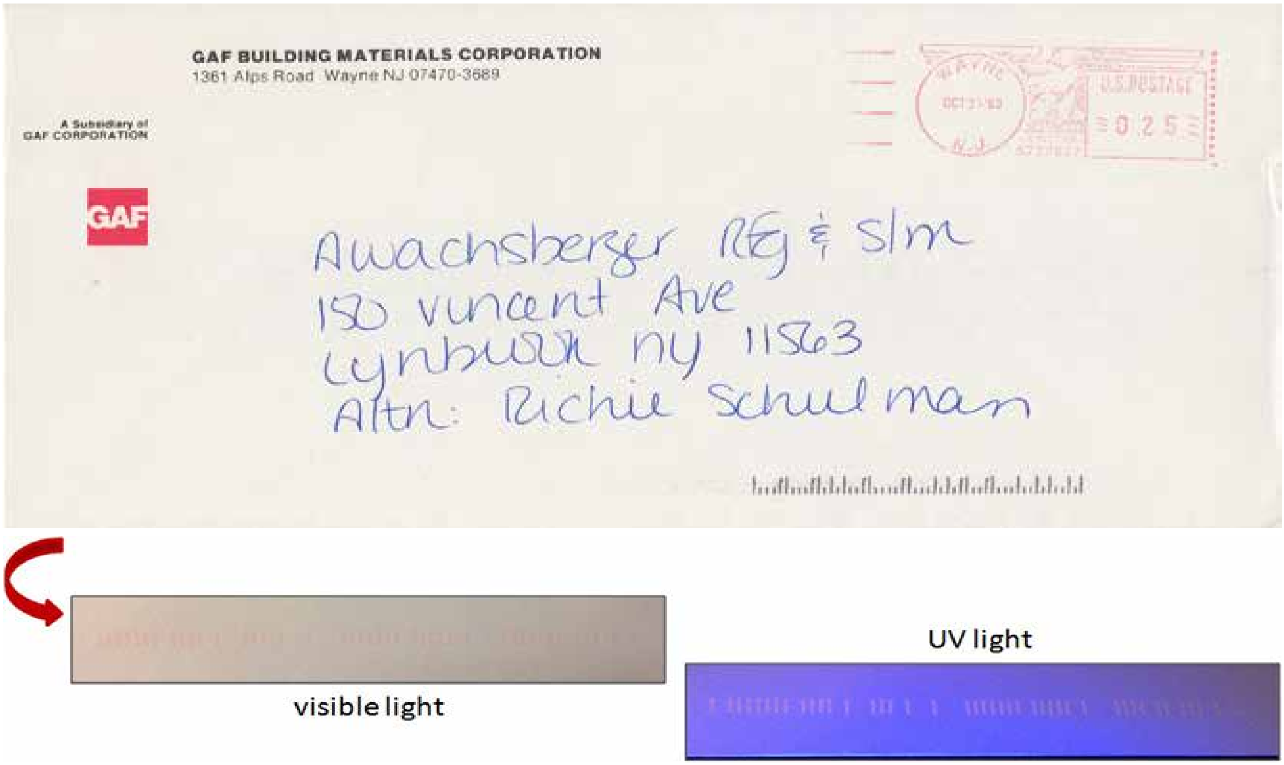

Figure 32. Handwritten letter processed through the Remote Barcoding System (RBCS) in 1990. The pale pink fluorescent barcode on the back is photographed below in natural light and black light (UV). OCR could not read handwriting in the early days and the address on this envelope was complicated by having the addressee's name at the bottom of the address block.

(Figure 33). If the envelope has been double fed (two envelopes inadvertently pulled together) on the first pass through the MLOCR when the tracking barcode was being applied, then the tracking barcode would be applied to the back of the 2nd (back) envelope while the image would be captured from the first (front) envelope. When re-fed after the RBCS encoding process, the tracking barcode would be read from the rear second envelope which would call up the address data from the first, unrelated, envelope. As a result, the second envelope would become POSTNET encoded with the first envelope's address information. This appears to be the most likely explanation for completely inappropriate POSTNET codes that sometimes appear on envelopes.

The use of the fluorescent RBCS barcodes has expand-

Figure 33. Double feeds can cause completely wrong POSTNET codes: 60568-0001 (4) This barcode represents the unrelated envelope that was imaged in front of this cover. (The addressee on this envelope happened to have moved and therefore a yellow Computerized Forwarding System label was later applied as the envelope was forwarded from Louisiana to Illinois.)

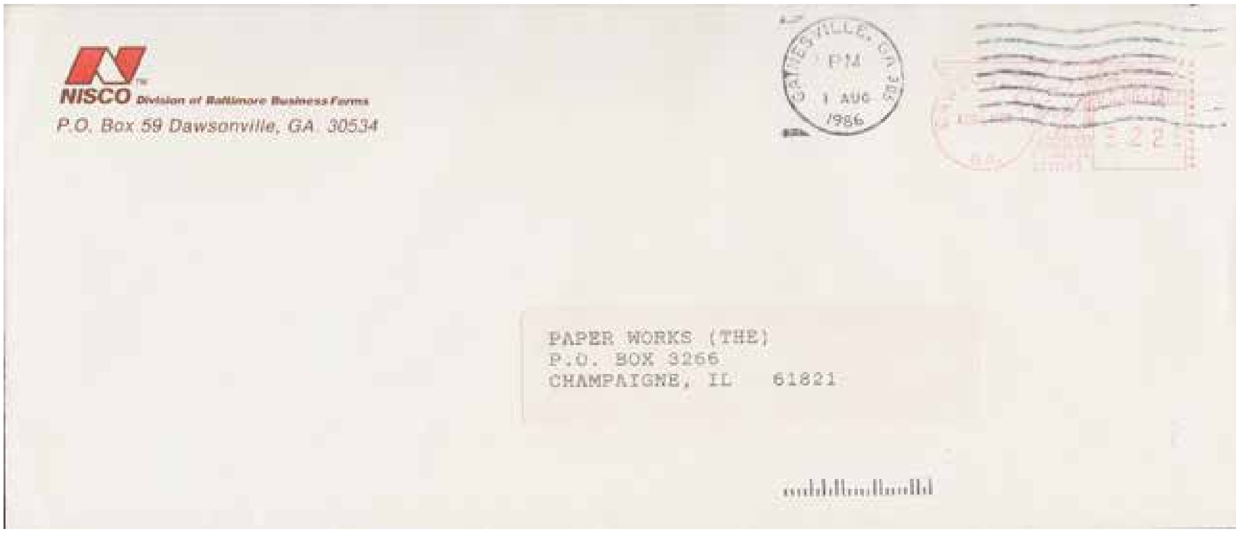

Figure 34. Fragmentary barcode showing the right side of the POSTNET barcode (left side will be found on the other envelope presumably addressed to Aurora IL 60506): 60506 (3) is deduced from these bars.

ed past their original temporary use as identifiers until the RBCS operators provided ZIP code data for the envelope. In recent years, all letter mail pieces have been marked with the RBCS tracking barcodes which can be used as a surrogate for the POSTNET barcode on subsequent sorting passes if the POSTNET code is obscured or damaged. They also can be used for forensic purposes to trace an envelope through the postal system.

D. Fragmentary Barcodes

In addition to the double feed issues discussed above, double feeds may occur in which the two pieces are overlapping (shingled in postal terminology) but not aligned exactly as they feed through the inkjet printer. In such cases, it is common to see that a mispositioned POSTNET barcode has been printed on the face of one envelope and extends off the end onto the other envelope. Each of them, therefore, has a partial barcode which is not properly positioned. Whenever a barcode is observed that lacks tall bars at the start and end – or - that lacks the proper number of bars for one of the expected barcode types, there is a good chance that the barcode is a fragment (Figure 34).

Computerized Forwarding System (CFS)

On average about 15% of the US population moves every year. This means that "correctly" addressed letters may get to their destination only to discover that the intended recipient is no longer there. When the carrier sees a change of address (which was not already intercepted by FASTForward) or the new residents return the mail for a previous occupant, the letter is sent to the Computerized Forwarding System (CFS). There an operator types in the first 4 characters of the recipients last name together with the last 3 digits of the street number (e.g. QUIN583 as shown in the top left corner

Figure 35. CFS label forwards mail to correct address while blocking old POSTNET code: 87194-7822 (2).

Figure 36. POSTNET Barcode Blocker.

of the forwarding label of Figure 35). This combination is used to quickly identify the moved individual. A POSTNET barcoded yellow CFS forwarding label is then printed and affixed (over the incorrect POSTNET code) to the letter. This process both prevents inappropriate reading of the old POSTNET and successfully directs the letter to the new address.

A. Barcode Blockers

The POSTNET barcode guides all sortation of letters after the barcode is applied in first pass through the MLOCR. It is used to sort the letter to the appropriate postal hub (the 3 digit ZIP code SCF), to the appropriate city (5 digit ZIP), and then through the Delivery Barcode Sorter (DBCS). The DBCS sorts the letter in the appropriate sequence for the mail trays which are handed to the letter carriers to deliver on their delivery routes. While this degree of automation produces tremendous time, cost, and accuracy savings, it does mean that incorrect POSTNET barcodes cause the letter to speed to the incorrect destination without being detected. If the letter is misbarcoded, it may be thrown in a mail box by the recipient and repeat the same process – creating what is referred to as "Loop Mail". If a CFS label is not being used to forward the letter, the remedy is to obscure or cover incorrect POSTNET codes so that they do not continue to misdirect the mail. One example of the many styles of barcode blockers is shown in Figure 36.

Figure 37. Letter Mail Labeling Machine (LMLM) white label enables covering and reprinting of incorrect barcodes. The RBCS barcode on the back of this card has been covered.

The broad use of POSTNET and RBCS barcodes makes it necessary to have an efficient means to quickly create a "clean slate" when barcoding errors require pieces to be rebarcoded. Automatically affixed Letter Mail Labeling Machine (LMLM) opaque white labels cover the incorrect barcode(s) and allow a corrected barcode to be printed on top (Figure 37).

International POSTNET generations 1 and 2

My discussion of POSTNET history should have made clear the tremendous benefits that POSTNET barcodes have afforded the USPS in accuracy, speed, and efficiency of mail processing. One might wonder about mail which is leaving the United States for destinations abroad. While the USPS is not responsible for the ultimate delivery of those pieces, it does need to process and transport them from the original mailing location to the ultimate port of embarkation (e.g. JFK airport for European mail or San Francisco for mail to Asia). While the USPS ***never mentioned*** any such international barcodes, Prof. Terry Hines, founder of the *Modern Postal History Journal*, lived in Poland during the early 1990's and observed POSTNET barcodes on his incoming mail. At first he assumed they were USPS barcoding errors from misreading fragments of the address and barcoding them to incorrect domestic locations. Further research, however, revealed that the same code - 00148-0000 (7) always appeared on the mail to Warsaw. This was a number below the range of any known assigned domestic ZIP codes. In parallel, reports started appearing in the *Postal Mechanisation Study Circle*

Figure 38. International POSTNET code to UK (with early UK blue dot sort codes): 00144-1000-00 (0).

Newsletter of POSTNET barcodes from the USA to the UK with the code 00144-1000-00 (0) (Figure 38 which also shows an early UK blue "dot" domestic sorting code). Apparently the USPS had adopted a system similar to that used by the telephone company for international calls with an international prefix (001) followed by a country code (44 for the UK). The first five digits therefore specified a specific foreign country. Subsequent digits, usually '0000', but sometimes varying, represented different locations within the country. Five years later, I published a comprehensive listing of the 9 digit International POSTNET codes for about 90 countries (Quine, 1998). Finally, the puzzle of outgoing foreign mail automation was solved.

About a decade later, another chapter unfolded as I started getting reports of 11 digit International POSTNET codes (matching the deployment of 11 digit POSTNET codes domestically) but with changed numbers for some familiar locations. Wales, for example, changed from 00144-9000 (2) to 00122-0001-00 (4). Additional international prefixes 002 and 004 were added (expanding the possible international country codes from 100 to 300) to cover all 240+ different countries. Again the first 5 digits represented a country while the remaining digits could encode an area within the country. The UK continued to have major regions coded by digits 6 through 9 and mail to Canada had most cities encoded by digits 6 through 9. A revised listing of the longer 2nd generation codes was subsequently published (Quine, 2012).

Interestingly, much earlier, the 004xx ZIP code series had been used for a specialized domestic assignment of the firm specific "Reader's Digest" ZIP code of 00401 for Pleasantville NY. That had been the lowest assigned USPS ZIP code until the International POSTNET codes were first reported in the 001xx range. Later the USPS also assigned the very low range of 00210 to 00215 to Portsmouth NH for some special purpose and assigned 00501 to the IRS in Holtsville NY. I don't know why the (slightly) used 002xx and 004xx ranges were selected and 003xx was skipped.

PLANET Codes

At some point, an ingenious engineer at the USPS realized that the strict 2 of 5 tall rule for POSTNET barcodes presented an opportunity for another barcode symbology with the inverse rule (2 of 5 short). With minor software modifications, this code could be printed and read by the same systems that were creating and processing POSTNET codes. This new code was launched by the USPS as the PostaL AlphaNumeric Encoding Technique (PLANET) code (Figure 39). It could be used for low cost tracing and tracking of the mail by programming the scanners at the USPS to read both the POSTNET codes (the destination household) and the PLANET code which contained information about the sender (origin confirm customer ID shown here) or a document serial number (destination confirm). Such information allowed mailers to track the arrival of their envelopes at post offices across the country to coordinate multimedia advertising campaigns or as evidence of (likely) delivery.

Intelligent Mail Barcodes (IMB): 4 State Barcodes

While the simple POSTNET code delivered extraordinary benefits to the USPS for three decades, technology evolved. Laser print technology replaced dot matrix printers and mailers now had the flexibility to print a wide range of high resolution arbitrary patterns. The two states (heights) of the

Figure 39. National Postal Forum vendor demonstration mail (with humorous facsimile stamp) PLANET code (above address): 21-721797167-0 Origin CONFIRM (Residual Mail) - customer ID - checksum. POSTNET code lower right: 75200-4025-30 (2).

POSTNET code (tall or short bar) meant that adding information required adding more bars and more width. While the PLANET code, in conjunction with the POSTNET code, permitted special service coding, this also required a pair of barcodes and the coordination of data across them. The use of 4 different barcodes (tall, short, ascending, descending), which had been pioneered by Royal Mail years earlier, provided a mechanism to encode 4 times the data in the same space. This meant that a single higher information content barcode could replace paired POSTNET and PLANET codes. The USPS launched the Intelligent Mail Barcodes (IMB) in 2006 with an intended mandatory use date of 2011 for postal discounts. With millions of mailers using POSTNET codes, the transition period of overlapping usage was prolonged but eventually the USPS confirmed the retirement of the POSTNET code: "Effective January 27, 2013, the Postal Service™ will revise the Mailing Standards of the United States Postal Service, *Domestic Mail Manual* (DMM®) throughout various sections to discontinue price eligibility based on the use of POSTNET™ barcodes on all types of mail." (USPS *Postal Bulletin* 22353). While the new IMB (Figure 40) symbology is much more difficult to decode, interested philatelists can decode the barcodes with the IMBscan Smartphone APP (Table 2) or use (http://bobcodes.weebly.com/imb.html) online.

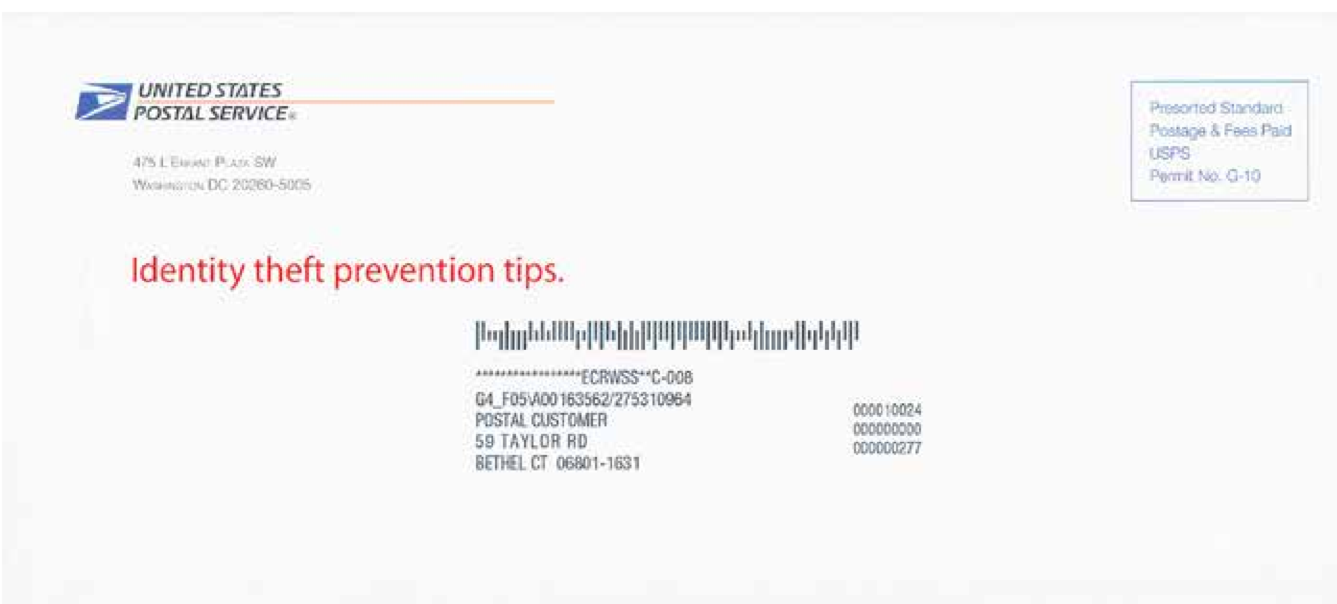

Figure 40. POSTNET barcode successor: the IMB 4 state code.

Table 2. IMB Decode of Figure 40 barcode

Format:	IMB
ID:	(00) No OEL
Service:	(702) STANDARD MAIL
Mailer:	(106325)
Ser No:	275310964
Zip:	06801-1631
Add L2:	BETHEL CT 06801-1631

These barcodes are not amenable to manual decoding by inspection. Barcodes on multiple envelopes to a household also usually differ because of the mailer and customer ID information embedded within the barcode. This makes it harder to find barcode errors. It is no longer possible to line up the day's incoming mail and look for mismatches between the barcodes. Nevertheless, I've already found some errors in my casual examination of IMB barcoded mail.

The Legacy of POSTNET Barcodes

POSTNET barcodes were an essential catalyst for the transformation of mail processing from a manual endeavor to an automated process. POSTNET barcodes can also help philatelists authenticate modern postal history covers. USPS-printed POSTNET barcodes provide evidence that a mail piece has passed through the postal system and the style of barcode provides an indication of the era in which a mail piece was processed. Finally, POSTNET barcodes allow interested observers like me to observe USPS automation tools in use and therefore to gather data and understand the root causes of observed errors. In this way, POSTNET barcodes have moved the study of postal history into a new generation of evidence-based hypothesis development and testing.

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Internet and Smartphone Resources

IMBscan. POSTNET and IMB decoder app for Smartphones

Mathews, Bob. On-line IMB decoder:
http://bobcodes.weebly.com/imb.html

Quine, DB. International POSTNET barcode lists:
www.quine.org/phil-pub.html

Quine, DB. On-line POSTNET decoder:
www.quine.org/postnetj.html

Quine, DB. USPS Acronyms:
www.quine.org/uspsglos.html

USPS. ZIP code and address lookup web site:
https://tools.usps.com/go/ZipLookupAction!input.action

Wawrukiewicz, A. USPS *Postal Bulletin* archive:
www.uspostalbulletins.com

Acknowledgements

I thank Tony Wawrukiewicz for his kind invitation to contribute a chapter to his book. While billions of POSTNET codes have been created and mailed over the past few decades, relatively little has been written about them. Much of the information in this chapter is based upon my personal research and observations. As such, there may be errors of fact or interpretation for which I accept responsibility. I encourage corrections and ongoing dialogue. All covers are from the author's collection.

Appendix A: POSTNET Bar Spacing

Since barcode bars are very narrow, a clever engineer realized that barcodes could be printed at double the current printer pitch of 10 – 12 characters an inch. This was accomplished by creating just 4 custom characters ("2 short bars", "2 tall bars", "short-tall bar", and "tall-short bar") for the existing printers. Figure 41 illustrates each of these 4 new "characters" fitting one by one beneath the characters of the four letter word "Mail" in a traditional monospaced courier font. Any possible barcode can be printed using just these 4 barcode characters in the correct sequence. Since each character position prints two bars, the printing pitch of the barcode becomes 20 bars per inch on a 10 character per inch printer. If a 12 character per inch printer is used, the barcode will print at 24 bars per inch. This explains the genesis of the 20 to 24 bars per inch USPS barcode printing specification.

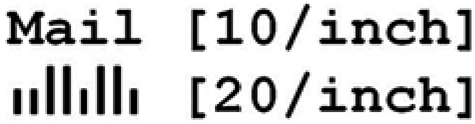

Figure 41: Illustration of 20/ inch printing of barcodes on a 10/ inch printer (2 short bars below the “M”, 2 tall below the “a”, short-tall beneath the “i”, and tall-short beneath the “l”) .

Appendix B: Radix Sort

As a technical note for those who are interested, the “radix sort” used on automation equipment permits optimization of the number of sortation passes required. The number of possible addresses that can be sequenced on a machine is determined by the number of bins raised to the power of the number of passes ($bins^{passes}$ = addresses). For example, as I’ve shown my students in postal automation classes with sample envelopes, a 3 bin sorter can sequence unlimited volumes of mail for 27 different addresses in 3 passes (3^3). As mentioned above, there are approximately 152,000,000 delivery points in the United States. Clearly it is not practical to sort mail using a 152 million bin sorter. A 25 bin sorter (including one reject bin) would require 6 passes to sequence mail for the entire country. The most practical solution is closer to a 113 bin sorter (with one reject bin). It can sequence mail for the entire country in just 4 passes which reduces the time and mail handling by more than a third from the 25 bin machine while still fitting in a reasonable space.

The USPS typically processes mail using a hub and spoke system since mail is generated and delivered across the country. Mail is collected at local post offices and aggregated at sectional center facilities (initial SCF hub). In the SCF it is sorted to the appropriate destination hub (3 digit ZIP code) and then transported to that destination hub. Next, the destination hub will carrier route sequence the mail for each delivery post office (5 digit ZIP). Finally, the 11 digit ZIP code sequenced mail in mail trays is shipped to the destination delivery post office for delivery. The multiple passes therefore are spread across several locations.

The USPS provides a list of the 11 digit ZIP codes of all delivery points along each carrier route to the Delivery Barcode Sorter (DBCS). The DBCS prepares the mail in that sequence; if a new house is added or an old house is removed then the associated 11 digit ZIP codes in the list are updated accordingly. As mail volumes change and carrier routes are remapped, the new sequence lists are loaded into the DBCS and the sortations change accordingly.

Crater Lake Anthony S. Wawrukiewicz 1989

Mt. Hood Anthony S. Wawrukiewicz 1988