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Technical Note 54

DETERMINATION OF A GENERAL INDEX OF EFFORT IN SORTING MAIL BY CONVENTIONAL METHODS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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The conventional method of sorting letters in stages is described. It is shown, through reference to available statistics, that about 90% of letters originating within the areas served by several large post offices will be involved in no more than five stages to be completely sorted to a carrier, firm or section of boxes. A method is presented for the accounting of each stage's individual letter readings which are defined as the units of measurement for the index of sorting effort. It is found that the upper bound average number of readings per letter for three large post offices varies from 3.16 to 2.98 and that these bounds are applicable to 96.2 to 92.4% of the local originating first class letters. It is anticipated that the values of such indexes for all large post offices will be consistently close to the range already determined.

1. Introduction

Our adventure into a program of consultation to the Post Office Department on the problem of letter sorting led us directly into the need for a number of well-founded generalizations. One of these generalizations concerns the average number of times that letters must be sorted between source and destination.

In order to choose a system for development from a number of sorting mechanization proposals, it is desirable to find and compare their significant factors of cost. In machine systems which require human reading at the input end of sorting, it is easily observed that this labor cost is the most significant factor. For a given volume of mail sorted by conventional methods, the total input effort increases almost exclusively with the average number of sortings per letter. In systems where other factors (such as capital investment, human output and supporting effort, and space cost) are substantially equal, decisions can be based solely on input effort differences. Conversely, where the input efforts of systems are found to have little variation, decisions can be based on the comparison of the other factors.

Many inquiries were made among postal officials and employees concerning this average number of sortings, but the information that was turned up pertained rather to the number of times that it was possible to sort some of the letters. Furthermore, only inadequate statistics were at first available in regard to the mail volumes to each category of a post office's sorting. With a knowledge of conventional postal sorting methods and the availability of more complete and reliable statistics, it has become possible to close in on this average number of sortings per letter.

A study of current methods indicates that most letters may pass through one to three sorting stages at both the "shipping" and "receiving" post offices. Besides this, there are letters that may be sorted several times in transit either on vehicles or at intermediate stations, or both.

The multiple stages appear to be warranted in the larger post offices which are required to separate their mail to large numbers of categories. These categories (of the outgoing stages) consist of other post offices and transit routes. It can be seen that letters which are separated directly to another post office, and are packaged for shipment to it, require no further sorting enroute. It is significant that, among three large post offices for which outgoing separation statistics were evolved from sampling counts [1][1], approximately 90% of all the letters are in 1000 to 2000 categories of such post office "directs". The remaining 10% of the letters might be addressed to any of our country's balance of 36-37,000 post offices. Because each of these are shipped zero to a few letters per day, groups of these minor post offices are resolved into less than 300 (or so) transit route and state residue categories at the "shipping" office.

A determination of the sorting effort involved for 90% of the letters originating at large post offices should be useful although not fully comprehensive.

At the "receiving" or incoming part of a post office, sorting for local delivery is performed on letters arriving from out-of-town as well as on a substantial portion of the output from its own "shipping" or outgoing section. Here again, several thousand categories, carriers and large firms, may be required. For these categories, the large city offices need no more than two stages of sorting for most of the mail, but carriers must also collocate their mail.

The outgoing and incoming sorting is generally performed at the city's main post office while the final stage, the collocation of letters according to the carriers' walks, is performed at their stations. This final stage of sorting is special because of the manner and the place where it is now done. Practically all letters leave the outgoing section of a post office after up to three stages of sorting, and 90% of these letters are subject, additionally, to no transit sorting and no more than two incoming stages when carrier collocation is discounted. Therefore, without the final stage, 90% of the letters originating within the area served by a large post office will not go through more than five sorting stages.

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[1] Figure in brackets indicates the reference at the end of this paper.

2. Category Allocation Among Stages

For the maximum conservation of sorting effort, the larger volume directs are usually separated in the earlier stages. The completion of some of the separation categories in a stage of sorting reduces the volume of letters for the succeeding stage.

In general, the first outgoing stage (primary) consists of (1) secondary categories and (2) post office directs; the second outgoing stage (secondaries) consists of (1) post office directs and (2) tertiary categories or state residues; the third outgoing stage (tertiaries) consists substantially of (1) post office directs and (2) transit routes. Likewise, the first incoming stage (primary) consists of (1) station (branch post office) categories, (2) firm directs and (3) main office boxes; the second incoming stage (secondaries) consists of (1) firm directs, (2) station boxes and (3) carriers.

Of the above types of categories, post office directs, transit routes, state residues, firm directs, boxes and carriers are completed separations with respect to the sorting office.

3. Index of Effort

The sorting effort expended in each stage is related to the total volume of letters minus that part of the volume which bypassed the stage or was completed in previous stages. The average effort (or operator time) expended per letter at each sorting is known to vary with the complexity of each sorting scheme (part of a stage), but the common operation to each letter in each stage is a single reading of the address. The number of readings in a stage is identical with the number of letters sorted in a stage. A reading, as defined here, is divorced from the variability of each sorting effort and so provides us with a standard unit of measurement.

The bypassed part of the volume is derived by the patron's separation into two or more of his post office's sorting categories. The largest and simplest of these categories is the mail for local delivery. When the patron puts such mail into a letter drop designated "local", this mail is directed to the incoming primary and, therefore, bypasses the normal first stage, the outgoing primary. The potentiality of bypass for this category is equal to its proportion of 40 to 60 percent of the local originating mail.

For the local delivery mail which is received by a post office from out-of-town, it is easily imagined that some difficulty might be encountered in tracing the previous sorting effort performed on letters which could have originated at any one of 38,000 other post offices.

With the preceding background, it is now possible to derive an upper bound estimate on the average number of readings per letter involved in reaching a carrier, a firm or a section of boxes for 90% of a post office's local originating mail. This estimate is considered to be an upper bound, because we will assume that two readings per letter are required at all out-of-town post offices, although we know that many of the smaller ones need only one reading per letter, and we can account for all the other readings in this 90% with much greater accuracy.

$$\text{Average Readings Per Letter} = \frac{\text{Total Letter Readings in System}}{\text{Letters in System}} = \frac{\text{Sum of Stage Letter Volumes}}{\text{Letters in System}} = \frac{\text{Sum of Stage Fractions of Sampled Entire Local Originating First Class Letters}}{\text{Corrected First Class Letter System Fraction}}$$

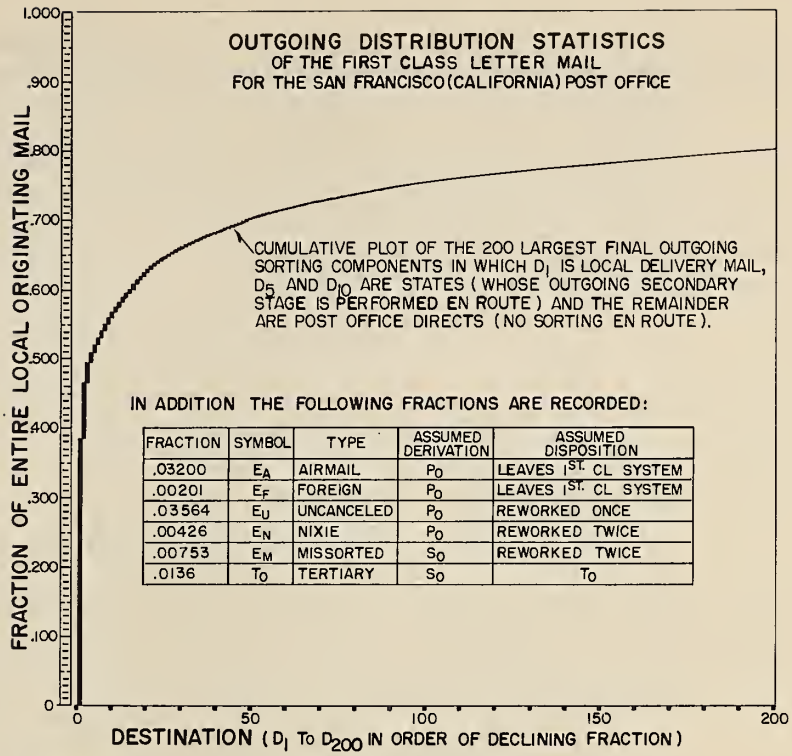
4. Example

For an example of this accounting, let us use the statistics of distribution [1] for one of the post offices where sample counts were made. The pertinent data from these statistics are shown in Figure 1 for the San Francisco (California) Post Office. Let us also assume that patron separation of local delivery and out-of-town mail has developed to the point that 20% may bypass the outgoing stages to directly enter the incoming primary. A second assumption is the availability of sorting machines with separation capabilities of 100 categories each. However, the possible benefits of this separation capability were not taken into consideration for incoming primaries of either the source or destination post offices. These benefits will be determinable when incoming distribution statistics become available.

There was also no consideration made for a very minor fraction of the mail which presently goes through an additional sorting stage in the outgoing or incoming sections of some post offices. It is anticipated that this practice can be eliminated by the use of the greater separation capability of machine sorting over that of manual.

Step 1 of Figure 2 illustrates the method of extrapolating to an outgoing primary of a desired separation capability from the statistical distribution data. This step yields the fraction which can be expected to be completed in the first outgoing stage and consequently the balance remaining for the second stage.

Step 2 of Figure 2 illustrates the fractions of the entire local originating mail which are worked through the five stages pertinent to the post office directs of the three significant outgoing stages.



FRACTION	SYMBOL	TYPE	ASSUMED DERIVATION	ASSUMED DISPOSITION
.03200	E_A	AIRMAIL	P_0	LEAVES 1ST. CL SYSTEM
.00201	E_F	FOREIGN	P_0	LEAVES 1ST. CL SYSTEM
.03564	E_U	UNCANCELED	P_0	REWORKED ONCE
.00426	E_N	NIXIE	P_0	REWORKED TWICE
.00753	E_M	MISSORTED	S_0	REWORKED TWICE
.0136	T_0	TERTIARY	S_0	T_0

STAGE LEGEND:

No.	SYMBOL	NAME	
1	P_0	OUTGOING PRIMARY	
2	S_0	OUTGOING SECONDARY	
3	T_0	OUTGOING TERTIARY	
4_L	P_L	INCOMING PRIMARY	LOCAL DELIVERY
5_L	S_L	INCOMING SECONDARY	
4_D	P_D	INCOMING PRIMARY	DESTINATION DELIVERY
5_D	S_D	INCOMING SECONDARY	

FIGURE 1. PERTINENT DATA FROM POST OFFICE MAIL STATISTICS [1]

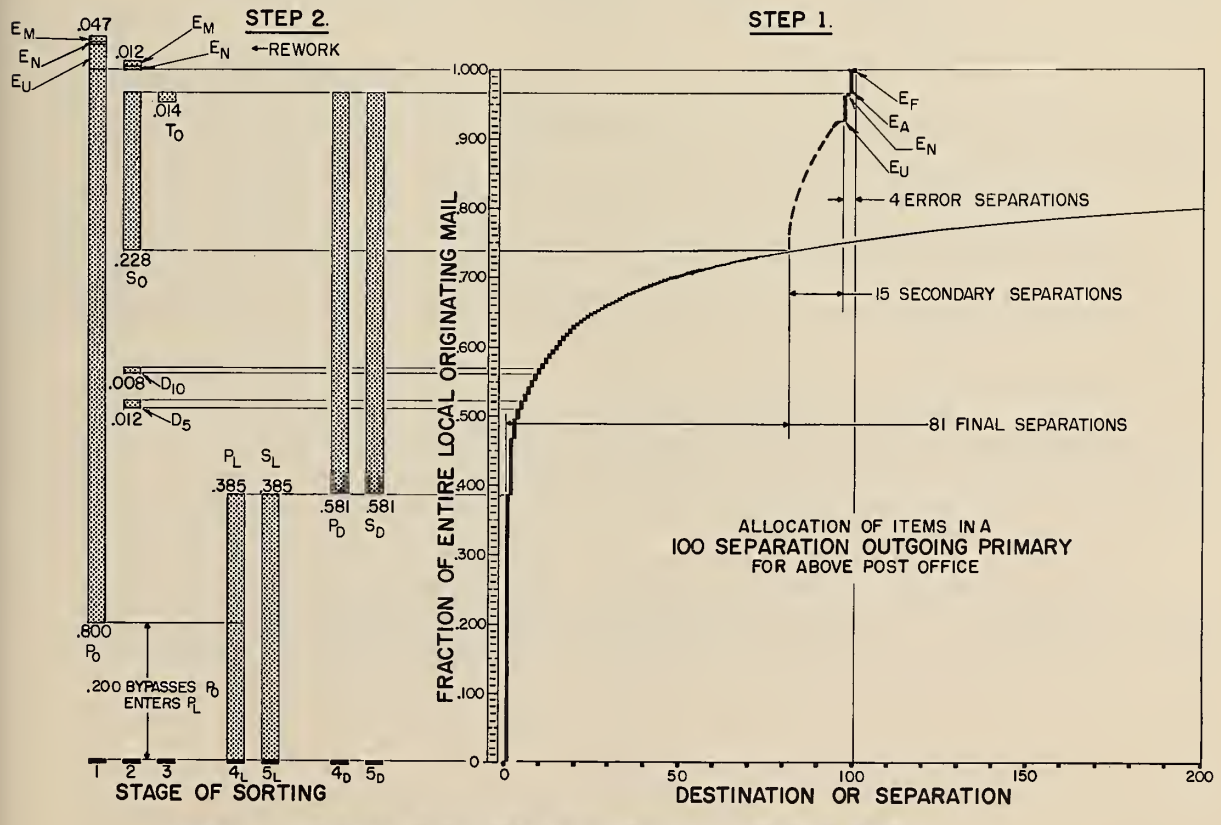


FIGURE 2. ILLUSTRATION OF ANALYSIS OF MAIL FRACTION TO SORTING STAGE

The summary accounting of the stage fractions of the sampled entire local originating first class letters is as follows:

Note: Symbols are consistent with those in Figures 1 and 2.

Stage No. 1	$P_0 + E_U + E_N + E_M$ .800 + .03564 + .00426 + .00753	.847
Stage No. 2	$S_0 + D_5 + D_{10} + E_N + E_M$ .228 + .012 + .008 + .00426 + .00753	.260
Stage No. 3	T_0 .014	.014
Stage No. 4	$P_L + P_D$ .385 + .581	.966
Stage No. 5	$S_L + S_D$ .385 + .581	.966

Sum of Stage Fractions of Sampled Entire

Local Originating First Class Letters 3.053

It should be noted that the airmail and foreign mail items in the table of Figure 1 are considered to leave the first class sorting system after the outgoing primary in which all of the foreign and most of the

airmail should be withdrawn. This is believed to be a fair assumption, because no sampling was made of the final separations in either the foreign or airmail sorting systems, and because the volume indicated by the fraction for each of these types probably represents only part of each total; the part which normally missed being segregated at the culling or facing operations. The entire local originating first-class mail (as sampled), which for simple outgoing accounting is considered unity, therefore is corrected to allow for this loss to the system in the more general problem.

Corrected First Class Letter System Fraction

$$= 1 - (\text{Airmail Fraction} + \text{Foreign Mail Fraction})$$

$$= 1 - (E_A + E_F)$$

$$= 1 - (.03200 + .00201) = \underline{.966}$$

It should also be noted that the system does not lose the other error categories among which the uncancelled mail predominates but which includes the missorted and the nixie (defective address; sometimes grouped with postage due) mail. Practically all of this mail is resolved into a transmittable separation after rework.

Then

$$\text{Average Readings Per Letter} = \frac{3.053}{.966} = \underline{\underline{3.16}}$$

5. Applicability of Index

We have repeatedly indicated 90% as an estimate of the post office direct separation categories of the outgoing mail. This figure was based on a summation of those fractions of the sampled entire local originating first class letters. In order to be consistent with our determination of average readings per letter, these post office directs relative to the letters in the system will be:

% Post Office Directs

$$= \left[\frac{\text{Corrected First Class Letter System Fraction} - (\text{States Residue Fraction} + \text{Transit Route Fraction})}{\text{Corrected First Class Letter System Fraction}}\right](100)$$

From the Original Data [1]:

States Residue Fraction = .0434

Transit Route Fraction = .0027

Then

$$\% \text{ Post Office Directs} = \left[\frac{.966 - (.0434 + .0027)}{.966}\right](100) = 95.2$$

6. Indexes for Other Post Offices

The sample count outgoing distribution statistics are available also for the Los Angeles (California) and Baltimore (Maryland) Post Offices [1]. From these data, we have made similar accountings. The Los Angeles Post Office makes an outgoing primary separation for one of its large local zones to effect an easy economy in eliminating that much work from its incoming primary. The Baltimore Post Office effects such an economy to an even greater extent and, besides, has advanced patron separation to a point where it actually exceeds the value of 20% which was assumed for the other two post offices. Aside from taking into consideration their already practiced economies and their individual distribution data, the method of accounting is the same for Los Angeles and Baltimore as the example shown for San Francisco. A summary table follows:

	% of Their First Class System Letters	Receive Less Than (No.) Average Readings/Letter
San Francisco	95.2	3.16
Los Angeles	96.2	3.16
Baltimore	92.4	2.98

7. Discussion

From this table, it may be seen, that there exists a very high and fairly consistent percentage of letters which requires no intermediate sorting between source and destination post offices and that, for these letters, the upper bound average number of readings under the given conditions is consistently in the vicinity of three.

It appears reasonable to expect that the results of such an accounting for any large post office could not significantly vary. If this consistency is indeed common to all post offices which warrant at least one sorting machine, then we have determined a useful index for all the sorting effort to be performed on those letters which may be processed by such machines.

More specifically, it appears that over 90% of the letters processed in post offices equipped with sorting machines will pass through such machines an average of less than 3.2 times and will require no other

sorting in order to reach a firm, a section of boxes or a carrier.

It will be possible to reduce this upper bound average readings per letter to a truer index when specific machines with higher separation capabilities are taken into consideration; when machine separation capability benefits are applied to incoming mail; and when an estimate can be made for those proportions of mail for out-of-town destinations which require one and two stages of sorting.

8. Reference

[1] N. C. Severo and A. E. Newman, Distribution of mail by destination at the San Francisco, Los Angeles and Baltimore Post Offices, NBS Tech. Note 27 (1958) PB 151386. (Order by PB number from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.)

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