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# University Grant Program Research Report

COMPUTER-ASSISTED CASH MANAGEMENT  
IN A  
TECHNOLOGY-ORIENTED FIRM

by

J.C.T. Mao

Faculty of Commerce and Business  
Administration,  
University of British Columbia.  
March, 1973

## Rapport de recherche sur le Programme de subventions aux universités



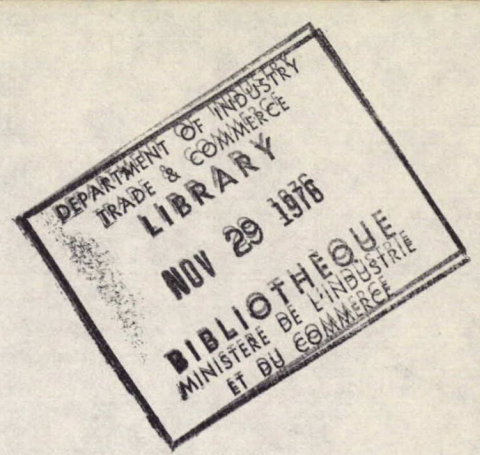
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Ottawa, Canada





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The views and opinions expressed in this report are those of the author and are not necessarily endorsed by the Department of Industry, Trade and Commerce.

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IN A TECHNOLOGY-ORIENTED FIRM

James C. T. Mao

SUBMITTED to Planning and Evaluation Branch,  
Office of Science and Technology,  
Department of Industry, Trade and Commerce

March 1973

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## INTRODUCTION

This research project is intended to show how the cash budgeting procedure in a firm can be computerized and how computer simulation of cash flow can be used to control the risk of cash insolvency. The paper is divided into four major sections as indicated below.

### I. Cash Budgeting Procedures in Practice

This is a report of actual budgeting procedures used, based on personal interviews with executives in technology-oriented firms both in Canada and the United States.

### II.A Computerized Cash Budgeting Program

This section contains an illustration of the way in which the cash budgeting procedure of a firm can be computerized. Although a hypothetical firm is used, the computer program is, with only slight modification, applicable to any firm.

### III. Sensitivity Analysis

This section recognizes the fact that all firms must operate under conditions of uncertainty.

Taking the computerized budget as a starting point, we show how simulation can be used to analyze the effects of sales growth, change in inventory policy and change in accounts receivable policy on the cash position of a firm.

### IV. Simulation of a Business Recession

This section presents a computerized model for simulating the effect of a business recession on cash flows.

Appendices containing the listings of the computer programs used in this paper are included, so that any firm may re-run these programs with its own data. Although some adaptation may be necessary for the particular needs of a given company, the listings are presented in sufficient detail that any needed adaptations can be easily made.



## I. CASH BUDGETING PROCEDURES IN PRACTICE

### Background

To gain an idea of the potential for computerization of cash budgeting, it was necessary to survey the actual cash budgeting procedure in business firms in order to determine what specific problems exist and whether these problems are amenable to correction by computerization. Executives in a number of technology-oriented firms, approximately half of them Canadian and half American, were interviewed to ascertain exactly what cash budgeting procedures were being employed. Since cash budgeting is only one facet of a firm's entire budgetary system, a full understanding of this budgeting can only be obtained through a view of the complete system: operating budget, capital budget, statement of projected income, projected balance sheet, and so on. In our survey, therefore, we did not restrict our inquiry to cash budgets, but extended it to the entire budgetary system, though keeping primary focus on the cash budgets.

The factual information sought included the following points :

- (1) In what types of budgetary planning does the firm engage (e.g. long-range planning budget, short-term operating budget, capital expenditures budget, cash budget)? What types of budget does the firm prepare, and in what detail? At what time of year is the budget prepared? What is the planning horizon? How frequently is the budgeting updated? Who is responsible for preparing the budgets, and where does he get his information? How is uncertainty incorporated into his figures?
  
- (2) How is the information from cash budgets utilized? That is, what is the role of cash budgeting in determining how much of a cash balance the firm holds? Which executive or executives in the firm decide how much cash it will keep on hand; and how frequently and through what channel is information supplied to him or them? If there is a temporary cash surplus, does the firm invest it? If so, who is in charge, what investment model (if any) does he use to optimize the portfolio of short-term investments, and in what instruments does he invest?

A high percentage of the firms included in the survey had only very simple budgetary systems. This was expected, because we deliberately focussed on small firms in the early stages of growth. Due to their newness and smallness, many of these firms have only one or two employees to handle budgeting, and even these usually have other accounting and finance tasks as well. For completeness, we also studied several larger, well-established companies, where we found much more comprehensive and well-developed systems. Since the companies studied were chosen for judgmental reasons, not by random selection, no probabilistic statement as to their representativeness can be made. We did, however, detect sufficient uniformity among the sampled firms to suggest that the circumstances observed are not isolated instances but fairly common.

Since the object of this study is not to describe the cash budgeting procedure in the companies surveyed, but to identify areas where the computer can be of assistance, our description of budgeting procedure in practice will be confined to two typical situations : Company A, a small, rapidly-growing company with a simple budgeting system typical of many small firms and

exhibiting many of the weaknesses which hinder efficient cash management; and Company B, a well-established firm with a comprehensive budgeting system which smaller companies could use as a model, but which could be further improved through computerization. Since our data were obtained confidentially, the designations A and B are used even though the companies referred to are real, not hypothetical.

Company A

Business. The company produces photoplates and photomasks for the semiconductor industry for use in the manufacture of integrated electronic circuits for computer memories, calculators, computer terminals and other devices. The company's customers are generally able to perform all the required steps in the processing of integrated circuits, beginning with the preparation of the artwork. Various factors, however, occasionally make it desirable for these manufacturers to contract out part or all of the photomask fabrication on certain projects to the company. Depending on the case, the



company may furnish only the photoplates, or it may furnish photomasks manufactured with the use of artwork from the customer, or photomasks manufactured with the use of artwork prepared by the company from the customer's drawings. The photomasks may be supplied in small quantities as masters to be photographically-copied by the customer, or the company may supply both masters and copies. Since the requirements of individual customers for outside contracting vary from time to time, there is a fluctuation in the level of orders placed with the company for its photoplate and photomask products.

Approximately 64% of the company's sales for the fiscal year ended March 31, 1971 were for photoplate packages. These packages are made by cutting high resolution photographic plates purchased by the company into various specified sizes, ultrasonically cleaning the plates, and then stacking them into packages specially designed by the company to facilitate handling of the photoplates in the future fabrication of photomasks. The company developed the technology for manufacturing these packages as part of its program for improving its own photomask manufacturing techniques. The remainder of the company's

sales for the fiscal year were for photomasks manufactured to customer specifications from company-supplied photoplates.

Budgeting Procedure. Preparation of the budgets (including the cash budget) in this company is the sole responsibility of the assistant treasurer, who has a recent M.B.A. degree from a business school. There is no longer-term budget, and the planning horizon is one year. When asked why there is no longer-term budget, the vice-president of finance answered that "We don't have that kind of visibility".

The annual budget included the following documents :

- (1) Operating Budget and Actual Performance (see Figure 1);
- (2) Projected Income and Cash Flows (Figure 2);
- (3) Cash Flows Statement (Figure 3).

The operating budget is the basic document of the three. It is essentially a projected income statement used to control the profitability of the various divisions. Shortly before the end of each fiscal year (March 31st), the assistant treasurer receives

OPERATING BUDGET AND ACTUAL PERFORMANCE  
FOR FISCAL YEAR 19\_\_, COMPANY A

	1st	Budget			Fiscal Year 1973
	Quarter Actual	1st Quarter	2nd Quarter	3rd Quarter	
<u>Photoglass</u>					
Sales					
Gross Profit Margin					
PPI 1% plus \$80,000					
internal transfer					
profits					
Relocation Allowance					
<u>Photomask</u>					
<u>Computer Artwork</u>					
Sales					
<u>Tooling</u>					
Sales					
<u>Prints</u>					
Sales					
<u>Hard Surface</u>					
Sales					
Total Photomask Sales					
Gross Profit Margin					
<u>Thin Film (Chrome Dept.)</u>					
Sales					
Gross Profit Margin					
Plus \$107,800 internal					
transfers at cost during					
year					
<u>Equipment &amp; Instruments Dept.</u>					
Sales					
Gross Profit Margin					
<u>Total Operations</u>					
Total Sales					
Total Gross Profit Margin					
DTC Publishing Expenditures					
Selling, General and					
Administrative Costs					
DTC Corporate Costs					
Profit Before Tax					
Profit After Tax (45%)					
Per Share Earnings					

FIGURE 2.

PROJECTED INCOME AND CASH FLOWS  
FOR FISCAL YEAR 19\_\_\_, COMPANY A

	<u>1st</u> <u>Quarter</u>	<u>2nd</u> <u>Quarter</u>	<u>3rd</u> <u>Quarter</u>	<u>4th</u> <u>Quarter</u>	<u>Total</u>
<u>INCOME</u>					
Sales					
Cost of Sales					
Gross Profit					
General, Administrative and Selling Expenses					
Operating Income					
Other Income					
Income Before Taxes					
Income Taxes					
NET INCOME					
<u>FUNDS FLOW</u>					
In: Income					
Depreciation					
Sale of Stock					
Out: New Equipment					
Increase of W.C.					
Inventory Increase					
Leasehold Improvements					
Debt Service					
NET IN-FLOW (OUT-FLOW)					



FIGURE 3.

CASH FLOWS STATEMENT FOR  
FISCAL YEAR 19\_\_\_, COMPANY A

<u>April</u>	<u>May</u>	<u>June</u>	<u>1st Quarter</u>	<u>July</u>	<u>August</u>	<u>Sept.</u>	<u>2nd Quarter</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>3rd Quarter</u>	<u>January</u>	<u>February</u>	<u>March</u>	<u>4th Quarter</u>	<u>Total</u>
--------------	------------	-------------	------------------------	-------------	---------------	--------------	------------------------	-------------	-------------	-------------	------------------------	----------------	-----------------	--------------	------------------------	--------------

SALESCASH RECEIPTSDISBURSEMENTS

Raw Materials  
Payroll  
Rent  
Expenses\*  
Taxes  
Equipment  
Long-Term Debt  
Leasehold  
Improvements

NET CASH FLOWMONTHLY PEAK BANK  
BORROWING

\*Includes General, Administrative and  
Selling Expenses for all companies  
net of Payroll, Taxes and Rent Expenses.

a month-by-month sales forecast for the next twelve months from the managers of each operating division. These are single-value estimates rather than range estimates or probability distributions. The division managers also submit projections of equipment needs and of inventory build-up. The assistant treasurer uses this information, plus data he himself generates on payroll, raw material purchases, and so on, to derive the operating budget. During the budgetary year, he prepares a comparison of the actual with the budgeted figures month by month, so that top management and divisional managers can all see how well the company is doing. The budgetary figures, however, are not changed once they have been prepared.

The "Projected Income and Cash Flows" document in Figure 2 is in essence a combination income statement and fund statement. The top half of the statement reproduces the data on income and expenditures from the operating budget: the difference is that here the figures are more aggregative, being for the company as a whole, with no divisional breakdown. The bottom half is the standard flow-of-funds document, which projects for the management

where it will obtain funds and where they will go.

Finally, the "Cash Flows Statement", Figure 3, is the standard cash budget giving receipts and disbursements month by month for the next twelve months. Although the "Operating Budget" and "Projected Income and Cash Flows" are not updated during the year, the company does update its "Cash Flows Statement" every three months. This necessitates the sales department's updating its sales forecasts every three months, since the volume of sales determines how much the firm can expect in the way of cash receipts.

The assistant treasurer was asked how he allows for uncertainties in preparing the cash budget, and replied that he keeps close watch on cash flows and knows how much the company should be receiving every day. He also knows how much their current borrowings are. If he sees that cash is not coming in, he calls his customers, watches the company's disbursements, and delays them out.

When asked how much cash he keeps on hand, he said, "A very small amount". He stated that when cash comes in, it is used to pay off bank loans. The company repays

the loans in weekly installments of \$50,000 or \$100,000. If they have \$20,000 or \$30,000 cash they do not try to invest it, but leave it in their bank account. Two or three months previous to the interview, the company had invested a good deal of excess cash in time securities.

#### Company B

Business. Company B emphasizes development of a line of products of high technological content. The company has for some years been principally engaged in the development, manufacture, and sale of commercial gas lasers, which represent the core of the product line of their laser products division. This division also produces electro-optical and mechanical devices used in conjunction with laser and electro-optical experimentation and applications, and, as an adjunct to this business, fabricates optical substrates and applies thin film coatings to precision optics. An engineering division designs and produces laser alignment systems for use in the construction industry, and precision ranging lasers used for geodetic and distance measurements. A third division produces electronic integrators for the automation of gas and liquid chromatographs used in chemical analysis.



The engineering division resulted from the company's 1970 acquisition of a firm engaged in production and sale of gas lasers for the construction industry.

The division producing electronic integrators was purchased from another corporation in 1971 for an undisclosed sum. A 1971 merger with a company manufacturing optical accessories for lasers and other high-technology optical devices added the electro-optics products and thin-film coating services to the company's laser products division.

The company's income is almost wholly derived from sales and services at fixed prices. It does not receive significant income from research and development contracts. In the fiscal year ended September 30, 1971, gas laser products accounted for approximately 53% of the company's sales. Optical products and thin-film coating services accounted for approximately 20%, construction and ranging laser systems for 27%. No one of the company's numerous domestic and foreign customers accounted for more than 2% of its overall revenues in the 1971 fiscal year. Sales to the United States government and government contractors amounted to less than 10% of the year's total.

Budgeting Procedure. The budgeting system in Company B is considerably more comprehensive than that of Company A. Not only does the system contain a greater number of basic budgeting documents, the planning horizon is longer (five years). The company uses detailed one-year budgets for controlling current operations and condensed five-year budgets for long-range planning. The one-year budgets are broken down month by month, whereas the five-year budget is broken down year by year.

The basic budgetary documents include the following:

- (1) Monthly Profit Plan (see Figure 4);
- (2) Five-Year Operating Forecast (Figure 5);
- (3) Monthly Cash Flow Projection (Figure 6);
- (4) Five-Year Capital-Expenditure Program (Figure 7).

Of these four documents, the most basic is the "Monthly Profit Plan", which, as the name indicates, is essentially a projected profit and loss statement, month by month for the coming year. Although the fiscal year of this company ends December 31st, the company controller receives the sales forecast (or sales sub-budget) from the marketing manager as early as October. With the assistance of the production manager, the controller derives

a production budget from the sales figures, making allowances for any planned change in the inventory.

From the production schedule, the controller derives the projected cost of goods sold month by month, which becomes the manufacturing sub-budget. The other expense and income classifications are also each supported by a sub-budget, usually prepared by the executive in charge (e.g. the marketing sub-budget by the marketing manager, the engineering sub-budget by the product engineer, and so on). The "Monthly Profit Plan" results from the integration of these sub-budgets by the controller.

Besides this annual profit plan, the company prepares a projection of the profit plan for the next five years. This is the "Five-Year Operating Forecast". The procedure is the same as above, with the difference already mentioned that whereas the annual plan is divided into months, the longer-range plan is figured by years. Also, some of the income and expense facts are lumped together in order to condense the statement. This five-year plan is updated every year. Naturally, the coming year's profit plan is always the first year of the five-year plan.



FIGURE 5.

FIVE-YEAR OPERATING FORECAST  
COMPANY B

	Year 1		Year 2		Year 3		Year 4		Year 5	
	Amt.	%	Amt.	%	Amt.	%	Amt.	%	Amt.	%
<u>Gross Sales</u>										
Less: Sales to Related Co.										
Gross Sales to Customers										
Less: Returns										
Freight										
Cash Discounts										
<u>Net Sales</u>										
Cost of Goods Sold										
Standard										
Less: Sales to Related Co.										
Cost of Sales										
<u>Gross Profit</u>										
Operating Expenses										
<u>Income from Operations</u>										
Other Income (Expense)										
<u>Income before Taxes</u>										
Federal & State Taxes										
<u>Net Income</u>										







The "Five-Year Capital-Expenditure Plan" is based on the long-range sales forecast and its implications for additional plant and equipment. Finally, the "Monthly Cash Flow Projection" is the standard statement of cash receipts and disbursements.

As in the case of Company A, the annual profit plan is used to gauge the operating efficiency of the various divisions submitting the sub-budgets. Once the profit plan is submitted and approved by top management, it is not changed. At the end of each month in the budgeting year the controller collates the actual income and expense figures with the budget figures, to tabulate comparisons for the month and for the year to date so that each budget center knows exactly how it is doing in relation to the original plan.

The only exception to this procedure is the cash budget: the controller does not prepare a comparison here, and no formal attempt is made to explain why the cash balance is higher or lower than expected. The reason given for this was that the information obtained would not be worth the cost, since a full-time man would be required for the task. This may be true. Perhaps another reason is that the cash

budget does not represent an operating center, whereas in marketing, production, and so forth, some one person can be held accountable for the performance of the division. Cash inflow and outflow largely represent a convergence of decisions made in other centers. Yet systematic comparisons of actual to projected cash flows might show how well or badly forecasts were being made, and indicate whether the deviations were inevitable or not.

The financial executive was asked how he allows for uncertainty in his forecasts, especially for the short-run (one-year) operating budget, and in particular whether the company makes any sensitivity tests to determine how the budget would change in response to sales' exceeding or falling below forecasts. The answer was that no sensitivity tests are used. Like Company A, the company uses only a single set of figures, not range estimates or probability distributions, in making its forecasts. The controller stated that the sales forecasts have been so reasonable that although there may be month-to-month error, the yearly forecasts have proved accurate enough that no probabilistic analysis is necessary. On further discussion it became clear that what he meant was that sales forecasts are

deliberately cautious, so that any error is usually on the conservative side. In fact, the error has been as high as ten percent in certain years.

The financial executive was also asked how he decides how much cash to keep on hand, and how he insures that the company has enough cash for unexpected needs. Again, the executive felt that this was not an important decision, because the company has always been able to meet cash payments. As it turned out, the company has always kept an excessively large amount of cash on hand. Its balance sheet shows that ten percent of its assets are in the form of cash and short-term marketable securities. This primarily reflects the philosophy of the management: the company is publicly owned, but dominated by several financially conservative individuals who happen to be on the management team. The company has invested surplus cash in government securities, but has no well-conceived plan for optimizing its short-term marketable securities portfolio.

#### Opportunities for Improvement

What possible improvements can we suggest in the budgeting system in general and in cash budgeting in particular for companies A and B? There are three:

(1) Although both companies are technology-oriented, neither company has computerized its budgeting process. Even in the larger company, the entire set of budgets is prepared manually, without computer assistance, by members of the controller's office. In fact, the controller of Company B confides that despite their starting as early as October, they have a race against time to get the entire set of reports ready by January. Also, as mentioned before, the budgets once prepared remain unchanged for the year.

The controller indicated that if the budget were computerized so that less time and effort were needed in its preparation, he would like to see quarterly or semi-annual updating of the operating budget, especially when there are changes in the fundamental assumptions underlying it. For example: the company produces several different lines of products, having different profit margins; if the product mix changes during the year so that there is a major shift from the assumptions used in preparing the original budget, the controller would like to see it revised. The first possible improvement, therefore, is to put the budget on the computer to reduce the time and effort that goes into preparing it.

(2) The second area of possible improvement is in allowance for uncertainties in the budgets. In both companies, the budgets are fixed, in that they are based on one set of numbers, with no attempt being made to show how the budget would be affected by changes in underlying conditions. In both A and B, the method used seems to be to allow for uncertainty by building a slack into the budgetary forecasts. That is, sales are forecast on a conservative basis so that if there is an error, it is likely to be in actual sales exceeding the budget, rather than the other way around; actual profit will be likely to exceed budgeted profit. This may be psychologically pleasing to the management, but such a budget could easily result in operating inefficiency, since understatement of sales leads to understatement of cash, accounts receivable, inventory, and plant and equipment needed to support the sales.

A much more desirable way of taking cognizance of uncertainty in sales is to forecast a probability distribution for sales and derive a separate set of budgets for each possible value of sales in the probability distribution.

If the budgets are manually prepared, this multiplication of budgets may not be feasible, but if the process is computerized, time and cost will both be minimized.

(3) There is still another advantage to computerization: once the budget is computerized, it is just as easy to test the sensitivity of the budget to changes in other variables as in sales. The other variables which a company may wish to test for sensitivity of budget include, e.g. change in accounts receivable, change in inventory policy, and the effect of short-run and long-run fluctuations in sales.

## II. A COMPUTERIZED CASH BUDGETING PROGRAM

This section will use a hypothetical company to illustrate how the cash budgeting procedure can be computerized.

### A Hypothetical Cash Budget<sup>1</sup>

Applied Science, Inc., is a medium-sized firm specializing in the manufacture of electronic talking dolls which deliver various messages. Because the dolls are especially appropriate for gifts, the sales of Applied Science tend to exhibit pronounced seasonal variations. The bulk of the company's revenue is derived from sales for special occasions such as Christmas, Halloween, Thanksgiving, Easter, and Valentine's Day. The company's sales, therefore, tend to be lowest in the second quarter and highest in the fourth quarter of each year. Table 1 presents the company's forecast of monthly sales for the next twelve months.

The company's business is reasonably profitable. On every dollar of sales, the firm pays fifty cents in production costs, with 25 cents going to labor, 12.5 cents to material, 6.25 cents to cash overhead, and 6.25 to depreciation.

1 Adapted from the presentation of Fancycraft, Inc., in my "Application of Linear Programming to Short-Term Financial Decisions", Engineering Economist, XIII (Summer 1968), pp. 221-241.



The firm also incurs fixed selling and administrative expenses of \$70 per month, and pays 62% of its before-tax profits into taxes and dividends.

Many factors determine the cash position of a firm: collection on receivables, cash sales, interest income on securities, payments for materials, labor, and overhead expenses, payments for taxes and dividends, and so on. Cash is converted into inventory which, in turn, becomes accounts receivable, finally to return again as cash. This circular flow is shown in Figure 8, where arrows indicate the direction of flow.

The sales forecast in Table 1 provides the basis for deriving the company's cash budget for the next twelve months (Table 2). For this budget, the following assumptions were made regarding payment schedules, terms of sales, rate of capital expenditure, and so on:

1. Applied Science, Inc., sells its products on terms of "net 90", meaning that the full amount of a bill is due in 90 days. January sales are collected in April, February sales in May.

2. The company maintains a production policy such that its end-of-month inventory is always equal to forecast sales for the next three months.
3. Labor and cash overhead are paid for in cash in the current month, while costs of materials are paid for on terms of "net 90".
4. Selling and administrative expenses are paid for in cash once every ninety days, in January, April, July, and October.
5. Dividends and taxes are paid in March, June, September, and December.
6. Sinking-fund payments of \$20 must be made in January and July.
7. The production department has two \$100 items of equipment on order, one to be delivered in January and the other in June.
8. On December 31, the company's balance sheet shows the following current assets and liabilities: cash,

CIRCULAR FLOW OF CASH

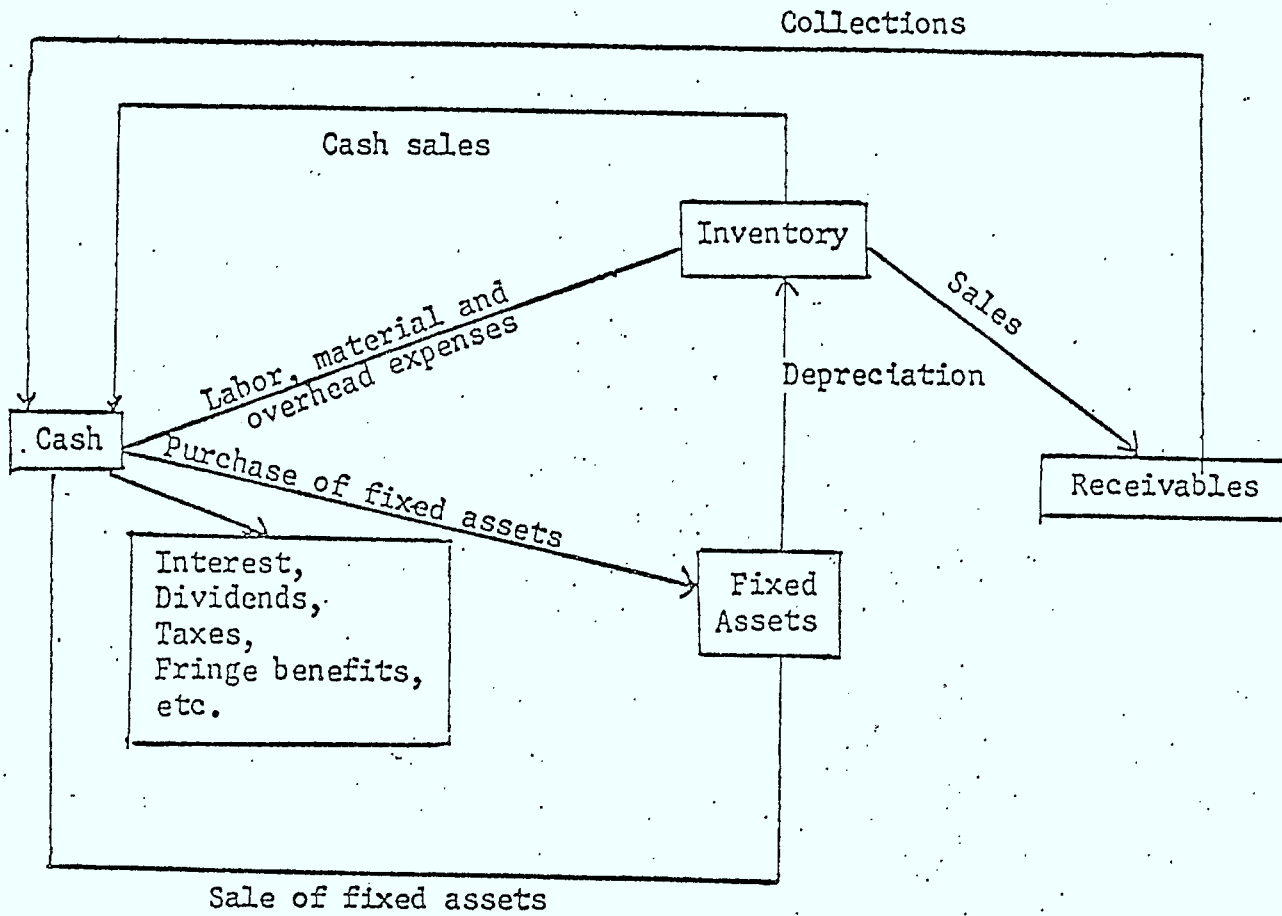


TABLE 1

TWELVE-MONTH SALES FORECAST FOR  
APPLIED SCIENCE, INC.

Month	Sales	Month	Sales
January	\$183	July	\$150
February	183	August	150
March	183	September	150
April	83	October	250
May	83	November	250
June	83	December	250

MANUALLY-DERIVED ONE-YEAR CASH BUDGET  
FOR APPLIED SCIENCE, INC.

Table 2.

Line	Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Receipts due to operations:												
1	Accounts receivable	200	200	200	183	183	183	83	83	83	150	150	150
	Disbursements due to operations:												
2	Payments for purchases of materials	23	23	23	10	10	10	18	18	18	31	31	31
3	Labor and cash overhead	25	25	25	47	47	47	78	78	78	57	57	57
4	Selling and administrative expenses	210			210			210			210		
5	Net cash flow due to operations	(58)	152	152	(84)	126	126	(223)	(13)	(13)	(148)	62	62
6	Change in minimum operating cash balance	28	0	(54)	54	0	(193)	193	0	(118)	118	0	(30)
	Other cash requirements:												
7	Dividends and taxes	0	0	(25)	0	0	(25)	0	0	(25)	0	0	(25)
8	Sinking fund	(20)	0	0	0	0	0	(20)	0	0	0	0	0
9	Purchase of plates	(100)	0	0	0	0	(100)	0	0	0	0	0	0
10	Total cash requirement for period (before interest payments and receipts)	(150)	152	73	(30)	126	(192)	(50)	(13)	(156)	(30)	62	7
11	Cumulative cash requirement (before interest payments and receipts)	(150)	2	75	45	171	(21)	(71)	(84)	(240)	(270)	(208)	(201)

## \* Key assumptions:

- (a) The company's production in any month is always equal to the forecast sales three months hence.  
 (b) The company has an initial cash balance of \$58 and follows a policy of maintaining its month-end cash balance equal to \$30 or the net drain during the following month, whichever is larger.  
 (c) Sales, made on terms of "net 90," equaled \$200 monthly during the final quarter of the preceding year.

\*\* In lines 5 to 11, bracketed figures denote cash requirements which need to be financed.

\$58; accounts receivable, \$600; inventories, \$300; accounts payable, \$69; accrued expenses, \$210.

9. The company maintains its month-end cash balance at \$30, or the net drain during the following month, whichever is larger.
10. Borrowing transactions and interest and principal repayments occur only at the beginning of each month.
11. During the last quarter of the preceding year, the company had monthly sales of \$200.

#### A Computerized Cash Budgeting Program

The cash budget in Table 2 was derived manually without the assistance of a computer. This section presents a computer program which will automate the procedure, thus saving a great deal of time and effort. The cash budget program given in Appendix A calculates and presents a cash budget based on forecast sales and expenditures during a one-year planning period. It also presents analogous cash budgets for cases where all sales are a certain

percentage above or below the forecasts.

### Definition of Variables

The budget in the computer program is calculated using the following definitions of variables:

FSALES(I) ... FSALES(1), FSALES (2), and FSALES(3) are the sales for the last three months of the previous year. FSALES (I +3) is the original forecast value of the sales in the  $i^{\text{th}}$  month of the coming year.

AFACT(J) ... the  $j^{\text{th}}$  percentage by which the values in FSALES are to be raised or lowered

SALES(I) ... the adjusted forecast sales; for the first budget presented SALES(I) is identical to FSALES(I); for the next,  

$$\text{SALES}(I) = \text{FSALES}(I) * (1.0 + \text{AFACT}(1) / 100.0);$$
for the next,  

$$\text{SALES}(I) = \text{FSALES}(I) * (1.0 - \text{AFACT}(1) / 100.0);$$
for the next,  

$$\text{SALES}(I) = \text{FSALES}(I) * (1.0 + \text{AFACT}(2) / 100.0);$$
and so on.



PRML ... the percentage of present sales which must be paid for materials now

PLCO ... the percentage of sales three months ahead which must be paid for labor and cash overhead now

SAE ... selling and administrative expenses

ASAE(I)... - selling and administrative expenses for the  $i^{\text{th}}$  month (equals SAE in the first month of each quarter, zero otherwise)

DVT ... dividends and taxes

ADV(T(I) ... dividends and taxes for the  $i^{\text{th}}$  month (equals DVT in the third month of each quarter, zero otherwise)

SKF ... sinking fund

ASKF(I)... sinking fund costs in the  $i^{\text{th}}$  month (equals SKF in January and July, zero otherwise)

PLT ... equipment items

APLT(I)... equipment costs in the  $i^{\text{th}}$  month (equals PLT in January and June, zero otherwise)

For each month, the computer calculates the following:

TSD(I) ... total surplus or deficit in the  $i^{\text{th}}$  month, i.e.,  $TSD(I) = SALES(I) - .01 * PRML * SALES(I+3)$

-.01\*PLCO\*SALES(I+6)-ASAE(I)-ADVT(I)

-ASKF(I)-APLT(I)

CSD(I) ... cumulative surplus or deficit for months  
up to and including the  $i^{\text{th}}$  month, i.e.,

$$CSD(I) = \sum_{J=1}^I TSD(J)$$

Input.

To implement the program, one should input data as follows:

CARD 1 Variables: FSALES(1), FSALES(2), ...FSALES(9)

Format: (2x,9F8.1)

CARD 2 Variables: FSALES(10), FSALES(11),...FSALES(18)

Format: (2x,9F8.1)

CARD 3 Variables: PRML, PLCO, SAE, DVT, SKF, PLT

Format: (2x,9F8.1)

CARD 4 Variables: AFACT(1), ...,AFACT(4)

Format: (2x,9F8.1)

For example :

10.	20.	30.	40.						CARD 4
12.5	31.25	210.0	25.0	20.0	100.0				CARD 3
150.0	150.0	150.0	250.0	250.0	250.0	183.0	183.0	183.0	CARD 2
200.0	200.0	200.0	183.0	183.0	183.0	83.0	83.0	83.0	CARD 1

### Output.

The basic block of output for this program is as shown in Table 3. Note that this budget differs from that given in Table 2 in that we have multiplied the sales forecast by a factor of 0.60. The row titled "Collection" contains the sales for the month three months before. This basic block of output is repeated for the cases where the original forecasts are multiplied by factors of  $(1 + \frac{AFACT(1)}{100})$ ,  $(1 - \frac{AFACT(1)}{100})$ , etc.

### III. SENSITIVITY ANALYSIS

As already pointed out, computerized budgeting enables a firm to prepare its budgets with only a fraction of

the time and effort needed to prepare the budgets manually. This saving in time and effort will enable the firm to experiment with different sets of assumptions in preparing their budgets. Such experimentation would otherwise be too costly. This section will show how the computerized cash budget of Applied Science, Inc., can be readily adapted to analysis of the cash flow impact of :

- (1) a change in accounts receivable policy;
- (2) a change in inventory policy; and
- (3) an upward trend in sales.

Section IV will demonstrate analysis of the impact of a business recession of uncertain intensity.

#### A New Accounts Receivable Policy

The cash budget of Applied Science shown in Table 2 is based on the assumption that the company sells its products on terms of net 90. Should the company contemplate changing its credit terms to net 30 at the beginning of the next year (Year 2), what would be the effect of this change on cash flows?

TABLE 3.

A COMPUTER-GENERATED CASH BUDGET  
FOR APPLIED SCIENCE, INC.

In this budget the original forecasts have been multiplied by a factor of 0.60

LINE	ITEM	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	COLLECTION	200.0	200.0	200.0	109.8	109.8	109.8						
2	MATERIALS	13.7	13.7	13.7	6.2	6.2	6.2						
3	LABOR & CASH OVERHEAD	15.6	15.6	15.6	28.1	28.1	28.1	49.8	49.8	49.8	90.0	90.0	90.0
4	SELLING & ADMINISTRATIVE EXPENSES	210.0	0.0	0.0	210.0	0.0	0.0	11.3	11.3	11.3	18.8	18.8	18.8
5	DIVIDENDS & TAXES	0.0	0.0	25.0	0.0	0.0	25.0	46.9	46.9	46.9	34.3	34.3	34.3
6	SINKING FUND	20.0	0.0	0.0	0.0	0.0	0.0	210.0	0.0	0.0	210.0	0.0	0.0
7	PLATES	100.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	25.0	0.0	0.0	25.0
								20.0	0.0	0.0	0.0	0.0	0.0
								0.0	0.0	0.0	0.0	0.0	0.0
8	TOTAL SURPLUS	-159.3	170.7	145.7	-134.6	75.4	-49.6						
9	CUMULATIVE SURPLUS	-159.3	11.4	157.1	22.6	98.0	48.5	-238.3	-8.3	-33.3	-173.1	36.9	11.9
								-189.8	-198.2	-231.5	-404.6	-367.6	-355.7

SALES FOR THE LAST THREE MONTHS OF THE YEAR WERE TAKEN TO BE 150.0 150.0 150.0  
 SALES FOR THE FIRST THREE MONTHS OF THE FOLLOWING YEAR WERE TAKEN TO BE 109.8 109.8

PAYMENT FOR MATERIALS IS 12.5 PERCENT OF PRESENT SALES  
 LABOR AND CASH OVERHEAD IS 31.3 PERCENT OF SALES THREE MONTHS AHEAD

09.8

To simplify the analysis, let us suppose that the change is industry-wide, so that the effect on sales will be minimal and may be neglected. The following schematic presentation (Table 4) gives a visual indication of the impact on cash flow of a shift from net 90 to net 30 occurring on January 1, Year 2.

The annual sales in each of the three years equal \$1998. The collection in Year 1 is also \$1998, since we assume that the change in credit terms does not occur until the beginning of Year 2. The change will not affect collections from sales in Year 1, so in Year 2 the company will receive \$250 per month in January, February, and March from sales in October, November, and December of Year 1.

The net-30-day policy will speed up collections on sales made in Year 2 and thereafter: sales of \$183 in January, February, and March will be collected in February, March, and April respectively, sales of \$83 per month in April, May, and June will be collected in May, June, and July, and so on. The result will be that in Year 2, the transition year, the company will collect fourteen months'

worth of sales (\$2498). The shift in credit policy from net 90 to net 30 will therefore create a once-for-all bulge in collections. After the transition effect has been felt, the collections will return to the \$1998 level, and will remain at that level unless sales change or the company shifts its credit terms again.

Table 5 shows the output from our computerized cash budget program for Year 2 with incorporation of the new net-30-days credit terms. To make the example more realistic, we have included the following assumptions:

- (1) that the company gives a cash discount of 1.5% if the customer pays on or before the expiration of thirty days from the date of the invoice;
- (2) that sixty percent of the customers take the discount, and the other forty percent pay at the end of ninety days.

#### A New Inventory Policy

The cash budget of Applied Science in Table 2 is based on the assumption that the company produces each month



TABLE 4.

IMPACT ON CASH FLOW OF A SHIFT IN  
CREDIT TERMS FROM NET 90 TO NET 30

Collections on Accounts Receivable

	Year 1											
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Net 90	250	250	250	183	183	183	83	83	83	150	150	150
	Year 2											
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Net 30 Starting Jan 1, Year 2	250	250	250									
		183	183	183	83	83	83	150	150	150	250	250
	Year 3											
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Net 30 Starting Jan 1, Year 2	250	183	183	183	83	83	83	150	150	150	250	250

what it expects to sell three months hence. This schedule of production may not be the optimal, because while it minimizes the level of physical inventory which the company has to carry, it increases the frequency of start-up. A theory of optimal production scheduling is not within the scope of this paper: let us merely suppose that the company chooses to produce every other month, each month producing two months' expected sales. To be specific, the firm will produce in January for March and April, in March for May and June, and so on. Everything else will remain the same as in the original model: material costs equal 12.5% of production, payable in ninety days; labor and cash overhead equal 31.25% of production, payable in the same month; production sales are made on terms of net 90 days, and sinking funds, dividends and taxes, and selling and administrative expenses also remain the same. The question, then, is how will the new production schedule and the resulting change in inventory-level policy affect the cash flows of the company?

TABLE 5.

A COMPUTER-GENERATED CASH BUDGET INCORPORATING  
A CHANGE IN CREDIT TERMS FROM NET 90 TO NET 30

		DATA FOR YEAR 1											
LINE	ITXM	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	COLLECTION	250.0	358.2	358.2	181.4	122.3							
2	MATERIALS	22.9	22.9	22.9	10.4	10.4							
3	LABOR AND CASH OVERHEAD	25.9	25.9	25.9	46.9	46.9	122.3	82.3	121.8	121.8	148.6	207.7	207.7
4	SELLING AND ADMINISTRATIVE EXPENSES	210.0	0.0	0.0	210.0	0.0	10.4	18.8	18.8	18.8	31.3	31.3	31.3
5	DIVIDENDS AND TAXES	0.0	0.0	22.2	0.0	0.0	46.9	78.1	78.1	78.1	57.2	57.2	57.2
6	SINKING FUND	20.0	0.0	0.0	0.0	0.0	0.0	210.0	0.0	0.0	210.0	0.0	0.0
7	PLATES	100.0	0.0	0.0	0.0	0.0	22.2	0.0	0.0	22.2	0.0	0.0	22.2
8	TOTAL SURPLUS	-128.8	309.3	287.1	-85.9	65.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
9	CUMULATIVE SURPLUS	-128.8	180.5	467.7	381.8	446.8	-57.2	-244.6	25.0	2.8	-149.8	119.3	97.1
10	INVENTORY CHANGE	-100.0	-100.0	-100.0	67.0	67.0	389.6	144.9	169.9	172.7	22.9	142.2	239.3
11	CUMULATIVE INVENTORY CHANGE	-100.0	-200.0	-300.0	-233.0	-166.0							
12	AVERAGE INVENTORY CHANGE	0.0					67.0	100.0	100.0	100.0	-67.0	-67.0	-67.0
							-99.0	1.0	101.0	201.0	134.0	67.0	0.0
13	RECEIVABLES CHANGE	0.0	108.2	108.2	-1.6	-60.7							
14	CUMULATIVE RECEIVABLES CHANGE	0.0	108.2	216.3	214.7	153.9							
15	AVERAGE RECEIVABLES CHANGE	23.7					-60.7	-0.7	38.8	38.8	-1.4	57.7	57.7
							93.2	92.4	131.3	170.1	168.8	226.5	284.3
16	ACCOUNTS PAYABLE CHANGE	-12.5	-12.5	-12.5	8.4	8.4							
17	CUMULATIVE PAYABLE CHANGE	-12.5	-25.0	-37.5	-29.1	-20.8							
18	AVERAGE ACCOUNTS PAYABLE	0.0					8.4	12.5	12.5	12.5	-8.4	-8.4	-8.4
							-12.4	0.1	12.6	25.1	16.8	8.4	0.0

TABLE 5 cont.

		DATA FOR YEAR 2											
LINE	ITEM	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	COLLECTION	247.7	208.2	208.2	181.4	122.3							
2	MATERIALS	22.9	22.9	22.9	10.4	10.4	122.3	82.3	121.8	121.8	148.6	207.7	207.7
3	LABOR & CASH OVERHEAD	25.9	25.9	25.9	46.9	46.9	10.4	18.8	18.8	18.8	31.3	31.3	31.3
4	SELLING & ADMINISTRATIVE EXPENSES	210.0	0.0	0.0	210.0	0.0	46.9	78.1	78.1	78.1	57.2	57.2	57.2
5	DIVIDENDS AND TAXES	0.0	0.0	22.2	0.0	0.0	0.0	210.0	0.0	0.0	210.0	0.0	0.0
6	SINKING FUND	20.0	0.0	0.0	0.0	0.0	22.2	0.0	0.0	22.2	0.0	0.0	22.2
7	PLATES	100.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0
8	TOTAL SURPLUS	-131.1	-159.3	137.1	-85.9	65.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
9	CUMULATIVE SURPLUS	-131.1	28.3	165.4	79.5	144.5	-57.2	-244.6	25.0	2.8	-149.8	119.3	97.1
10	INVENTORY CHANGE	-100.0	-100.0	-100.0	67.0	67.0	87.3	-157.3	-132.3	-129.6	-279.4	-160.1	-62.9
11	CUMULATIVE INVENTORY CHANGE	-100.0	-200.0	-300.0	-233.0	-166.0	67.0	100.0	100.0	100.0	-67.0	-67.0	-67.0
							-99.0	1.0	101.0	201.0	134.0	67.0	0.0
12	AVERAGE INVENTORY CHANGE	0.0											
13	RECEIVABLES CHANGE	-2.3	-41.8	-41.8	-1.6	-60.7							
14	CUMULATIVE RECEIVABLES CHANGE	-2.3	-44.1	-85.9	-87.6	-148.3	-60.7	-0.7	38.8	38.8	-1.4	57.7	57.7
15	AVERAGE RECEIVABLES CHANGE	-1.5					-209.1	-209.8	-171.0	-132.1	-133.5	-75.7	-18.0
16	ACCOUNTS PAYABLE CHANGE	-12.5	-12.5	-12.5	8.4	8.4							
17	CUMULATIVE ACCOUNTS PAYABLE CHANGE	-12.5	-25.0	-37.5	-29.1	-20.8	8.4	12.5	12.5	12.5	-8.4	-8.4	-8.4
18	AVERAGE ACCOUNTS PAYABLE CHANGE	0.0					-12.4	0.1	12.6	25.1	16.8	8.4	0.0
	SALES FOR THE LAST THREE MONTHS OF THE YEAR WERE TAKEN TO BE				250.0	250.0							
	SALES FOR THE FIRST THREE MONTHS OF THE FOLLOWING YEAR WERE TAKEN TO BE					183.0							
	PAYMENT FOR MATERIALS IS 12.5 PERCENT OF PRODUCTION						250.0						
	LABOR AND CASH OVERHEAD IS 31.3 PERCENT OF PRODUCTION						183.0	183.0					

The output of the computerized cash budget in Table 6 provides the answer to this question. Several salient aspects of this budget need pointing out:

- (1) The cumulative cash surplus remains at \$200 for the year, as before. This is as it should be, because we are changing only the production schedule, not the level of sales or production. The firm collects the same amount of cash for sales, incurring the same aggregate cash expenditures for labor and materials.
  
- (2) The only change is in the timing of the cash expenditures. Under the new policy, outlays in the month of production will be larger than before because the firm will be producing two months' supply. During these months, therefore, the net cash flow will be more negative or less positive than otherwise. During the month of no production, there will be less outlay; consequently the net cash flow will be more positive or less negative.

Scheduling production once every two months is, of course, only one possibility. The firm may schedule it once every three months or every four months. The impact on cash flow in these cases will follow the same pattern. Total cumulative cash flow for the year will not be affected, but within the year there will be greater fluctuations in cash balance due to bunching of payments. Also, as productions are bunched, the firm will be carrying a higher average level of inventory during the year. The computer program is written in such a way as to bring this out explicitly.

#### An Upward Trend in Sales

Many firms have found that as their sales rise, their cash position deteriorates, at least in the short run. The reason for this is that rising sales, if made on credit, will result in an increase in collections only after a time lag; while as sales climb, the firm must carry larger inventory and

TABLE 6.

A COMPUTER-GENERATED CASH BUDGET  
FOR A CHANGE IN INVENTORY POLICY

LINE	ITEM	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	COLLECTION	200.0	200.0	200.0	183.0	183.0							
2	MATERIALS	0.0	45.8	0.0	33.3	0.0							
3	LABOR & CASH OVERHEAD	83.1	0.0	51.9	0.0	93.8	183.0	83.0	83.0	83.0	150.0	150.0	150.0
4	SELLING & ADMINISTRATIVE EXPENSES	210.0	0.0	0.0	210.0	0.0	20.8	0.0	37.5	0.0	50.0	0.0	62.5
5	DIVIDENDS AND TAXES	0.0	0.0	25.0	0.0	0.0	0.0	125.0	0.0	156.3	0.0	114.4	0.0
6	SINKING FUND	20.0	0.0	0.0	0.0	0.0	0.0	210.0	0.0	0.0	210.0	0.0	0.0
7	PLATES	100.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	25.0	0.0	0.0	25.0
8	TOTAL SURPLUS	-213.1	154.3	123.1	-60.3	89.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0
9	CUMULATIVE SURPLUS	-213.1	-58.9	64.2	4.0	93.2	37.2	-272.0	45.5	-98.3	-110.0	35.6	62.5
10	INVENTORY CHANGE	83.0	-183.0	-17.0	-83.0	217.0	130.4	-141.6	-96.1	-194.4	-304.4	-268.8	-206.3
11	CUMULATIVE INVENTORY CHANGE	83.0	-100.0	-117.0	-200.0	17.0	-83.0	250.0	-150.0	350.0	-250.0	116.0	-250.0
12	AVERAGE INVENTORY CHANGE	10.0					-66.0	184.0	34.0	384.0	134.0	250.0	0.0
13	RECEIVABLES CHANGE	-17.0	-17.0	-17.0	-100.0	-100.0							
14	CUMULATIVE RECEIVABLES CHANGE	-17.0	-34.0	-51.0	-151.0	-251.0	-100.0	67.0	67.0	67.0	100.0	100.0	100.0
15	AVERAGE RECEIVABLES CHANGE	12.5					-351.0	-284.0	-217.0	-150.0	-50.0	50.0	150.0
16	ACCOUNTS PAYABLE CHANGE	33.3	-45.8	20.8	-33.3	37.5							
17	CUMULATIVE ACCOUNTS PAYABLE CHANGE	33.3	-12.5	8.3	-25.0	12.5							
18	AVERAGE ACCOUNTS PAYABLE CHANGE	0.0					-20.8	50.0	-37.5	62.5	-50.0	45.8	-62.5
							-8.3	41.8	4.3	66.8	16.8	62.5	0.0

SALES FOR THE LAST THREE MONTHS OF THE YEAR WERE TAKEN TO BE 250.0 250.0  
 SALES FOR THE FIRST THREE MONTHS OF THE FOLLOWING YEAR WERE TAKEN TO BE 183.0  
 PAYMENT FOR MATERIALS IS 12.5 PERCENT OF PRODUCTION 250.0  
 LABOR AND CASH OVERHEAD IS 31.3 PERCENT OF PRODUCTION 183.0 183.0

extend more credit. Liquidity will be reduced even more if, in order to meet its expanding sales, the company must expand its productive capacity.

The output of the computerized cash budget in Table 7 provides an explanation of the relation between expanding sales and decreasing liquidity described above. The company is now assumed to have in Year 1 sales of \$1800, divided equally among the twelve months. Starting in Year 2, sales rise to an even annual rate of \$2400 (i.e. \$200 per month). Labor and cash overhead and material costs remain the same percentage of production costs as before, but material costs are now assumed to be payable, like labor and cash overhead, in cash at the time of purchase. Tax and dividends are now 60% of taxable income. The company spends \$120 on replacement every year, but as sales climb to \$200 per month, it must also spend \$200 yearly in Years 2 and 3 for expanding its physical facilities. As sales rise in Years 2 and 3 the company's cash position will actually deteriorate, for the reasons mentioned above.



TABLE 7.

A COMPUTER-GENERATED CASH BUDGET  
FOR AN UPWARD TREND IN SALES

		YEAR 1												
SALES	COLLECTIONS	LABOR	MATERIAL	TAX	SELLING AND ADMINISTRATIVE EXPENSES	CAPITAL EXPENDITURES	CASH FLOW	ΔINVENTORY	Σ(ΔINVENTORY)	ΔRECEIVABLES	Σ(ΔRECEIVABLES)	ΔACCOUNTS PAYABLE	Σ(ΔACCOUNTS PAYABLE)	
1	150.00	150.00	46.88	18.75	3.00	70.00	320.00							
2	150.00	150.00	46.88	18.75	3.00	70.00	0.00	-308.63	0.00	0.00	0.00	0.00	0.00	
3	150.00	150.00	46.88	18.75	3.00	70.00	0.00	11.38	0.00	0.00	0.00	0.00	0.00	
4	150.00	150.00	46.88	18.75	3.00	70.00	0.00	11.38	0.00	0.00	0.00	0.00	0.00	
5	150.00	150.00	46.88	18.75	3.00	70.00	0.00	11.38	0.00	0.00	0.00	0.00	0.00	
6	150.00	150.00	46.88	18.75	3.00	70.00	0.00	11.38	0.00	0.00	0.00	0.00	0.00	
7	150.00	150.00	46.88	18.75	3.00	70.00	0.00	11.38	0.00	0.00	0.00	0.00	0.00	
8	150.00	150.00	46.88	18.75	3.00	70.00	0.00	11.38	0.00	0.00	0.00	0.00	0.00	
9	150.00	150.00	46.88	18.75	3.00	70.00	0.00	11.38	0.00	0.00	0.00	0.00	0.00	
10	150.00	150.00	46.88	18.75	3.00	70.00	0.00	11.38	0.00	0.00	0.00	0.00	0.00	
11	150.00	150.00	46.88	18.75	3.00	70.00	0.00	11.38	0.00	0.00	0.00	0.00	0.00	
12	150.00	150.00	46.88	18.75	3.00	70.00	0.00	11.38	0.00	0.00	0.00	0.00	0.00	
							AVERAGE VALUES	11.38	0.00	0.00	0.00	0.00	0.00	
		YEAR 2												
13	200.00	150.00	62.50	25.00	18.00	70.00	320.00							
14	200.00	150.00	62.50	25.00	18.00	70.00	0.00	-345.50	0.00	0.00	50.00	50.00	0.00	
15	200.00	150.00	62.50	25.00	18.00	70.00	0.00	-25.50	0.00	0.00	50.00	100.00	0.00	
16	200.00	200.00	62.50	25.00	18.00	70.00	0.00	-25.50	0.00	0.00	50.00	150.00	0.00	
17	200.00	200.00	62.50	25.00	18.00	70.00	0.00	24.50	0.00	0.00	0.00	150.00	0.00	
18	200.00	200.00	62.50	25.00	18.00	70.00	0.00	24.50	0.00	0.00	0.00	150.00	0.00	
19	200.00	200.00	62.50	25.00	18.00	70.00	0.00	24.50	0.00	0.00	0.00	150.00	0.00	
20	200.00	200.00	62.50	25.00	18.00	70.00	0.00	24.50	0.00	0.00	0.00	150.00	0.00	
21	200.00	200.00	62.50	25.00	18.00	70.00	0.00	24.50	0.00	0.00	0.00	150.00	0.00	
22	200.00	200.00	62.50	25.00	18.00	70.00	0.00	24.50	0.00	0.00	0.00	150.00	0.00	
23	200.00	200.00	62.50	25.00	18.00	70.00	0.00	24.50	0.00	0.00	0.00	150.00	0.00	
24	200.00	200.00	62.50	25.00	18.00	70.00	0.00	24.50	0.00	0.00	0.00	150.00	0.00	
							AVERAGE VALUES	24.50	0.00	0.00	0.00	150.00	0.00	
									0.00		12.50		0.00	



#### IV. SIMULATING A BUSINESS RECESSION

This section presents an example of the use of computer simulation to determine a firm's risk of cash insolvency during a recession. "Simulation" means simply experimentation on a mathematical model of the decision-making situation performed in order to evaluate the merits of alternative financial decisions. The mathematical model for this experiment consists of an equation which computes the net effect which a recession might have on a firm's cash inflows and outflows. We shall apply the equation to a simple example and show how the same analytical results can also be obtained through simulation on a computer.

##### The Model

The model used below to determine a firm's risk of cash insolvency in the event of a recession

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was initially constructed by Gordon Donaldson. A recession has the effect of causing sales to decline and the average collection period on receivables to rise. Both these changes are of uncertain dimension, but the management is assumed to be able to specify the distribution of their probabilities during the recession. It is also recognized that not all cash outflows are of equal priority for maintaining a firm's solvency. For example, if a firm is short on cash, it can easily postpone dividend payments, major capital expenditures, and so on without risking or precipitating insolvency. In predicting a firm's solvency position, these are discretionary cash expenditures.

2 The discussion in this section is based in part on Gordon Donaldson, Corporate Debt Capacity (Boston: Harvard Business School, 1961), Appendix B, pp.274-284; James C.T. Mao, Quantitative Analysis of Financial Decisions, (London: Collier MacMillan Ltd., 1969), chs. 11 & 14; James C.T. Mao, "Essentials of Computer Simulation", Financial Executive, XXXV(October 1967) pp. 55-62.

There are, however, other types of cash expenditures which must be made if the firm is to remain in business. These mandatory cash expenditures would include such items as interest payments, taxes, and manufacturing, selling and administrative expenses needed to maintain sales. Since our concern is with the risk of insolvency, only the mandatory cash outlays are considered in the following equation for calculating the firm's cash balance at the end of a recession; all receipts are of course considered.

$K_1$  represents the firm's cash balance at the end of the recession. Assuming that all of the firm's maturing debt can be successfully refunded at maturity,  $K_1$  is given by the expression:

$$\tilde{K}_1 = K_0 + \tilde{C} - (\tilde{V} + F + I + \tilde{T})$$

Ending Balance	Beginning Balance	Inflow	Outflow
-------------------	----------------------	--------	---------

where :

$K_0$  stands for the cash balance at the onset of the recession,  $C$  for collections on accounts receivable

3  
 during the recession,  $V$  for total variable cash expenses (excluding taxes) during the recession,  $F$  for total fixed cash expenses (excluding interest),  $I$  for total interest payment, and  $T$  for total tax payments. Since sales volume is a random variable, so are  $C$ ,  $V$ ,  $T$  and  $K_1$ : the  $\sim$  indicates random variables as distinguished from constants.

If the probability distribution of the recession sales and collection period are known, we can calculate the probability that the firm's final cash balance  $K_1$  will be negative. This probability will be designated as the firm's risk of cash insolvency.

$$3 \quad C = S_0 \times m + S_1 [n - m - \Delta m]$$

where  $S_0$  = pre-recession daily sales

$S_1$  = daily sales during the recession

$n$  = length of recession in days

$m$  = pre-recession average collection period,  
measured in days

$\Delta m$  = increase in average collection period  
during the recession, measured in days

Analytical Solution 4

To demonstrate use of the model as a basis of simulation, a simple numerical example will be used. We assume that the firm has an initial cash balance of \$26, daily fixed cash expenses of 40¢, daily fixed non-cash expenses of 4.17¢, normal daily sales of \$1, a normal collection period of thirty days, and a ratio of .3 between variable cash expenses and sales. The probabilities that in a recession daily sales will equal 80¢, 70¢, 60¢, and 50¢ are .1, .4, .4, and .1 respectively. The probabilities are .5, .2, .2, and .1 that the average collection period will lengthen by 10, 20, 30, and 40 days respectively if daily sales in the recession are 80¢; for daily sales of 70¢ the corresponding probabilities are .4, .3, .2, and .1; for daily sales of 60¢, .1, .2, .3, and .4; for daily sales of 50¢, .1, .2, .2, and .5. The firm is further assumed to have a debt of \$197 in its capital structure, with interest payable at 8.88% per year; tax on net

4 Based on Mao, Quantative Analysis of Business Decisions, pp. 452-456.

corporate income is given as 50%. Given this data, what is the probability that the firm will become insolvent if hit by a recession of 360 days?

To answer this question, we first form the joint probability distribution of recession sales and recession collection period (Table 8). The probabilities in this table are obtained by multiplying the probability of a given sales by the conditional probability of a given collection period. Thus, during the recession, there is a probability of .1 that sales will equal 80¢. Given sales of 80¢, the conditional probability is .5 that the collection period will lengthen by ten days. We assume for simplicity that the two events are statistically independent, so that the probability of their joint occurrence is the product of their individual probabilities: in this case,  $.1 \times .5$ , or simply .05. For this sales level and collection period, the company will have a cash balance at the end of the recession of \$51.55, calculated as follows :



TABLE 8.

JOINT PROBABILITY DISTRIBUTION OF RECESSION  
SALES AND RECESSION COLLECTION PERIOD

INCREASE IN COLLECTION PERIOD  SALES					
	10 DAYS	20 DAYS	30 DAYS	40 DAYS	TOTAL
80¢	.05	.02	.02	.01	.10
70¢	.16	.12	.08	.04	.40
60¢	.04	.08	.12	.16	.40
50¢	.01	.02	.02	.05	.10
Total	.26	.24	.24	.26	1.00

$$\begin{aligned}
K_1 &= \$26 && \text{(beginning cash balance)} \\
&+ \$1 \times 30 && \text{(collection on pre-recession sales)} \\
&+ \$0.80 \times (360-40) && \text{(collection on post-recession sales)} \\
&- \$0.80 \times 360 \times .3 && \text{(variable cash expenses)} \\
&- \$0.40 \times 360 && \text{(fixed cash expenses)} \\
&- \$197 \times .08881 && \text{(interest expense)} \\
&- .5 \times [\$ .8 \times 360 \times .7 - (\$0.40 \times 360 + \$0.0417 \times 360 \\
&\quad + \$17.50) ] && \text{(income tax)} \\
&= \$51.55 && \text{(ending cash balance)}
\end{aligned}$$

In Table 9, this value of  $K_1$  is shown along with sales of 80¢ and a corresponding lengthening in the collection period of ten days, with an associated probability of .05. The other sets of values in the table are calculated in a similar way. Thus, there is a probability of .02 that recession sales will be 80¢ per day and the average collection period lengthen by twenty days, with a resulting ending cash balance of \$43.55, and so on. The table shows three possibilities when the ending cash balance falls below zero: when recession sales drop to 50¢ per day and the collection period lengthens by twenty, by thirty and by forty days respectively. These possibilities occur with a total probability of .09 (= .02+.02+.05),

TABLE 9.

PROBABILITY DISTRIBUTION OF CASH  
BALANCE AT END OF RECESSION ( $K_1$ )

$K_1$ (\$)	SALES AND COLLECTION PERIOD		PROBABILITY OF EVENT
	$s_1$ (cents)	$\Delta m_1$ (days)	
51.55	80	10	.05
43.55	80	20	.02
35.55	80	30	.02
27.55	80	40	.01
42.90	70	10	.16
35.90	70	20	.12
28.90	70	30	.08
21.90	70	40	.04
21.70	60	10	.04
15.70	60	20	.08
9.70	60	30	.12
3.70	60	40	.16
0.50	50	10	.01
-4.50	50	20	.02
-9.50	50	30	.02
-14.50	50	40	.05

which is by definition the firm's risk of cash insolvency if it is hit by a recession lasting 360 days.

#### Computer Simulation

The first step in starting the simulation is to generate random observations on the level of recession sales in accordance with the probability distribution given in Table 8. This is done by generating random decimals and attaching to them the following meanings: any random number between 0 and .10 represents daily sales of eighty cents; any random number between .11 and .50 represents daily sales of seventy cents; numbers between .51 and .90 represent daily sales of sixty cents; between .91 and 1.00, fifty cents. Once the sales level is noted, random observations on the increase in the collection period in accordance with previously assigned probabilities must be generated. This is done by once again generating random numbers, and assigning to them appropriate meanings.

Using the formula given, which corresponds to any set of observed values for sales and collection period, we can now compute the firm's final cash balance,  $K_1$ . Running this experiment repeatedly will give us a probability distribution for  $K_1$ . The percentage of times that the value of  $K_1$  is less than zero will show the firm's risk of insolvency. Results for this experimental case indicate that should the firm be hit now by a recession of 360 days, the probability that the firm will become insolvent will be approximately .09.

The computer can also be used to test the sensitivity of the insolvency risk to other factors such as changes in the length of the recession, the size of the initial cash balance or initial debt, and the ratio of cash variable expenses to sales. The computer program for the simulation experiment is given in Appendix B.

## APPENDIX A

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DIMENSION FSALES(18),SALES(18),RML(12),ALCC(12),ASAE(12),ACVT(12),  
 1 ASKF(12),APLT(12),TSD(12),CSC(12),AFACI(4),ADJUST(9)

30 READ (5,30) (FSALES(I),I=1,18)

FORMAT (2X,9F8.1)

READ (5,30) PRML,PLCC,SAE,DVT,SKF,PLT

READ (5,30) (AFACI(I),I=1,4)

M=1

ADJUST(1)=1.0

DO 1 I=1,4

IF (ABS(AFACI(I)).LT..001) GO TO 1

ADJUST(M+1)=1.0+AFACI(I)/100.0

ADJUST(M+1)=1.0-AFACI(I)/100.0

M=M+2

1 SALES(I)=FSALES(I)

DO 8 K=1,M

DO 2 I=4,18

2 SALES(I)=FSALES(I)\*ADJUST(K)

WRITE(6,40)

40 FORMAT (55X,'CASH BUDGET'//)

IF (K.GT.1) WRITE (6,41) ADJUST(K)

41 FORMAT (30X,'IN THIS BUDGET THE ORIGINAL FORECASTS HAVE BEEN ',

1 'MULTIPLIED BY A FACTOR OF ',F5.2//)

WRITE (6,42)

42 FORMAT (2X,'LINE',4X,'ITEM',13X,'JAN FEB MAR APR MAY',

1 ' JUNE JULY AUG SEPT OCT NOV DEC'//)

WRITE (6,44) (SALES(I),I=1,12)

44 FORMAT (4X,'1 COLLECTION',7X,12F7.1 )

DO 3 I=1,12

3 RML(I)=.01\*PRML\*SALES(I+3)

WRITE (6,46) (RML(I),I=1,12)

46 FORMAT (4X,'2 MATERIALS',8X,12F7.1 )

DO 4 I=1,12

4 ALCC(I)=.01\*PLCC\*SALES(I+6)

WRITE (6,47) (ALCC(I),I=1,12)

47 FORMAT (4X,'3 LABOR & CASH QVHD',12F7.1 )

DO 5 I=1,12

ASAE(I)=C.C

ACVT(I)=C.C

ASKF(I)=0.0

5 APLT(I)=C.C

DO 6 I=1,4

J=3\*I-2

ASAE(J)=SAE

J=3\*I

6 ACVT(J)=DVT

ASKF(I)=SKF

ASKF(7)=SKF

APLT(I)=PLT

APLT(6)=PLT

WRITE (6,48) (ASAE(I),I=1,12)

```

48  FORMAT (4X,'4  SELLING & ADM EXP',12F7.1  )
    WRITE (6,49) (ACVT(I),I=1,12)
49  FORMAT (4X,'5  DIV & TAXES',6X,12F7.1  )
    WRITE (6,50) (ASKF(I),I=1,12)
50  FORMAT (4X,'6  SINKING FUND',5X,12F7.1  )
    WRITE (6,51) (APLT(I),I=1,12)
51  FORMAT (4X,' PLATES ',10X,12F7.1//)
    SLM=C.0
    DO 7 I=1,12
    TSD(I) = SALES(I)-RML(I)-ALCG(I)-ASAE(I)-ADVT(I)-ASKF(I)-APLT(I)
    SLM=SLM+TSD(I)
7   CSD(I)=SLM
    WRITE (6,52) (TSD(I),I=1,12)
52  FORMAT (3X,' 8  TOTAL SURPLUS          ',12F7.1//)
    WRITE (6,53) (CSD(I),I=1,12)
53  FORMAT (3X,' 9  CUM SURPLUS           ',12F7.1//)
    WRITE (6,54) (SALES(I),I=13,15)
54  FORMAT (2X,'SALES FOR THE LAST THREE MONTHS OF THE ',
1   ' YEAR WERE TAKEN TO BE ',3F7.1)
    WRITE (6,55) (SALES(I),I=16,18)
55  FORMAT (2X,'SALES FOR THE FIRST THREE MONTHS OF THE FOLLOWING ',
1   ' YEAR WERE TAKEN TO BE ',3F7.1)
    WRITE (6,56) PRML
56  FORMAT (2X,'PAYMENT FOR MATERIALS IS ',F5.1,' PER CENT OF ',
1   ' PRESENT SALES')
8   WRITE (6,57) PLCO
57  FORMAT (2X,'LABOR AND CASH OVERHEAD IS ',F5.1,' PER CENT OF ',
1   ' SALES THREE MONTHS AHEAD'////)
    STOP
    END

```

## APPENDIX B

```

INTEGER P
REAL N,I,K
DIMENSION N(3),E(3),X(17)
-----
5  READ(5,5)XN,XB,XD
   FORMAT(4F20.5)
   WRITE(5,10)XN,XB,XD
-----
10  FORMAT(3X,'N = ',F9.2,5X,'B = ',F9.2,5X,'C = ',F9.2//)
   WRITE(6,15)
-----
15  FORMAT(1X,'CONDITIONAL PROBABILITIES: '//)
   DO 30 JX=1,4
   JX1=(JX*4)-3
   JX2=JX1+3
-----
20  READ(5,5) (X(I1),I1=JX1,JX2)
   WRITE(6,20) (X(I1),I1=JX1,JX2)
   FORMAT(4X,4(2X,F5.3))
-----
30  CONTINUE
   DO 35 I1=1,3
   N(I1)=XN
   E(I1)=XB
   D(I1)=XD
-----
35  CONTINUE
   P=1
   WRITE(6,40)
-----
40  FORMAT(11H,26X,'LENGTH',7X,'GROSS MARGIN',5X,'OUTSTANDING',
15X,'PERCENT',6X,'PERCENT',6X,'AVERAGE')
   WRITE(6,45)
-----
45  FORMAT(11H,25X,'CF PERIOD',7X,'PERCENT',10X,'DEBT',
19X,'SOLVENT',5X,'INSOLVENT',6X,'CASH'//)
   AA=C.
   BB=C.
-----
50  ISEED=1743
   CONTINUE
   OVER=C.
   UNDER=0.
   CASH2=0.
   DO 1000 I=1,10000
   XX=UNIRAN(ISEED)
   IF(XX.GT..1) GO TO 100
   SALES=C.
-----
100  J=1
   GO TO 200
-----
100  IF(XX.GT..5) GO TO 110
   SALES=4.5
   J=5
   GO TO 200
-----
110  IF(XX.GT..9) GO TO 120
   SALES=4.
   J=9
-----
120  GO TO 200
   SALES=3.5
   J=13
-----

```



```

200  XX=UNIRAN(ISEED)
      DELTA=40.
      IF (XX.GE.X(J).AND.XX.LE.X(J+1))DELTA=10.
      IF (XX.GT.X(J+1).AND.XX.LE.X(J+2))DELTA=20.
      IF (XX.GT.X(J+2).AND.XX.LE.X(J+3))DELTA=30.
      (ASF)=50.
      C=30.+SALES*(N(P)-30.-DELTA)
      V=(1.-B(P))*SALES*N(P)
      F=2.444*N(P)
      I=E(P)*.08*N(P)/360.
      T=.4*(SALES*N(P)*E(P)-F-.0417*N(P)-I)
      IF (T.LT.0.0)T=0.
      K=(ASF+1+C-V-F-I-T)
      IF (K.GT.0.0)CVER=CVER+1.
      IF (K.LE.0.0)UNDER=UNDER+1.
      CASH2=CASH2+K
1000  CONTINUE
      CV1=CVER/100.
      UN1=UNDER/100.
      CA21=CASH2/10000.
      WRITE(6,1200)N(P),B(P),D(P),OV1,UN1,CA21
1200  FORMAT(1H .27X,F4.0,12X,F4.3,13X,F6.2,7X,F7.3,6X,F7.3,6X,F7.2)
      IF (D(P).GE.217.)WRITE(6,2100)
      IF (N(P).GE.400.)WRITE(6,2100)
      IF (AA.EQ.0.0) GO TO 2000
      IF (BB.EQ.0.0) GO TO 2500
      P=2
      E(P)=E(P)+.01
      IF (B(P).GE..81) GO TO 3000
      GO TO 50
2000  N(P)=N(P)+20.
2100  FORMAT(1H0)
      IF (N(P).GE.400.) AA=1.
      GO TO 50
2500  P=2
      D(P)=D(P)+5.
      IF (D(P).GE.217.) BB=1.
      GO TO 50
3000  CONTINUE
      STOP
      END
      REAL FUNCTION UNIRAN(KSEED)
      KSEED=KSEED*1220703125
      IF (KSEED) 1,2,2
1      KSEED=KSEED+2147483647+1
2      TEMP=KSEED
      UNIRAN=TEMP*.4656613E-9
      RETURN
      END

```

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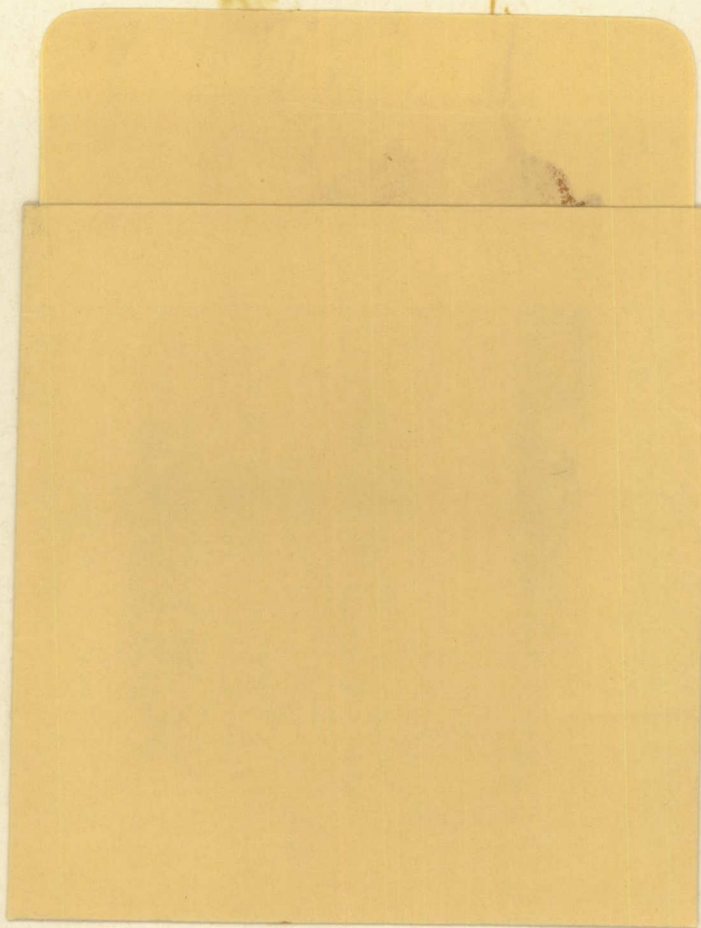


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