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Management Services Forum

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MANAGEMENT SERVICES FORUM

Gentlemen:

I am looking for some current literature on the subject of streamlining physical inventory taking. I have looked at a number of books in our library and have seen one or two brief articles on this subject, but none of the material I have seen is comprehensive enough to suit my needs. Could you suggest a bibliography on this subject?

It seems to me there should be technical articles that have been written in the last two or three years which would be of assistance in developing a simplified, possibly statistical sampling, approach to taking a physical inventory where large numbers of items (upwards of 25,000) are involved. Any help that you can give me would be very much appreciated.

I am a regular subscriber to your excellent magazine. I am rather hoping that the subject has been covered in one or more articles from your magazine in recent years. Unfortunately, I have not run across these that I can recall.

PANEL OF ADVISORS:

Under the auspices of MANAGEMENT SERVICES, a panel of management services advisors from leading accounting firms have agreed to answer to the best of their ability questions about any area of management services with which readers would like help. Both questioners and advisors will remain anonymous. One or more of the following members of our panel are responsible for the answers published in this department:

WILLIAM E. ARNSTEIN, *Main Lafrentz & Co., New York*
PHILIP L. BLUMENTHAL, *Geo. S. Olive & Co., Indianapolis, Ind.*
ROY A. LINDBERG, *J. H. Cohn & Company, Newark, N. J.*
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H. G. TRENTIN, *Arthur Andersen & Co., New York*
ALLEN WEISS, *Laventhol Krekstein Horwath & Horwath, New York*

Of the replies received, two seemed particularly pertinent. This is from one of the major accounting firms:

As you know, physical inventory counts serve two purposes:

(1) To verify inventory records for internal inventory control, and

(2) To provide internal financial people and external auditors with the inventory valuation for periodic synthesis of financial statements.

The best technique for eliminating the large, once-a-year, control type of inventory is cycle counting. You should find the attached References 1 and 2 helpful in this area.

You are correct in your assumption that the easiest method of accomplishing the periodic inventory for financial purposes is through statistical sampling. The requirements of the external auditors (References 3 and 4) will govern your sampling criteria. The steps involved in inventory sampling and some case examples are found in References 3-6.

Before embarking on a program of physical inventory through statistical sampling, it would be advisable to get a good grounding in the theory behind sampling (References 7 and 8) since every situation is unique and requires techniques to be applied accordingly.

References

1. *Inventory Control Techniques,* R. VanDeMark, Jensen-Townsend (Port Huron, Michigan), 1961, pp. 65-70.

2. "Inventory Control Methods Which Eliminate Annual Inventories," J. O'Donnell, Jr., American Production and Inventory Control Society Annual Conference, Nov. 1960.

3. "Inventory Determinations by Means of Statistical Sampling Where Clients Have Perpetual Records," W. Hall & R. Nest, *Journal of Accountancy*, Mar. 1967.

4. "Inventory Determination Through Statistical Sampling Procedures," R. Simpson, *Massachusetts CPA Review,* Aug.-Sept. 1968, pp. 10-19.

5. "Physical Inventory by Statistical Sampling Methods," H. Arkin, *The New York Certified Public Accountant,* Oct. 1959, pp. 741-745.

6. "An Example of Sample Stocktaking," J. Draper, *The Cost Accountant,* Sept. 1963, pp. 330-335.

7. *Sampling Manual for Auditors,* The Institute of Internal Auditors, 1967 (revised edition).

8. *Statistical Sampling for Accounting Information,* R. Cyert & H. Davidson, Prentice-Hall, 1962.

. . . and from a large firm:

In response to your letter of August 13 concerning the reader query on physical inventory taking, we didn't find very much in the way of published literature. However, a report and a memorandum in our files both contain some pertinent information on this problem. We particularly invite the reader's attention to the report, dated March 7, 1968, which deals rather specifically with the problem that he mentions. This was a report written to a wholesale book dealer:

Dear Mr. ——,

We have considered the problem of simplifying the annual inventory count at your various warehouses, while at the same time insuring that the count is sufficiently reliable to make possible an opinion on the fairness of your financial statements.

In 1967, the principal inventory problems at ———— were these:

1. Counting and listing an estimated 25-30 thousand titles, which placed a heavy burden on your personnel.

2. Pricing these items and subsequent audit verification of the prices used. Cost records were not then maintained in a manner that enabled our representatives to trace costs back to purchase invoices.

We understand that the second

. . . the easiest method of accomplishing the periodic inventory for financial purposes is through statistical sampling. The requirements of the external auditors will govern sampling criteria.

EXHIBIT A

Preliminary Estimate of Books Subject to Count and Cost Sampling, 1967 Inventory

	Cost Per Inventory 3/31/67	Estimated Number of Books	Count, List, And Extend		Count and Sample Cost		Estimated Sample Size	
			Books	Cost	Books	Cost	Cloth	Paper
Geology	$ 4,553	5,053	4,042	$ 3,943	1,010	$ 610	30	30
Back quantities	14,892	16,530	13,224	12,896	3,306	1,996	30	39
Ft. Knox	9,625	10,684	8,547	8,335	2,137	1,290	30	30
Mathematics	32,979	36,607	29,286	28,560	7,321	4,419	30	153
Spanish	4,401	4,885	3,908	3,811	977	590	30	30
History I	8,180	9,080	7,264	7,084	1,816	1,096	30	30
History II	3,936	4,369	3,495	3,409	874	527	30	30
History III	6,536	7,255	5,804	5,660	1,451	876	30	30
History IV	3,833	4,255	3,404	3,319	851	514	30	30
Education	17,314	19,219	15,375	14,994	3,844	2,320	30	50
Business	19,572	21,725	17,380	16,949	4,345	2,623	30	65
Statistics	963	1,069	855	834	214	129	30	30
Near East Languages	731	811	649	633	162	98	30	30
Center Aisle	10,340	11,477	9,182	8,954	2,295	1,386	30	30
Greek	4,874	5,410	4,328	4,221	1,082	653	30	30
German	2,299	2,552	2,042	1,991	510	308	30	30
English	19,296	21,419	17,135	16,710	4,284	2,586	30	65
Sociology	16,839	18,692	14,954	14,583	3,738	2,256	30	30
Art and Music	4,736	5,257	4,206	4,101	1,051	635	30	30
Law	2,628	2,917	2,334	2,276	583	352	30	30
Biology	6,420	7,126	5,701	5,560	1,425	860	30	30
Totals	$194,947	216,392	173,115	$168,823	43,276	$26,124	630	852
Titles listed			4,896				630	852
Titles not listed					21,156			

ASSUMPTION: Mix of paper vs. cloth and average prices same as in History I section.

. . . through the use of approved sampling techniques much of the physical labor (involved in inventory taking) can be eliminated without significant loss of reliability.

EXHIBIT B

Sample Size (n) For A Section, If Precision = ±$100, Confidence = 95%
Std. Deviation in Random Sample of 30

N = No. Books Counted	$.10	$.15	$.20	$.25
100	30	30	30	30
200	30	30	30	30
300	30	30	30	30
400	30	30	30	30
500	30	30	30	30
600	30	30	30	30
700	30	30	30	30
800	30	30	30	30
900	30	30	30	30
1,000	30	30	30	30
2,000	30	39	69	107
3,000	39	86	153	239
4,000	69	153	271	424
5,000	107	239	424	662
6,000	153	344	610	952
7,000	208	467	829	1,295
8,000	271	610	1,083	1,691

NOTE: In the larger sections (over 3,000 books counted without listing) values total $2,000-$4,000. If precision is reduced to ±$400, the sample size can be cut in half without loss of 95% confidence.

of these problems has been in large measure resolved by your action in recording costs directly on the books, using an alphabetical code, during the year now ending.

The first problem still remains. As a result of our recent brief study of your inventory mix, we believe that much of the physical labor can be eliminated without significant loss of reliability. This can be done by using approved sampling techniques. In summary, we recommend:

1. Counting and listing the books that are warehoused in wholesale quantities, the same as in past years. (This involves only an estimated 17-18 per cent of the titles, but an estimated 86-87 per

cent of the dollars in the inventory.)

2. For books on hand in small quantities, counting without listing, keeping separate counts within each section for paperbound and clothbound titles.

3. Use of sampling techniques, as described below, to find average prices to be used in determining total values of those books in each section which were not listed separately.

The remainder of this report will be devoted to a report of our study and to recommended procedures for the 1968 inventory.

If there are additional questions, kindly advise us.

Yours very truly,

_____

Certified Public Accountants

Results of study

Our study used the History I section for detailed examination. We were informed that the mixture in this section, as between small quantities and large quantities, was believed to be typical.

In the 1967 inventory, the History I section amounted to $8,180 of the $195,000 inventory, about 4.2%, or 1/24 of the total. To the extent that its mix is typical, an approximation of the mix in the total inventory can be obtained by multiplying the dollars and titles below by 24. This procedure is the basis for Exhibit A, page 48.

We propose that you sample and test each section at ——— separately in 1968. If it then develops that the mix in the History I section was not typical of the inventory as a whole, a statistically valid estimate for the small lots will still be obtained, if the procedures we recommend are followed. Differences from our estimates in Exhibit A will be reflected by more or fewer titles to be listed and extended and in different required sample sizes.

Our study shows that inventory distribution in the History I section was as follows on page 50:

EXHIBIT C

Random Sample of Small Inventory Quantity

Section_____ Type Binding_____(Paper or Cloth)

	Random Location No.	Author	Title	Cost	Cost²
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

EXHIBIT D

STANDARD DEVIATION

Computational Formula: $S_{X_j} = \sqrt{\frac{\Sigma(x_j)^2 - n\bar{X}^2}{n-1}}$

(see rounding suggestions at bottom of worksheet)

	A	B	C	D = A ÷ C	E = D²	F = C x E	G = B − F	H = G ÷ (n-1)	I = √H
	Σx_j	$\Sigma(x_j)^2$	n	$\bar{X}$	$\bar{X}^2$	$n\bar{X}^2$	$\Sigma(x_j)^2 - n\bar{X}^2$	$S_{X_j}^2$	S_{X_j}
Rounding (if necessary):	none	none	none	1 decimal	1 decimal	1 decimal	1 decimal	2 decimals	1 decimal

Number of copies per title:	Total Volumes On Hand	Titles Number	Titles %	Titles Cumulative %	Dollar Cost Cumulative %	Dollar Cost %	Dollar Cost Dollars
Over 100	2,470	13	1.1%	1.1%	39.5%	39.5%	$3,234
50 to 99	1,344	20	1.8	2.9	53.6	14.1	1,149
10 to 49	3,376	154	13.7	16.6	82.0	28.4	2,323
9	117	13	1.1	17.7	83.1	1.1	94
8	144	16	1.4	19.1	84.5	1.4	116
7	105	15	1.3	20.4	85.5	1.0	85
6	126	21	1.9	22.3	86.8	1.3	102
5	205	21	1.9	24.2	88.8	2.0	165
4	128	32	2.8	27.0	90.1	1.3	103
3	243	81	7.2	34.2	92.5	2.4	196
2	284	142	12.6	46.8	95.3	2.8	230
1	601	601	53.2	100.0%	100.0%	4.7	383
Totals	9,143	1,129	100.0%			100.0%	$8,180

We were reminded by this analysis that you are in the *wholesale* book business and that your inventory dollars *should* be invested mainly in wholesale quantities. Plotting the totals graphically suggested to us that the point of diminishing returns in listing and extending prices is reached somewhere between a quantity of 10 and 1.

We made a further analysis of the "singles" to determine the mix between paperbound and clothbound books. This indicated that costs for the singles tended to cluster either in the "30¢-50¢" area or at the "$1.25 and over" level. Very few of the 601 singles (only 28, or less than 5%) had costs between 80¢ and $1.25. We therefore arbitrarily classified singles with costs of $1 or more as "clothbound" and those with costs less than $1 as "paperbound." (Again, any inaccuracies here will be eliminated by the better sampling techniques to be discussed later.)

This analysis produced the results shown below.

	Cloth ($1 or Over)	Paper (Under $1)	Total Singles
Number of single titles	127	474	601
Inventory dollars	$232	$151	$383
Average cost per volume	$1.82	32¢	63¢

This correlates very well with Mr. ————'s statement that, "Overall, we handle five paperbacks at 25¢ each for each clothbound book at $2.50." For 600 books, Mr. ——'s estimate would yield an inventory cost of $250 in cloth and $125 in paper, or a total of $375.

This information, coupled with the remarkable uniformity of average costs in the "2 to 10" copies categories (all 80¢-81¢), leads us to conclude that your point of diminishing returns for listing should be 10 or more paperbacks and five or more clothbound books.

Adopting this cutoff should then result in your being able to assure yourselves of complete accuracy for about 86 per cent of your dollar value by listing and extending only 18 per cent of the titles.

Examining now the area subject to statistical sampling treatment, (that is, those books in which the quantities are less than 10 paperbacks or 5 clothbound titles), our estimate of the quantities involved at ———, based on the History I section analysis, is:

24 × 942 titles = 22,608 titles of an estimated 25-30 thousand

24 × 1,814 volumes = 43,536 volumes

The total dollar value involved at March 31, 1967, is estimated as:

24 × $1,100, or $25,240 of the $195,000 inventory.

This raises the question, "How reliable would the sampling techniques be?" It is clear that if sampling produced results that were in error by 50 per cent, the total inventory could be inaccurate for this reason by as much as $12,620. The statistical methods we propose should be able to do much better than that, however. Samples of 30 to 100 titles from each section, properly selected by random methods, should produce statistically reliable data with 95 per cent chance of being within ±$100 of the total for that section. The exact sample size would depend on the number of books counted in the section and on the spread or variance (technically, the "standard deviation") of costs found in the first 30 titles sampled in that section. In our study, the average cost of books subject to count and cost sampling was 61¢, and standard deviations of a few samples were from 10¢ to 20¢.

The largest section in 1967 had an estimated 37,000 books, of which an estimated 20 per cent or 7,400 would have been counted without listing. (These would have represented 83 per cent of the titles.) The smallest section had an estimated 811 books, of which about 162 would be counted without listing. Our sample size tables (Exhibit B, page 48) show that only in the largest sections, and under conditions of great variance in the items in the first sample, does the necessary final sample size exceed 100. On this basis, we believe that the maximum final sample in the largest section would need to be 153, as shown in Exhibit A. Sample sizes in most sections would be 30, which is the minimum sample acceptable without special calculations. On the basis of the section we tested, we believe that a total of 1,500 properly chosen sample titles should eliminate the listing, pricing, and extending of over 20,000 titles in your inventory. Details of this estimate are set forth in Exhibit A.

In the following section, we shall set forth the procedures recommended.

In order to take advantage of

the cost savings afforded by sampling methods the following procedures are recommended:

1. For titles where quantity on hand is greater than 5 cloth or 10 paper, count and list these titles, and extend by the cost price, as in previous years.

2. In each section, count the clothbound books in quantities of 1, 2, 3, or 4 in one total. Count the paperbound books in quantities of 1 to 9 in another total. A distinctive marker such as a special card or slip of paper should be placed after each hundredth book so counted and marked 100, 200, 300, etc. The last entries on the inventory listings for each section should be:

Clothbound, quantities less than 5.
Paperbound, quantities less than 10.

3. After the counting and listing for a section has been completed (and before that section is cleared for further receipts and shipments) random samples of the books not listed must be taken. The purpose of a random sample is to insure that each book has as much chance of being included in the sample as any other. In order to assure randomness, a table of random numbers is to be used.

These numbers, in groups of four digits, either may be taken to indicate the number of the book in the total count for that section (which will always be under 9999, according to our estimates) or they can be taken to be a shelf number (such as from 1 to 99 within that section) and a number of inches (from 1 to 36 or 48 or the width of the widest shelf) from the left edge of the shelf. We believe this latter method will be simpler. The "eligible" book nearest that location would be the one taken in the sample. By "eligible" is meant one of the books that were counted without listing. Initial sample size for each section should be 30 cloth and 30 paper.

4. In listing those books included in a sample, the format in Exhibit C on page 49 is recommended. (You will need at least two sheets for each section. We suggest duplicating about 100.) It should be noted that no "quantity" is listed here. Each title would count in the sample as only a single book, unless the random number table selected the same or another copy of that book for the sample. After author and title, the cost must be listed in the same manner as on high-count items.

5. Statistical calculations are then made as follows for each sample:

(a) Calculate the mean or average cost for the books in the sample.

$$\left(\bar{x} = \frac{\Sigma x_j}{n} \right)$$

(b) Calculate the estimated population standard deviation by the formula:

$$Sx = \sqrt{\frac{\Sigma(x)^2 - n\bar{x}^2}{n - 1}}$$

(c) Determine, considering the number counted and the value of Sx, whether a larger sample is required for 95% reliability. (It probably will be, in a few cases.) Use Worksheet 4 (about 10

EXHIBIT E

COMBINED SAMPLE

1	Σx_j (preliminary)	$			
2	Σx_j (additional)	$			
3	Σx_j (combined)	$			
4	n (combined)				
5	$\bar{x}$ (3 ÷ 4)				
6	$\Sigma(x_j)^2$ (preliminary)	$			
7	$\Sigma(x_j)^2$ (additional)	$			
8	$\Sigma(x_j)^2$ (combined)	$			
9	$\bar{x}^2$	$			
10	$n\bar{x}^2$ (4 x 9)	$			
11	$\Sigma(x_j)^2 - n\bar{x}^2$ (8 − 10)	$			
12	$S_{x_j}{}^2$ [11 ÷ (n-1)]				
13	S_{x_j} ($\sqrt{}$ row 12)				

EXHIBIT F

DETERMINATION OF PRECISION AT A GIVEN RELIABILITY LEVEL

	1	2	3	4 (2 x 3)	5
	RELIABILITY (R)	U_R	**STANDARD ERROR OF THE MEAN** $(\sigma_{\hat{\bar{X}}})$	**MAXIMUM** $\lvert\bar{x} - \bar{X}\rvert$ $(U_R \cdot \sigma_{\hat{\bar{X}}})$	**PRECISION (A)**
NOTE: Round off results in Columns 2, 3, and 4 to two decimals.	**In this context, R is the desired degree of confidence that the error of the total estimate will not exceed the precision computed in Column 5.**	**Table 1 indicates that R% of the time a sample mean will differ from the population mean by no more than this number times** $\sigma_{\hat{\bar{X}}}$	**Estimated by the formula** $S_{X_j} \div \sqrt{n}$	**Given the aove** $\sigma_{\hat{\bar{X}}}$ **and** U_R**, then R% of the time** $\bar{x}$ **will not differ from** $\bar{X}$ **by more than this amount.**	**The maximum** $\lvert\bar{x} - \bar{X}\rvert$ **(R% of the time), multiplied by N. R% of the time, the error in the estimate of the total will not be greater than this amount in either direction.**

sheets). The value of U_R for 95% in Worksheet 4 is 1.96. Exhibit B of this report gives some sample sizes required for certain combinations of Sx and number of books counted in a section (N). Separate N's apply, of course, to cloth and paper.

(d) If a larger sample is required, use Exhibit E (page 51) to combine the samples. Then use Exhibit F (above) to see that reliability, using the new $\bar{x}$ and Sx, is within the ± 100 limit. When a mean cost ($\bar{x}$) is reached by a sufficient sample to fall within the precision limits of ± 100 per section for cloth and paper (somewhat wider limits in the larger sections if you desire), use this cost to extend the number of books counted without listing, to obtain total valuation for these small quantities, and include in your inventory valuation.

e) The sampling plan used should be recorded as in Exhibit G (at left) for the use of our representatives in assuring themselves that the sample was random. You should duplicate about 50 of these, one for cloth and one for paper, in each section.

Some of the notation and concepts used in random sampling calculations at first seem formidable, but they can be mastered readily by any of the girls in the office after brief instruction. We shall be glad to assist in this brief instruction if you desire.

EXHIBIT G

Sampling Plan

Inventory Date_____

Section_____ Type Binding_____(Paper or Cloth)

Type of Sampling: Unrestricted random sampling with replacement.

Correspondence:

Each shelf in the section is assigned a number from 1 to 99.
Each book of its type (paper or cloth) is assigned a number (1 to 60) corresponding to the number of inches from the left end of the shelf at which it is located.
A pile or stack of books is given a shelf number.
If no eligible book is located at the specified location, use the nearest eligible book. In case of a tie, use the left hand book.

Route:

Use the left hand four digits of each group of numbers in the table, proceeding down the table.

Starting Point:

Method: Random Stab
Correspondence: First three digits in nearest usable line = Row, next digit = Column.

Starting row:
Starting column:

A case study in inventory control

Recently there has been increasing recognition of the importance of inventory control in all phases of business and industry. Many inventory control problems have actually existed for a number of years, but increased attention to them has brought out the fact that they often lead to excessive production costs, lost sales, and dissatisfied customers. In this case history, we will discuss the difficulties encountered by one typical manufacturer and the suggestions made for dealing with them.

Not long ago, we surveyed the perpetual inventory system of one of our clients as a part of our regular audit procedures. We needed to evaluate the reliability of the records produced by their new system, and we had become especially concerned because a number of employees had indicated that the results were not satisfactory.

Early in our examination, we ascertained that the system was indeed functioning erratically and that the concern about the system's reliability was fully justified. This company, as a result of revised procedures instituted several months before, had inadvertently removed many safeguards from its inventory control framework under the impression that a better system was being established. We summarized in a letter to management the weaknesses which we found, together with our recommendations for improvement.

Problem areas

Our survey indicated that inventory problems occurred because of the following weaknesses:

1. Source documents were often prepared incorrectly. The examples listed below indicated a lack of effective communication between departments as well as insufficient attention to paper work:

a. Bills of material used for inventory purposes often did not agree with parts used in actual products being built. In other words, parts used in production differed from parts called for by the bill of material.

b. Engineering changes were not always reported properly to the Inventory Control Section. The same situation that was noted in a. above then occurred.

c. Reversing documents for rework items were sometimes not completed. These documents refer to finished goods returned to production for repair or reprocessing.

2. Physical control over inventory was poor. The following inadequacies were noted:

a. Unauthorized personnel had access to the warehouse areas.

b. The warehouse had no controlled storage areas for material pulled but not issued to production.

c. The warehouse issuing office was too far from the entrances to the production areas to exercise any physical control over withdrawals from stock.

3. We found that responsibility for material control in production areas was too indefinite. The foremen, who supervised the processing of materials, were not accountable for variances. Final responsibility, or perhaps sole responsibility, appeared to rest with the Plant Manager, who obviously could not exercise detailed control over materials in the plant.

Part of the trouble was due to the lack of clear-cut lines of authority. Responsibility for each function was not assigned to a specific individual. For example, who would be responsible for a shortage of a specific part? Under the existing system, the shortage could have been in either the warehouse or the production area, or both. The purchasing department could have failed to order the required quantity, the engineering department might have failed to notify purchasing of additional amounts needed because the part was being used on other models, or the foreman might have made unauthorized withdrawals from stock because of excessive scrap or unauthorized substitution of parts. The result could be a line shut down because of a lack of parts without any way to determine the reason. Other examples are as follows:

a. Adherence to proper scrap reporting procedures was poor. Tests made by production engineering showed that scrap often ran much higher than either estimated scrap per bill of material or scrap officially reported by production. We did not observe any follow-up or investigation of abnormal scrap variances.

b. Substitution and replenishment procedures were sometimes disregarded. This was apparent because of the large volume of overages and shortages among interchangeable parts.

c. Replenishments and substitutions of materials as shown on source documents were not analyzed to determine why the additional issues were necessary.

During our survey, the production officials reported that they were already making certain changes in procedures, as detailed below:

1. The Inventory Control Section would count all items within six months.

2. Physical control over raw materials had been strengthened. The Plant Manager was transferring employees to the warehouse who were interested in proper control over inventory—an attitude which had been lacking in the past.

3. Paperwork errors are now published. The new "weekly report" of paperwork errors has been helping to reduce errors such as incorrect part numbers, inaccurate quantities, and illegibility of documents. This report has been especially valuable because the people who have been making mistakes are told about them. We have noted a general improvement in all paperwork, regardless of whether it affects inventory.

4. The specification department would now screen, on a sample basis, bills of material to determine whether part numbers listed

correspond to actual parts used in production.

5. The engineering and production staffs would prepare more written notices of deviation from authorized bills of material.

These changes indicated that progress was being made toward controlling the perpetual inventory system, but we could see that further improvements were necessary if the system was to function satisfactorily.

Recommendations

1. *Raw Materials Control.* To bring the system under control, the warehouse area would have to be physically segregated from the production area. This would require installation of a fence and gate so that the area would not be accessible to unauthorized personnel. The problem of unauthorized and unrecorded withdrawals from warehouse stock would then be eliminated. In addition, we recommended that the issuing office be moved from its present location to a position near the entrance to the production area. The office could then rapidly service requests for materials and could keep visual control over withdrawals from the warehouse.

2. *Accountability for Materials.* The warehouse manager would be responsible for receiving, storing, and issuing materials only. We believed that separate records should be maintained for raw materials inventory items. The warehouse manager would be responsible for differences between balances per records and items on hand. The Inventory Control Section would be charged with counting warehouse items and comparing counts to the records.

We suggested that accounting for parts in production be discontinued. It appeared to us that accounting for various materials items on the production line was unnecessary. If proper records were maintained for items issued to production and for components or assemblies completed and transferred out of each department, adequate control over production inventory could be achieved.

3. *Control of In-Process Items.* To accomplish this control, the foreman of each department would be accountable for materials issued to his department. In this way, the person who supervised the use of materials would be made responsible for them. Control would be very economically maintained by requiring the foreman to complete the number of units scheduled *without additional issues of material.* If he required replenishment of any items, he would complete an issue card and list his reason for the issue. The card would be approved by the Plant Manager or his authorized representative. The Inventory Control Section and the Production Engineering Section, working together, would investigate these supplemental issues to determine what corrective action was necessary.

To reduce concern over daily shortages of material, the warehouse would issue several days' requirements at one time. Depending on space available, production schedules, etc., between three and five days' requirements could be issued at a time. We also suggested that each issue include enough material to cover the estimated scrap allowance in the bills of material. Scrap allowances would be analyzed continuously and revised whenever necessary. If actual scrap was less than estimated and a foreman used less material than originally estimated, the surplus could be returned to stock and the foreman credited for the quantity turned in.

4. *Responsibility Reporting.* We mentioned that the system suggested would lend itself readily to inclusion in a responsibility accounting system. The company had already instituted responsibility accounting in several areas, but the persons accountable were generally in the top management category. An effective responsibility reporting program is a device for tying operating results directly to the company's organization chart (e.g., to the supervisor responsible for those results). Under this system, supervisors at each level of management receive reports reflecting only the results for which they are directly responsible, compared with expected performance—in the form of a budget, standards costs, or the like. An absolute requirement of this system is an organization which has clear-cut lines of authority, with every function clearly assigned to a single individual. Responsibilities must be identified carefully. We believed the company could definitely use this type of system and recommended that it be considered carefully for installation in the future.

5. *Data Processing.* We discussed with company representatives the new data processing units available which allow transmission of receiving, issuing, and producing information directly from the plant to the computer installation. These units might improve the accuracy and speed of the reporting system while at the same time decreasing the amount of paperwork needed and we recommended that their use be considered.

6. *Specifications Review.* We suggested the expansion of the specifications department to include the examination of all engineering models to be sure they agreed with the approved bills of material. Also, the comparison by the specifications department of models taken at random from production to approved bills of material would be increased. Any deviation from the bills of materials would be reported promptly to the Inventory Control Section so appropriate corrections could be made to the records.

Weaknesses in inventory control procedures can definitely create serious problems. This case study points out the difficulties which confronted one company and the steps taken to correct them. It is our hope that others faced with similar situations may, through review and comparison, find it easier to institute corrective measures.

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