COLLECTED PAPERS

The Canadian Region of the American Accounting Association

ANNUAL CONFERENCE

JUNE 1975

Edmonton, Alberta

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American Accounting Association

REGIONAL MEETINGS ACTIVITIES

March 10, 1976

The Members,
The Canadian Region,
American Accounting
Association.

At the Annual Meeting of the Region in Edmonton in June, 1975, the membership instructed and empowered me to provide for the publication of the papers presented at the Annual Conference then in progress. The minutes will show that a maximum of $200 was allocated to this project, and that I was free to seek financial assistance for any additional funds required.

I am pleased to report that Peat, Marwick, Mitchell & Co., Chartered Accountants have provided their services and resources, and have made this publication possible. On behalf of the members of the Region, I wish to thank them for their support of this particular effort to encourage research in Accounting in Canada.

The authors of papers presented at the Conference were required to limit the length of papers to ten pages, and I am aware that this was somewhat restrictive. Some of the papers presented at the conference were, at the decision of the author, not included here.

It is hoped that the publication of these papers will not only make them readily available, but will also serve to encourage accountants, practitioners as well as researchers, to participate in future conferences of the Region.

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A MULTIVARIATE APPROACH TO IDENTIFICATION OF OUTPUTS AND COST CONTROLS IN A NON-PROFIT ORGANIZATION

This research addresses the problem of output measurement in a hospital. The study was undertaken to determine (1) if hospital inpatients (products) can be defined as groups of diagnoses where each group is relatively homogeneous with respect to resource utilization, and (2) if estimated costs of such groups can be used for cost control and reimbursement and comparative analyses of efficiency. Because inpatient care is a dominant activity of hospitals and because of the extensive micro nature of the data collection and data analyses, only the inpatient care function is examined so that reasonable limits can be placed on the scope of the investigation. Also, no attempt is made to measure changes, if any, in the quality of care.

Several studies have defined or measured hospital output (Berry, 1970; Eldor, 1969; Feldstein, 1967; Lave and Lave, 1970; Lave, Lave and Silverman, 1971; Rafferty, 1972). However, the output surrogates have proven less than satisfactory. Although some of these studies have concentrated on the output measurement problem per se, most of the previous work has focused on and employed measures of resource availability (e.g., number and kind of facilities and services) as surrogates for output. The assumption underlying this approach is that hospitals with similar resources probably produce similar outputs. Such an assumption is weak if not incorrect because the availability of particular resources does not necessarily indicate their utilization by the actual mix of patients receiving care. Therefore, because different diseases have different resource usage patterns, this study attempts to define and measure (inpatient) output in terms of groups of diagnoses (cases), where each group of diagnoses, although medically heterogeneous, is relatively homogeneous with respect to types and amounts of resources used. The case (an individual patient) is defined as the unit of output since it seems more reasonable to say that a hospital produces quantities of "completed" cases rather than, say, patient days.

Methodology and Results

Product-Mix Model

The proposed model of inpatient product-mix is represented as $\underline{D} = D_1 \cup D_2 \cup \ldots \cup D_k$ where $\underline{D}$ is a set of diagnostic groups and D_k is the kth product (diagnostic) group where the diagnoses are relatively homogeneous with respect to a vector of resource utilization measurements. Each D_i $(i = 1,k)$ is defined as an

output.

Iso-resource outputs are derived by factor-analyzing a sample of diagnoses representative of major resource utilization patterns. The basic data set is depicted by an M x N matrix. Each row or subject is a diagnosis, and the total number of diagnoses, M, is representative of the population of diagnoses. The N columns or variables are hospital cost centers such as Radiology and Operating Room and the (i,j) cell entry represents the average number of dollars of resources used by diagnosis "i" in cost center "j". Charges are used in the data matrix since they are available on a per unit of service per patient basis. Because charge (billing) rates remained constant during the time period covered in this study, different amounts of charges for the same service provided to different patients are valid surrogates for the quantities of that resource utilized. Although not available on a per unit of service per patient basis, costs are not required for deriving a taxonomy of iso-resource diagnostic groups (however, total inpatient costs are available and serve as the dependent variable in the estimated regression equation).

Thus, a complete row of the data matrix is a profile of average amounts of resources used by a given diagnosis. For a particular diagnosis or row of the matrix, the profile is the set of means obtained from a 20% random sample of the patients discharged with that diagnosis during a six-month period.

To factor-analyze the data matrix, the principal components model was selected. An advantage of this model is that one basic source of indeterminancy in factor analysis, estimation of communalities, is eliminated. In this model, $R = FF'$ where R is the matrix of correlations between diagnostic profiles and F is the matrix of loadings for each variable (i.e., diagnosis) on each factor (type).

The collection of diagnoses loaded (correlated) highly with a factor, F_1, constitutes a group or cluster of diagnoses relatively alike with respect to resource utilization; thus, for F_j ($j = 1,k$ where k = total number of factors), there is a group D_j, where D_j is a set of diagnoses. Thus, the set of groups $\underline{D} = D_1 \cup D_2 \cup \ldots \cup D_k$ constitute the hospital inpatient output groups (products). Using a similarity measure, each diagnosis not employed in establishing the types was then classified into the group to which it is most similar.

Factor analysis of the data matrix produced three factors (groups of diagnoses) accounting for 86.7% of the total variance. An analysis of the nature of each factor follows.

Analysis of Non-Economic Differences Between Groups

After the diagnostic composition of each group was known, analysis of the medical nature of the three groups was undertaken to determine if the three factors were substantively different. The results are summarized as follows:

Factor or Group No.	Medical Nature of Cases	Average Fatality Rate
1	Predominantly normal births and normal deliveries	-0-
2	Diseases range from Hodgkins Disease to various surgical complications	.15%
3	Diseases (conditions) range from various malignancies, heart diseases and cirrhosis to fatal accidents	3%

Not only does the fatality rate increase substantially from the first to the third factor, but the number of departments and amounts of resources consumed in a given cost center also increase. That is, in addition to intensity, the complexity of resource utilization increases from group one to group three. Consequently, the conclusion is that the factors are economically and medically different.

Use of the Output Model

The proposed product-mix model is potentially useful for cost estimation and control, prospective reimbursement and comparative analyses of efficiency.

For the field study hospital, an inpatient direct cost function was estimated with the model

$$Y_i = B_1X_{i1} + B_2X_{i2} + B_3X_{i3} + B_4t_i + e_i$$

where

Y_i = total inpatient direct costs in month i

B_1, B_2 & B_3 = cost coefficients of a unit of output (a case) in output groups 1, 2 and 3 respectively

X_{i1}, X_{i2} & X_{i3} = number of units of output (cases) in output groups 1, 2 and 3 respectively in month i (the total number of discharged cases in each group was tabulated for each month of the 16 month time period employed in the regression analysis)

B_4 = coefficient of time variable (to capture price level effects)

t_i = linear time trend dummy variable

e_i = error term

i = 1,16 (months)

Because the cost data excludes capital costs, an intercept term is omitted. Hence the model is most appropriately considered to be a long-run variable cost function. A similar argument and specification is presented by Feldstein (1967).

Results of ordinary least squares applied to the above equation are as follows:

Parameter	Estimated Coefficient	Standard Error of Coefficient	t Statistic
B_1	578.37	268.09	2.16
B_2	252.36	266.27	0.95
B_3	954.62	529.22	1.80
B_4	13.93	2.65	5.26

Durbin-Watson Statistic = 2.65
R^2 = .7226
F Value = 10.4, significant at 0.05 level

Two coefficients are significant at the 0.1 level. Additionally, standard errors are large and there is a moderate degree of multicollinearity among X_1, X_2 and X_3. However, the presence of a significant F value indicates that we can reject the hypothesis that the joint influence of the product variables is insignificant; i.e., reject H_o: $B_1 = B_2 = B_3 = 0$. The coefficient of the time variable, B_4, is significant, and its mean value as a percentage of the mean value of the dependent variable indicates an average rate of inflation of 1 1/2 percent per month.

Proportions of output in each group are nearly constant, thus demonstrating the difficulty of deriving more reliable estimated costs per unit of each output. However, constancy of product mix is not surprising because other research has found the casemix of a single hospital to remain constant over periods of a few years (Lave and Lave, 1971). Nevertheless, where past relationships between the independent variables can be assumed to exist in the future (i.e., constancy of product mix), such a cost function would be useful for prediction (Johnston, 1963). In the 17th and 18th time periods, predicted costs fell within the confidence interval for Y; consequently, the model appears to be useful for cost estimation.

The resource utilization model should also be useful for prospective reimbursement. Standard (i.e., predicted) costs could be negotiated or "set" and, subsequently, only actual costs falling within a defined interval about the predicted costs would be reimbursed. Decision makers should be more highly motivated to control or limit costs to levels agreed upon in pre-reimbursement negotiations.

Finally, the model should facilitate determination of price standards for similar hospitals and comparative analyses of efficiency. Both proposed studies assume that the appropriate data are available. The first proposal would involve a cross-section analysis where total costs were regressed on the various outputs (numbers of cases in each output group). The estimated coefficients could then serve a dual role: First, reimbursement rates could be negotiated with the set of estimated costs functioning as a guideline. Second, if relative inefficiency were defined as costs in excess of the average for a group of hospitals, then an individual hospital's product costs could be compared with the average; the institution would be judged ineffi-

cient if its costs exceeded those of the group. Also, investigation should reveal why product A's cost in hospital X exceeds the same product A's cost in hospital Y. Quality of care in the first hospital might be greater than that in hospital Y. Or, hospital Y may use a more efficient or different combination of resources. In any event, the comparative analyses, based upon a uniform measure of output, should not only aid cost control in a single hospital but also facilitate comparisons of costs between hospitals.

Summary and Conclusion

Two major results of this study were 1) the identification of inpatient types or outputs and 2) estimation of an inpatient direct cost function employing quantities of the defined outputs as explanatory variables. A discussion of the potential uses of the inpatient output model included cost prediction, prospective reimbursement and comparative analyses of efficiency.

Certain aspects of this study and their possible influence on the results should be noted. First, dollar amounts rather than physical units were used as entries in the data matrix from which the set of patient types was derived. Use of dollar amounts may appear to be less desirable than use of physical measures which presumably are more stable over time.

However, counting the number of units of service in a particular cost center (e.g., number of X-rays) would not provide an adequate measure of the relative costliness of services. For example, if patient A received a lung scan while patient B received a chest X-ray, although each received a single service, patient A's lung scan was far more costly than B's X-ray. Equating the number of services received in this manner would not adequately reflect the costliness of one patient's treatment relative to that of another.

Therefore, because no other more meaningful measure was available, it was concluded that comparison of diagnoses on the basis of dollar amounts of resources used was an acceptable methodology. Also, the sample of patients from which inpatient types were derived was drawn from a time period spanning only a few months, and because changes in the charge structure were relatively minor during this period, resource-use relationships in dollars between patients were stable. Therefore, it may be argued that diagnoses defining or constituting a product group were alike because their utilization of physical quantities of resources were alike.

Technology changes, if any, were not measured. To the extent that change did occur, some diagnoses may not be classified into the proper group. However, because the time period over which disease comparisons were made was not lengthy, the effect of any change on the diagnostic composition of each product group is probably negligible.

One particular assumption is related to the use of discharged cases as monthly units of output. Because "discharges"

is equivalent to "units completed" during the period, the implicit assumption is that work-in-process is constant from month to month. This assumption is not unreasonable because the proportions of discharges of each product are fairly constant from period to period.

Finally, an observation concerning the permanence of the inpatient output model should be made. Since changes in technology do occur over time, relationships between diagnoses can shift. Consequently, implementation and use of the model would necessitate periodic re-estimation of the relationships under-lying the model.

Appendix

Portions of this paper are abstracted from "Measuring and Costing Hospital Casemix with an Iso-Resource Inpatient Taxonomy" which has been submitted to Operations Research.

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CAAS 1975 Conference
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AN EMPIRICAL EVALUATION OF THE EFFECT OF GENERAL PRICE-LEVEL RESTATEMENT ON EARNINGS AND RETURN ON COMMON EQUITY: PRELIMINARY RESULTS[1]

Introduction

Recently the accounting profession has taken several steps in the direction of recommending or requiring the disclosure of general price-level (GPL) restated financial statement information.[2] The purpose of this paper is to report the preliminary results of an empirical study of the effects of GPL restatement on earnings available to common shareholders before extraordinary items and return on common shareholders' equity for listed U.S. industrials.[3] The former measure was selected primarily because of its perceived importance to investors and the latter because it reflects the combined impact of GPL restatement on profitability and position. Differential effects on industries will also be investigated.

The authors gratefully acknowledge research support received from Cornell University, the Society of Industrial Accountants of Canada, and McMaster University. A substantial portion of the empirical research was completed while one of the authors was affiliated with Cornell.

1 A detailed preliminary paper that considers the impact of restatement on other financial statement items will be available from the Faculty of Business, McMaster University, Hamilton, Canada (Research and Working Paper Series: No.112) in July 1975.

2 Justification for these steps is presented in CICA Dialogue, December 1974, p.1 and FASB Exposure Draft, Financial Reporting in Units of General Purchasing Power, December 1974, p.iii.

3 This paper presents partial results of a larger research study that will investigate the impact and usefulness of: (a) GPL restatements, (b) specific price-level adjustments, and (c) combined GPL and specific price-level adjustments on Canadian and American companies. Earlier studies have been restricted to preparation and analysis of GPL restated data for a limited number of companies, usually for only income statement data and for one year. See, for example, Davidson and Weil [1975], Parker and Gibbs [1974] and Petersen [1973].

Data & Methodology

The primary data for this study was drawn from a magnetic tape containing the Investor Management Sciences' COMPUSTAT file of U.S. industrials for the period 1946-73. In order to prepare GPL adjusted financial statements employing this data base, assumptions relating to the monetary-nonmonetary dichotomy and the ages of nonmonetary items must be made. Monetary items were assumed to be net quick assets, other long-term investments, long-term debt and preferred stock (excluding convertibles), deferred taxes and investment credit.[4] Accordingly, all other balance sheet items were deemed to be nonmonetary and were restated as follows:[5]

1) Fixed Assets and Depreciation. Fixed assets were aged to 1946 using reported capital expenditures and assuming disposals occurred on a FIFO basis. The ratio of restated to reported gross fixed assets was employed in determining adjusted depreciation expense. Restated accumulated depreciation was then determined simply as the sum of restated depreciation expense allowing for write-off of disposals on a FIFO basis.

2) Inventories. Using the cost flow method reported by each firm, FIFO and average inventories were aged on the basis of turnover and LIFO inventories were aged in layers from 1946. Restated inventory figures were also employed to determine adjusted cost of goods sold, assuming purchases (current manufacturing costs) were incurred evenly during the year.

3) Other Items. (a) Investments in non-consolidated subsidaries, intangibles, convertible debt and preferred stock, minority interest and common stock were restated assuming a FIFO flow. (b) All other balance sheet items (with the exception of retained earnings) were treated as having been acquired at year end. (c) Income statement items not discussed above were assumed to have been acquired evenly over the year.

Purchasing power gains and losses (PPGL) were determined assuming that changes in all monetary items occurred uniformly over the year. Our GPL restatements were made using the U.S. G.N.P. implicit deflator; the years considered were 1967-73. A total of 448

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4 As a result of the differing treatments recommended for deferred taxes by the CICA and FASB, the effect of considering this item to be nonmonetary was also investigated.

5 Two major problems encountered in restating nonmonetary items pertained to (1) acquisition of assets through mergers and (2) the determination of lower of restated cost or market. All major mergers (defined as the acquisition of at least 100% of pre-merger gross fixed assets) were excluded from our sample. Fixed assets resulting from other mergers were restated on the basis of the fixed asset ages of the acquiring company. Data deficiencies prevent using market values when below restated cost except where market is lower than historical cost and market value is disclosed and employed.

companies satisfied the data requirements implicit in the restatement procedures set out above. While our sample is composed of firms from the entire spectrum of industries, it does share the usual shortcomings associated with the use of COMPUSTAT tapes. Finally, the reader should note that validation of our restatement procedures is incomplete at this time and due consideration should be taken of this fact when interpreting these initial results.

Empirical Results

Initially, the restatement procedures described above were employed to generate common dollar financial statements for each firm in the sample under the alternative assumptions regarding deferred taxes (monetary vs. nonmonetary). The effect of GPL restatements on earnings available for common (before extraordinary items) and return on common equity were then measured in terms of an index of relative change--the difference between the restated and reported amounts as a percentage of the latter. The percentage changes were also measured before PPGL.

Aggregate Analysis. Selected fractiles from the distributions of order statistics of these percentage changes for the entire sample are shown in Table I. Overall, we note that while the impact of GPL restatements does vary considerably between firms and over time, the primary effect is to decrease earnings available for common and return on common equity for a clear majority of companies. On average, this decrease is about 20% and 25% for earnings and return on common equity respectively. Moreover, a distribution-free signed rank test (Wilcoxon test - see Hollander & Wolfe [1973]) indicates that the changes in earnings and returns are statistically significant at the 0.001 level for all of the years and all of the deferred tax-PPGL combinations under consideration.

Two additional comments may be made on the results reported in Table I. First, by comparing the second panel with the fourth, we note that the overall effect of assuming deferred taxes to be monetary or nonmonetary appears to be marginal, although statistically significant (Wilcoxon test) due to the uni-directional impact of the assumption on restated earnings. Second, a comparison of the first and second panels (or the third and fourth) reveals the aggregate effect of purchasing power gains on monetary items.

Analysis by Industries. A fundamental shortcoming of the aggregate analysis presented above is that it masks the impact of GPL restatements on firms in different industries. Accordingly, we first divided the sample into 20 industry groupings on the basis of SIC codes, and then computed the indexes of relative change in earnings and return on common equity for each of these groups. Tables II and III show the median percentage changes by industry classes for the two financial parameters respectively under the assumption that deferred taxes are monetary.

Table I

Percentage Change in Earnings Available for Common and Return on Common Equity for Sample: Selected Fractiles From the Distributions of Order Statistics

DEFERRED INCOME TAXES			FRACTILE	EARNINGS AVAILABLE FOR COMMON YEAR/ RATE OF INFLATION [a] 1967 3.5%	1968 4.1%	1969 5.2%	1970 5.4%	1971 3.5%	1972 3.7%	1973 7.4%	AVG. 4.2%	RETURN ON COMMON EQUITY YEAR/ RATE OF INFLATION [a] 1967 3.5%	1968 4.1%	1969 5.2%	1970 5.4%	1971 3.5%	1972 3.7%	1973 7.4%	AVG. 4.2%
	MONETARY PPGL	BEFORE	.05	-66	-96	-131	-226	-234	-207	-165	-154	-67	-90	-134	-216	-206	-189	-173	-154
			.25	-29	-34	- 44	- 66	- 61	- 56	- 65	- 61	-34	-39	- 50	- 68	- 62	- 60	- 67	- 63
			.50	-18	-22	- 26	- 36	- 35	- 34	- 39	- 34	-23	-28	- 33	- 43	- 41	- 39	- 45	- 40
			.75	-10	-13	- 16	- 20	- 21	- 21	- 24	- 22	-15	-19	- 23	- 28	- 27	- 27	- 32	- 28
			.95	- 3	- 4	- 6	- 7	- 8	- 8	- 8	- 8	- 6	- 9	- 12	- 14	- 14	- 13	- 16	- 14
		AFTER	.05	-52	-67	- 78	-109	-147	-140	- 99	- 99	-54	-65	- 84	- 99	-162	-131	-108	-103
			.25	-20	-23	- 26	- 36	- 35	- 33	- 33	- 34	-23	-26	- 30	- 40	- 40	- 39	- 37	- 39
			.50	-11	-12	- 13	- 19	- 21	- 20	- 18	- 19	-16	-18	- 20	- 25	- 28	- 27	- 25	- 25
			.75	- 4	- 3	- 1	- 4	- 11	- 10	- 3	- 7	-10	-12	- 13	- 16	- 19	- 19	- 16	- 16
			.95	15	23	39	40	11	10	54	28	3	4	18	9	- 1	- 8	15	5
	NONMONETARY PPGL	BEFORE	.05	Substantially unchanged from deferred income taxes- monetary - before PPGL								-67	-90	-133	-222	-221	-190	-181	-155
			.25									-33	-38	- 49	- 68	- 61	- 59	- 66	- 63
			.50									-23	-27	- 32	- 42	- 40	- 39	- 45	- 40
			.75									-15	-19	- 23	- 28	- 27	- 27	- 31	- 28
			.95									- 6	- 8	- 12	- 13	- 14	- 14	- 16	- 14
		AFTER	.05	-54	-68	- 83	-132	-141	-154	-103	- 99	-56	-65	- 85	-123	-144	-139	-109	-102
			.25	-20	-24	- 27	- 40	- 38	- 36	- 36	- 36	-23	-27	- 32	- 43	- 42	- 41	- 40	- 41
			.50	-12	-13	- 16	- 20	- 23	- 21	- 19	- 21	-16	-19	- 22	- 27	- 29	- 28	- 28	- 26
			.75	- 5	- 5	- 4	- 6	- 13	- 12	- 7	- 10	-10	-12	- 14	- 17	- 20	- 20	- 17	- 18
			.95	10	18	25	24	3	7	44	16	1	3	10	4	- 7	- 9	11	3

a. Inflation rate estimated by annual change in 4th Quarter GNP Implicit Deflator. The inflation rate shown under the column heading "AVG." is the geometric average of annual rates.

Table II

Median Percentage Change in Earnings Available for Common by Industry Classes & Kruskal-Wallis χ^2 Variates

(Deferred Income Taxes are Assumed to be Monetary)

Industry Class (Number of firms)[a]	BEFORE PPGL								AFTER PPGL							
	1967	1968	1969	1970	1971	1972	1973	AVG.	1967	1968	1969	1970	1971	1972	1973	AVG.
1. Mining(14)	-11	-10	-14	-25	-36	-29	-15	-29	-10	- 9	- 9	-10	-11	-24	- 7	-10
2. Food(45)	-18	-25	-32	-36	-30	-30	-53	-39	-10	-11	-13	-15	-16	-18	-19	-15
3. Bev. & Tobacco(25)	-13	-22	-21	-16	-22	-16	-23	-20	- 9	-14	-12	-10	-15	-12	-12	-10
4. Textiles(13)	-29	-30	-39	-68	-46	-60	-65	-55	- 6	-23	-31	-52	-44	-52	-39	-41
5. Paper & Printing(24)	-16	-19	-19	-30	-36	-31	-24	-26	-11	- 9	- 9	-13	-18	-14	- 8	-13
6. Chemicals(23)	-21	-23	-29	-57	-49	-42	-41	-41	- 6	- 9	- 9	-25	-26	-24	-15	-19
7. Drugs(12)	- 5	- 9	-11	-12	-11	-10	-12	-10	-13	- 8	- 9	- 9	-13	- 9	-14	-10
8. Cosmetics(16)	-10	-21	-24	-32	-26	-26	-25	-26	- 7	-12	-15	-28	-16	-19	-19	-18
9. Oil(18)	-12	-15	-18	-25	-30	-32	-26	-23	-13	- 8	- 8	-10	-17	-20	- 6	-13
10. Rubber,Glass,Clay(30)	-20	-24	-30	-44	-41	-36	-41	-40	-13	-13	-15	-29	-24	-23	-20	-25
11. Steel(20)	-25	-25	-30	-59	-64	-50	-49	-43	-13	- 6	- 4	- 7	-31	-26	-15	-14
12. Other Metals(12)	-15	-16	-11	-16	-56	-49	-56	-43	- 5	- 3	- 2	- 5	-22	-18	-13	-26
13. Bldg. Materials(15)	-17	-22	-29	-25	-23	-36	-44	-32	- 8	-17	-15	-20	-17	-25	-24	-22
14. Machinery(39)	-17	-22	-26	-32	-36	-39	-36	-33	-13	-19	-20	-31	-28	-33	-29	-27
15. Electricals(26)	-15	-22	-25	-37	-35	-32	-37	-40	-12	-16	-16	-26	-24	-25	-29	-27
16. Auto & Trans.Eqpt.(33)	-21	-26	-31	-53	-47	-36	-49	-46	-17	-18	-22	-28	-31	-24	-20	-23
17. Scientific Eqpt.(13)	-22	-27	-37	-42	-36	-29	-31	-35	-20	-24	-32	-37	-32	-32	-31	-32
18. Trans. & Comm.(16)	-15	-22	-29	-49	-84	-39	-44	-53	+11	+20	+38	+23	+ 7	+ 3	+49	+21
19. Retail & Wholesale(34)	-21	-28	-39	-44	-37	-36	-61	-54	-11	-15	-17	-19	-17	-12	- 7	-17
20. Miscellaneous(20)	-19	-24	-33	-38	-29	-28	-38	-35	-14	-18	-22	-31	-28	-20	-16	-21
Sample(448)	-18	-22	-26	-36	-35	-34	-39	-34	-11	-12	-13	-19	-21	-20	-18	-19
K-W χ^2 Statistic[b]	62.7	55.5	75.6	84.0	66.8	56.7	85.9	77.4	74.6	85.2	86.0	94.9	49.8	66.8	79.4	84.1

a. The number of firms is for 1967; due to mergers, etc. the numbers decline slightly by year 1973.

b. All figures are significant at the 0.01 level: $Pr(\chi^2(19) > 38.6) = 0.01$.

Table III

Median Percentage Change in Return on Common Equity by Industry Classes

& Kruskal-Wallis χ^2 Variates

(Deferred Income Taxes are Assumed to be Monetary)

Industry Class (Number of firms)[a]	BEFORE PPGL								AFTER PPGL							
	1967	1968	1969	1970	1971	1972	1973	AVG.	1967	1968	1969	1970	1971	1972	1973	AVG.
1. Mining(14)	-17	-18	-25	-33	-41	-41	-30	-37	-16	-16	-18	-19	-24	-33	-22	-20
2. Food(45)	-23	-31	-36	-43	-35	-38	-56	-43	-15	-17	-22	-24	-26	-24	-28	-25
3. Bev. & Tobacco(25)	-23	-29	-30	-24	-34	-31	-34	-30	-16	-21	-21	-20	-30	-32	-22	-21
4. Textiles(13)	-30	-32	-42	-69	-45	-59	-66	-56	-26	-32	-33	-54	-39	-51	-44	-40
5. Paper & Printing(24)	-22	-28	-30	-41	-41	-39	-37	-36	-14	-17	-18	-21	-30	-28	-25	-23
6. Chemicals(23)	-29	-33	-45	-52	-51	-49	-47	-48	-15	-16	-19	-28	-29	-24	-22	-22
7. Drugs(12)	-10	-15	-18	-22	-21	-15	-19	-19	-11	-15	-19	-20	-19	-19	-23	-19
8. Cosmetics(16)	-22	-26	-31	-36	-34	-31	-32	-31	-14	-18	-20	-33	-24	-24	-25	-24
9. Oil(18)	-14	-17	-23	-33	-37	-38	-34	-30	- 8	-12	-14	-18	-25	-22	-13	-17
10. Rubber,Glass,Clay(30)	-27	-28	-36	-51	-43	-40	-47	-44	-17	-18	-19	-34	-33	-27	-27	-30
11. Steel(20)	-34	-34	-41	-63	-69	-61	-61	-50	-23	-18	-21	-25	-41	-40	-35	-29
12. Other Metals(12)	-33	-33	-30	-32	-65	-61	-68	-57	-16	-16	-15	-19	-39	-35	-28	-32
13. Bldg. Materials(15)	-19	-27	-31	-30	-32	-45	-48	-35	-13	-17	-22	-22	-22	-30	-32	-29
14. Machinery(39)	-21	-24	-31	-40	-41	-43	-38	-41	-16	-22	-24	-35	-31	-34	-31	-30
15. Electricals(26)	-17	-32	-35	-37	-36	-35	-40	-43	-16	-21	-22	-30	-28	-27	-26	-32
16. Auto & Trans.Eqpt.(33)	-24	-30	-42	-56	-51	-41	-54	-50	-16	-21	-24	-31	-35	-28	-25	-28
17. Scientific Eqpt.(13)	-26	-31	-38	-47	-41	-30	-38	-36	-21	-25	-34	-39	-39	-34	-33	-33
18. Trans. & Comm.(16)	-19	-27	-39	-55	-61	-53	-55	-57	+ 3	+15	+22	+25	-11	-11	+33	+13
19. Retail & Wholesale(34)	-29	-34	-45	-51	-43	-44	-74	-59	-16	-20	-23	-25	-23	-22	-21	-26
20. Miscellaneous(20)	-22	-24	-35	-42	-33	-31	-43	-37	-17	-22	-27	-34	-29	-25	-19	-25
Sample(448)	-23	-28	-33	-43	-41	-39	-45	-40	-16	-18	-20	-25	-28	-27	-25	-25
K-W χ^2 Statistic[b]	71.0	59.1	67.1	72.3	63.8	60.6	80.6	76.6	78.4	76.5	72.8	78.4	42.0	64.0	72.1	76.0

a. The number of firms is for 1967; due to mergers, etc. the numbers decline slightly by year 1973.

b. All figures are significant at the 0.01 level: $Pr(\chi^2(19) > 38.6) = 0.01$.

A survey of the results shown in these two tables indicates that the impact of GPL restatements does vary between industries. The effect of PPGL can be seen clearly by making the appropriate comparisons. The industry effect was statistically tested employing distribution-free analysis of variance by ranks (Kruskal-Wallis test - see Hollander & Wolfe [1973]). The computed Kruskal-Wallis statistics are shown at the bottom of Tables II and III. It will be readily noted that they all exceed the 0.01 confidence interval suggesting that the effect of GPL restatements on the various industries is not homogeneous.

In order to ascertain which of the industries differ from one another in terms of GPL adjustments, Dunn's distribution-free multiple comparison test was employed (see Hollander & Wolfe [1973]). Table IV shows the computed values of Dunn's statistic for the 1967-73 average return on common equity. At an experimentwise error rate of 0.10 we note that primarily three industries are different - drugs, oils and utilities. Furthermore, utilities are not significantly different on a before PPGL basis, and drugs are not different from other industries on an after PPGL basis. Similar results are obtained for earnings available for common.

Concluding Remarks

Subject to the limitations of this study and the preliminary nature of the analysis, we offer the following tentative conclusions regarding the effect of GPL restatements during the period 1967-73: (1) generally, restated earnings and return on common equity are lower than their conventionally reported counterparts; (2) the two accounting measures for a majority of the firms studied are relatively insensitive to the treatment of deferred taxes as monetary or nonmonetary; and (3) the impact of GPL restatements on the earnings and return measures (after PPGL) are significantly different only for oils and utilities.

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Table IV

Dunn's Multiple Comparison Test For Return on Common Equity by Industry Classes: Computed N(0,1) Variates[a,b]

(Deferred Taxes are Assumed to be Monetary)

AFTER PPGL[c] \ BEFORE PPGL[c] Industry Class	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1.Mining	X	1.2	0.1	2.3	0.3	1.4	2.6	0.6	1.5	1.8	2.5	1.9	0.1	0.6	0.8	2.1	0.3	1.9	2.5	0.3
2.Food	1.3	X	1.6	1.6	1.0	0.4	4.3	2.0	3.2	0.9	1.9	1.2	1.1	0.8	0.4	1.4	0.8	1.2	1.9	0.9
3.Bev. & Tobacco	0.3	1.2	X	2.6	0.4	1.7	2.9	0.6	1.6	2.2	3.0	2.2	0.2	0.9	1.1	2.6	0.4	2.3	3.1	0.5
4.Textiles	3.0	2.4	3.1	X	2.2	1.2	4.8	2.9	3.8	0.9	0.0	0.3	2.2	2.1	1.8	0.6	2.0	0.4	0.3	2.1
5.Paper & Printing	0.6	0.8	0.3	2.8	X	1.2	3.2	1.0	2.0	1.7	2.6	1.8	0.2	0.4	0.6	2.1	0.0	1.9	2.5	0.1
6.Chemicals	0.3	1.1	0.0	3.0	0.3	X	4.2	2.1	3.1	0.4	1.4	0.8	1.3	1.0	0.7	0.8	1.0	0.8	1.2	1.1
7.Drugs	1.1	3.5	1.5	4.0	1.7	1.5	X	2.2	1.4	4.7	5.2	4.4	2.8	3.7	3.7	5.1	2.8	4.6	5.4	3.1
8.Cosmetics	0.2	1.1	0.2	2.9	0.4	0.2	1.3	X	0.9	2.5	3.3	2.5	0.7	1.4	1.5	2.9	0.8	2.6	3.3	1.0
9.Oil	1.6	3.4	2.2	4.7	2.4	2.2	0.4	1.8	X	3.6	4.3	3.4	1.6	2.5	2.6	4.1	1.7	3.6	4.5	2.0
10.Rubber,Glass,Clay	1.7	0.7	1.6	1.8	1.3	1.6	2.9	1.6	3.7	X	1.1	0.5	1.7	1.5	1.1	0.4	1.4	0.5	0.9	1.6
11.Steel	1.1	0.0	0.9	2.2	0.6	0.9	2.2	1.0	2.9	0.6	X	0.4	2.5	2.5	2.1	0.7	2.2	0.5	0.4	2.4
12.Other Metals	1.4	0.5	1.3	1.5	1.0	1.3	2.4	1.3	3.0	0.0	0.5	X	1.9	1.7	1.4	0.2	1.6	0.1	0.1	1.7
13.Bldg. Materials	0.8	0.3	0.6	2.2	0.3	0.6	1.9	0.7	2.5	0.8	0.2	0.7	X	0.5	0.7	2.1	0.2	1.9	2.4	0.2
14.Machinery	1.9	0.9	1.8	1.8	1.5	1.8	3.1	1.8	4.0	0.1	0.7	0.1	0.9	X	0.3	2.0	0.3	1.8	2.5	0.3
15.Electricals	1.5	0.4	1.3	2.0	1.0	1.3	2.6	1.3	3.4	0.2	0.3	0.2	0.6	0.4	X	1.5	0.5	1.4	2.0	0.5
16.Auto & Trans.Eqpt.	1.4	0.2	1.2	2.2	0.9	1.2	2.6	1.2	3.4	0.5	0.2	0.4	0.4	0.6	0.2	X	1.8	0.1	0.4	2.0
17.Scientific Eqpt.	1.6	0.8	1.5	1.3	1.3	1.5	2.6	1.5	3.3	0.2	0.7	0.2	0.9	0.2	0.4	0.6	X	1.6	2.1	0.1
18.Trans. & Comm.	3.2	5.3	3.9	6.2	4.1	3.9	1.9	3.4	1.7	5.5	4.6	4.5	4.0	5.8	5.1	5.2	4.8	X	0.2	1.8
19.Retail & Wholesale	1.0	0.4	0.8	2.6	0.4	0.8	2.2	0.8	3.0	1.0	0.3	0.7	0.0	1.2	0.7	0.5	1.0	4.8	X	2.4
20.Miscellaneous	1.1	0.0	0.9	2.2	0.6	0.9	2.2	1.0	2.9	0.6	0.0	0.5	0.2	0.7	0.3	0.2	0.7	4.6	0.3	X

a. All entries in boxes are statistically significant at the 0.10 level.

b. Average return on common equity for the period 1967-73 is employed in this test.

c. The entries above the diagonal refer to N(0,1) variates for return on common equity before PPGL and those below the diagonal to the measure after PPGL.

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REPLACEMENT COST - IS IT RELEVANT?

A CAPITAL MAINTENANCE BASED ANALYSIS

> The enterprise must conserve its income-producing facilities ... replace its resources as soon as they are consumed.
>
> The cost of the used resources is actually the cost to replace them.

These quotes from P. Bakker's recent book, Inflation and Profit Control, (1974 p.2), illustrate two propositions prevalent in the present debate concerning inflation accounting which are usually presented as unassailable declarations. It is contended that a company should seek to maintain its physical capital or facilities and that replacement costs are therefore the relevant data for both management decision making and external reporting.

In this paper it is contended that the first proposition, the maintenance of the physical operating level of the firm, is and should not necessarily be accepted as the objective of the firm. It is then shown that, if the maintenance of physical capital is not automatically assumed to be the objective of the firm, replacement cost is not necessarily the relevant or only relevant piece of data in management decision making. That is, the second proposition is also not necessarily valid. In fact, a need will be shown for both general price-level adjusted data and data on net realizable values.[1] To reach this conclusion, several viewpoints concerning capital maintenance will first be discussed and subsequently several management decisions will be analyzed from one specific viewpoint.

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[1] Net realizable value of an asset can be adequately defined as "the maximum net amount which can be realized from the disposal of that asset within a short period of time (not a forced sale situation, but not long enough to allow disposal of fixed assets through ordinary use of service). Net amount is defined as the selling price less disposition costs including tax effects discounted to the point of measurement". (Bedford and McKeown, 1972, p.333)

Capital Maintenance

While there may be many measurement bases for capital invested (See Rosen, 1971, p.14), we will consider three main ones relevant in discussions of inflation accounting:

1) original money invested,
2) original purchasing power invested and
3) operating or physical capacity.

The first basis is the usual historic cost model. Net income represents any increase in resources of a company after the original dollar amount invested in the firm has been maintained; this original capital is measured strictly in terms of the number of units (dollars) invested without regard to the value of that dollar.

Using the second basis, no income exists until the purchasing power of the money invested in the firm (the original investment adjusted for general price-level changes), has been maintained. Management's objective will be to maintain that "real" capital and earn an "adequate" return on that capital. Using the third basis, no income is considered to be earned until the physical resources consumed during an operating period have been replaced (or funds set aside to allow such eventual replacement).

Example A - No Inflation

Let us look at a simple example to illustrate the difference.

Assume an investment of $10,000 in a machine capable of producing 100 units of A. The machine has an expected life of 10 years; straight line depreciation will be used. Product A sells for $19.50 and there are no other costs. Assume that there is no general inflation, that is, the purchasing power of the dollar remains constant over the operating period. Assume further that there is no change in the replacement value of the machine. For simplicity, we will assume that net income and funds retained to cover depreciation are withdrawn in cash as they are received, uniformly throughout the period. The results, under all concepts of capital maintenance, will be:

Sales	100 x 19.50	$1,950
Depreciation		1,000
Net Income		$ 950

$$\text{R.O.I.} \quad \frac{950}{\frac{10{,}000 + 9{,}000}{2}} = 10\%$$

A 10% rate of return has been earned on the original capital invested--making due allowance for that portion withdrawn. Furthermore, if the $1,000 depreciation withdrawn is set aside each year funds will be available to replace the machine when its life is over.

Now, assume that immediately after the machine is purchased, the replacement cost of the machine goes to $15,000. Under the first two concepts, the original money invested and the purchasing power maintenance concepts, the situation remains as above. However, under the maintenance of physical capital concept we must deduct from sales the "replacement cost" of depreciation. We get:

	Maintenance of Physical Capital	Maintenance of Purchasing Power[2]
Sales	$1,950	$1,950
Depreciation	1,500	1,000
Net Income	$ 450	$ 950
R.O.I.	3%	10%

If 10% is assumed to be a satisfactory rate of return, those who adhere to the maintenance of physical capital concept using replacement cost, would contend that prices must be raised to $29.50 to give the following result:

	Maintenance of Physical Capital	Maintenance of Purchasing Power
Sales	$2,950	$2,950
Depreciation	1,500	1,000
Net Income	$1,450	$1,950
R.O.I.	10%	20%

The believers in the maintenance of physical capital would maintain that management has legitimately raised its prices to ensure that it recovers its "real" costs and earns a satisfactory return on capital. Believers in the objective of maintaining general purchasing power would contend that the extra charge of $500 is income, not cost, and might argue that this income is more than satisfactory and perhaps exhorbitant.

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[2] Or maintenance of original money capital since the two are the same here.

Example B - Inflation

Up to now, assuming no inflation, the maintenance of purchasing power has been equivalent to our usual historic cost concept. Let us now relax the assumption of no general price-level changes and assume that a 10% rate of increase in all prices occurs. Again, for simplicity's sake, assume the price change took place at the beginning of the period just after the investment has been made.

If the selling price is left at $19.50 a general price-level adjusted income statement in terms of end of period dollars would show:

Sales	$1,950
Depreciation	1,100
Adjusted Net Income	850

The purchasing power represented by the average capital invested (again allowing for the assumed payout) is $10,450 end of period dollars $\left(\frac{11,000 + 9,000}{2}\right)$. The return on this investment has therefore dropped to 8%. Since in fact the value of the dollar has changed, the maintenance of original money capital concept is no longer relevant and would lead to an encroachment of the shareholder's original purchasing power. This concept will therefore be disregarded in the remainder of this discussion since we will deal with inflationary conditions.

To ensure that the original cost (properly adjusted to equivalent purchasing power) is recovered and an adequate rate of return is obtained (assumed to be 10%), the selling price must be increased to $21.45.

Sales	$2,145
Depreciation	1,100
Adjusted Net Income	$1,045
R.O.I.	10%

At an inflation level of 10% then, a price increase of 10% will allow the company to recover its real costs (in terms of general purchasing power) and earn its normal return on the original capital invested (again in terms of equivalent purchasing power).

Which Concept?

We have seen before, however, that a price of $29.50 is required to ensure that enough capital is retained to

replace the equipment and make a normal return on the replacement value of the physical capital of the firm.

Who is right then - the proponents of purchasing power maintenance or the proponents of physical capital maintenance (replacement cost)? This is an ethical question not subject to an answer based on accounting theory. Is a company entitled to recover its actual cost of production (allowing for purchasing power changes) or is it legitimately entitled (so far as it is able) to recover its replacement cost? Let us look at an extreme example to clarify this issue.

This time, assume away all price changes.

A invests $100 to purchase a product from a farmer at $100 a unit, puts it through a secret process and sells it for $120. He buys one unit at a time, processes it, sells it, uses $100 to purchase a further unit and pockets the $20 profit each time.

While he has a finished unit yet unsold, the farmer tells him the worms have eaten his crop and there will be no further supply until the next growing season. A, upset by this uncertainty of raw material supply, discovers a totally different product and decides to change his line of business. The new product can be purchased from a manufacturer for $200 a unit and sold, after processing for $240.

Should A now try to sell his last unit of the original product at $240 in order to ensure that he has $200 available to purchase a unit of the new product? Of course not. He would obtain an exhorbitant profit of $140. He will have to sell the unit at the regular price of $120, retain his $20 profit as well as his original investment of $100 and make a further investment of $80 to be able to switch his product line.

By dealing in $200 units instead of $100 units he has expanded his business. The decision is a financing decision, not a pricing decision.

In my opinion, the situation is exactly the same when the replacement cost of the existing product goes up. If it is necessary to maintain the same physical capacity in plant or inventory, then additional financing may be required. As long as the normal return can be expected on this additional financing, this capital should be available. However, that does not necessarily mean that today's customer must now pay the new price.

The problem may be put into extreme perspective by asking whether we, the present consumers, should now be asked to pay the cost of future tar sands or McKenzie Delta oil since present resources will no doubt have to be replaced from these sources. I would expect that few of you would agree to an immediate price hike.

While all may not agree with the position taken here, it has been shown that the maintenance of original purchasing power concept does have some merit and can not be automatically rejected in favour of a physical maintenance concept. Before we resolve the debate concerning "current value" accounting, a discussion must take place as to which of these concepts is relevant under inflation.

This discussion should not be limited to accountants since the issue has far wider scope. Government statements indicate that we are moving further in the direction of a pricing policy. Whether, voluntary or otherwise, the business sector may be required to restrict selling price increases to cover increases in costs. To make any such policy effective in a period of inflation, the government will have to define costs: historic costs, general price-level adjusted cost or replacement costs. Which concept of capital maintenance will the regulators consider to be legitimate? Experience to date suggests that only the first will be acceptable; justice requires rather that the second be so considered. An educational task lies ahead for accountants and managers.

Management Decision making and the Maintenance of Purchasing Power

It seems obvious that the manager's viewpoint concerning capital maintenance objectives will affect his actions and his information needs. The proponents of replacement cost accounting, as illustrated by the quote at the start of this paper, tend to accept, explicitly or implicitly, the objective of maintaining physical capital and assume therefore that replacement cost is relevant information for management decision making.

If, however, one accepts the maintenance of purchasing power viewpoint, replacement cost is not necessarily relevant information. In the remainder of this paper we shall analyze some management decisions from this point of view.

Decisions Relating to Depreciating Fixed Assets

Depreciating fixed assets are essentially acquired in order to produce income and are in that process consumed over time. At any given point in time management must make decisions as to the pricing of products or services produced by the assets and, in the final analysis, whether the asset is to be used and the product manufactured at all.

To simplify, let us consider a piece of equipment used to produce one unique product; it has no alternative uses.[3] Once the equipment has been acquired, there are two recurring decisions to be made by the company: one, should the equipment be replaced with alternate, newer or better equipment? (i.e. is this the best means to produce the product?), and two, how is the product produced by the equipment to be priced? Let us discuss the replacement decision first.

In this decision, management must choose the least cost alternative and compare the cost of the new alternative equipment plus the sum of the future cash operating costs (discounted to their present value at some appropriate hurdle rate) with the present sales value of the existing equipment plus the present value of its future cash operating costs. In addition, if, for instance, the output of the machines differ, the present value of the difference in future revenues must be brought in. In this analysis, the only equipment values that are relevant are 1) the net realizable value (exit value) of the present equipment and 2) the cost of the alternative equipment.

It should be understood that this "cost of the alternative equipment" is not necessarily the "replacement cost" of the existing equipment as used in the current value literature. Bakker (1974, p.2),for instance, suggests that replacement value is:

> "the current market price for fixed assets less an allowance for depreciation caused by wear and tear and for economic obsolescence based on the estimated lifetime of the assets involved".

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[3] If alternative uses exist, the rational decision (based on the quantitative analysis only) is to produce the product that yields the highest contribution. The subsequent discussion can then be applied to this particular product.

It will not likely be true that the alternative equipment to be analyzed is strictly a new version of the same equipment. Even in this case, the "current market price less depreciation" has no relevance to the decision. Only the full current cash cost of the equipment is relevant. In summary then, the necessary data for this decision is the net realizable value of the old machine and the current purchase price of the contending alternative. Neither historic cost or replacement cost is relevant.

When we now turn to the pricing decision, we can assume that the previous decision has been made and the present equipment is the best alternative available. We must now distinguish two extreme situations -- either the company is a price-leader or a price-follower. If the company is a price-taker, the company can only decide to accept the price or stop selling the product. To make this decision management needs to know whether the present value of the net future cash flows to be generated by the sale of the product will be higher than the present realizable value of the equipment. If the answer is yes, the equipment is used to manufacture the product; if no, the equipment is sold. In this situation, only the exit value of the equipment is relevant, not its replacement cost or historic cost.

If on the other hand the company is a price-setter, the company has another alternative - it can raise the price of the product to ensure that the value of the assets in use by the company is at least as high as the realizable value. This exit value will then be the floor. If you can't at least recover that value over time, sell the assets. Therefore, again the replacement cost is not relevant.

A company that has no legal or ethical price constraints should, in theory, set its price so that its total contribution derived from the sale of the product is maximized. That is, it must consider, whether, when the price is increased, the extra revenue gained through the price increase will offset the revenue lost on the decreased volume and further how a decrease in volume will affect its variable costs per unit. For these companies the assets utilized (fixed costs) are of no concern except as a floor, in which case the exit value is relevant.

A company that does have a moral or legal price constraint such that it tries to set its price to cover all its costs and ensure a reasonable profit only, must obviously concern itself with the costs of the fixed

assets utilized. Here than our concept of capital maintenance comes in. Following the concept of purchasing power maintenance previously espoused, the company should seek to recover in its prices the purchasing power originally invested in the asset. That is, the relevant asset value now becomes its general price-level adjusted cost. This value acts as a ceiling for management decision making. If we can not receive a fair return on the exit value of the equipment (the floor) we must get rid of it; if we have flexibility in pricing we can and should legitimately increase our prices to cover the general price-level adjusted cost of the assets consumed.

It follows then, that, for management decisions concerning fixed assets, it is always necessary to know the exit value of the assets. Under implicit or explicit price constraints it is also necessary to know the general price-level adjusted cost.

Decisions Relating to Inventory

Whether or not an item is produced at all depends, as we have seen, on whether the present value of future cash inflows (contributions) is adequate to ensure an adequate return on the exit value of the fixed assets committed to its production. Once the item has been produced and is in inventory the cost of the fixed assets utilized may become irrelevant.

If the company is a price-follower (in general or on this particular product) it can only hold or sell. Holding is indicated only if the difference between the present realizable value and the realizable value at some future time (appropriately discounted) is greater than the costs of holding. Note, the relevant decision variables are the present exit value and the future exit value.

In the price-setting situation the company has another alternative i.e. change the selling price. In the no constraint case, the company can maximize the contribution obtained by selling both the products in inventory plus those yet to be produced i.e. the long run price/volume effect must be considered. In the constraint case we are in somewhat the same position as with fixed assets. A floor exists: if a potential price increase does not cover our holding costs we must sell. The ceiling depends on cost and in this case must be a general price-level adjusted "full" cost to recover the purchasing power expended on direct costs as well as the costs of all assets consumed by the product. Again, when maintenance of purchasing power is assumed as an

objective, replacement cost is not relevant for this decision.

Conclusion

We have noted that maintenance of physical capital is not the only possible objective of the firm. In fact, it has been contended that a definite choice can be made only on ethical grounds - not on those of accounting theory. The maintenance of general purchasing power was, however, seen to have significant merit as an objective.

It was then noted that if this concept is adopted, replacement cost is not relevant to recurring management decisions involving fixed assets or inventory. Instead, the relevant data for such decisions was found to be net realizable value in all cases and, in the case of a price-setter with explicit or implicit price constraint, general price-level adjusted historic cost.

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ALTERNATIVE METHODS OF EVALUATING INVESTMENT DECISIONS WILL DIFFERENT DECISIONS EMERGE?

Introduction and Objectives

Capital expenditure decisions (capital budgeting), due to their relative size and permanent nature, have long been recognized as one of the crucial areas of management decision-making. The problem of analyzing capital budgeting alternatives is to decide which of the available investment opportunities should be accepted and which should be rejected. In order to make this decision rationally, the major consideration must be economically oriented. It may be argued that the business organization has three major goals, survival, social responsibility and financial success. Given that the primary goals of survival and social responsibility are reasonably assured in a capitalistic economy the economic and financial success of the capital expenditure decision becomes paramount.

This paper will not deal with the conceptual efficacy of the alternative methods and criteria that are currently being used in practice, or theoretically advanced as the "best" criteria or method, but rather with an analysis of the differences in decisions that might result using the various alternative methods and criteria available. The major question for which a straightforward answer is not available in the literature is: "Will different decisions emerge if different methods or criteria are employed in appraising capital expenditure decisions?"

This paper has focused on the following cash flow and accrual criteria available for evaluating capital expenditure proposals:

Cash Flow Accounting	Accrual Accounting
Internal Rate of Return	Rate of Return
Net Present Value	Residual Income
Profitability Index	
Payback Period	
Discounted Payback Period	

The research was accomplished with the use of a simulation model which created hypothetical investment programs. The complexity of, and the interaction between, variables created a multiplicity of investment configurations. The simulation included such large sample sizes that, within the framework of the model, the theoretical situations posed would have to be unorthodox or have extreme values to refute the findings.

The objective of this paper is to generate, by a computer simulation, distributions of rank correlations between net present

value and each other criterion. Through an analysis of the means and deviations of these distributions determine if there are substantive differences in the capital investment set that would be selected if criteria other than that considered to be the theoretical "best" were utilized.

The term substantive used in the above objective of, and throughout this paper, was selected because a cursory review of all the detail results showed that there probably are "statistically significant" differences when these results are analyzed. Many of these differences although statistically significant are not "substative" from a pragmatic point of view, i.e. not large enough to influence the decision maker's choice. If the findings indicate that there is not a substantive difference in the projects that would be selected, companies would then be able to establish policies for capital expenditure decision-making that would be readily and easily adapted toward attaining "goal congruence" such as accrual accounting for decision making as well as performance evaluation.

Experimental Design

The following is a brief description of the computer simulation model and test technique used in this paper.

The accumulation of the data which made up each individual capital project and consequently each investment set was accomplished by using a computerized simulation model. A random number generator was used to simulate the key variables that are contained in the typical capital project. The testing technique utilized to analyze the data accumulated was the Spearman rank correlation.

The purpose of the computer program is to:

a) simulate individual capital expenditure projects to create hypothetical investment programs of n projects.
b) calculate the various criteria outlined previously, which form the basis for capital expenditure decision for each project.
c) test the degree of association between the NPV criterion and every other criterion using the Spearman rank correlation r (Seigel 1956). A consistently high correlation for simulated investment programs of various sizes would indicate a close associaton; therefore, the probability that the same projects would be selected under the various decision criteria is very high.

Specifics of the Computer Simulation

Prior to a discussion of the computer programs it sould be noted that there are only a few variables required to simulate a typical capital project. The decision whether to invest or not in a capital project is usually based on some criterion or measuring rule, such as the seven criteria used in this study. The following

are the few variables used in the simulation and these would suffice to calculate any criteria measurement desired: life of project, cash flow stream, dollars invested, accrual net income and cost of capital or required rate of return. This does not suggest that more detailed data is unnecessary when a capital expenditure project is presented. On the contrary, the submission of a capital project for management approval includes a quantification, in financial terms, of all aspects of the forecasted and budgeted events. These details are very essential, for the ability to forecast and budget such details is of paramount importance in assuring the highest probability of realiability of these major variables.

The computer program randomly generated these variables, simulating as realistic situations as possible, and it is capable of creating any number of projects and any number of project sets. All results $\bar{X}_r$ and S_r in this paper were based on a sample size of 500 investment sets.

The following inputs were used as the basis for, or used to determine the variables that create, individual capital projects, decision criteria, investment sets and finally the statistical results. In all instances realism in inputs was the objective even though the attempt at realism is admittedly subjective.

The following inputs were selected:

1) ISS: Investment set size is the number of projects that are in each investment set. The sizes selected were 10, 20, 30, 40, and 50.

2) CFD: Cash flow differential expressed as a rate accounts for the dollar difference that exists, every accounting period, between cash flow and accrual accounting. The rates selected were .50, .60, .70 and .80. The individual factors that make up the difference, depreciation, taxes, required funds, etc., are not important to the capital expenditure decision. It is the total difference represented by CFD that is important.

3) k: Cost of capital or required rate of return is used in the calculation of criteria requiring such a rate. Four rates were selected, .10, .15, .20, and .25.

The following inputs were randomly generated:

4) IRR: is a rate randomly generated from 3% to 50%. This rate is used to calculate the amount of each investment. It will also be the value of the internal rate of return criterion.

5) INCOM: is the amount randomly generated from $10,000 to $110,000 and is used as the base for the calculation of income flows and ultimately the cash flow and accrual accounting income.

6) CYCLE: is a randomly generated number from 1 to 5, repre-

senting any one of five INCOM flow cycles.

7) PROLIF: is the life of the project randomly generated from 2 to 14 years.

The following inputs were calculated:

8) INVEST: is the investment determined by finding the investment which would fit the IRR rate, the project life and cash flow income.

9) INCOME: is the accounting income calculated by taking INCOM for each year and subtracting depreciation.

10) CASH FLOW: is the INCOME times CFD adjusted each year for the 1 - CFD of the prevous year.

Once the criterion for each project in the investment set was calculated, the program then ranked each set of projects best first, and so on. After each set was ranked the Spearman r_s was computed for NPV versus each other criterion. A perfect association of correlation would be 1. This means the ranking of projects by the two criteria paired is the same. Any value r_s approaching 0 indicates that the ranking is poorly matched.

Frequency distributions of the 500 r_s for each of the 960 mean values were run. These were run to gain insight into the probability of occurrence of various r_s and also to study their distribution patterns. The 960 mean values resulted from 80 combinations for six criteria pairings and two Spearman runs which can be summarized as follows:

Eighty combinations: 5 ISS x 4 CFD x 4 k
Two Spearman runs: Mixed income flow and constand income flow.
Six criteria pairings: NPV compared to IRR, ROR, RI, Discounted payback, Payback and PI.

Analysis and Implications of Simulation Results:
The Spearman Rank Correlation Coefficient: r_s

Constant Income Flow and Mixed Income Flow

Two sets of rank correlations, one with a constant income flow and the other with a mixed income flow, using Spearman's r_s for the specified ranked criteria were run on the computer.* The results of the eighty possible combinations are summarized in Table 1 and every mean r is the average of 500 correlation coefficients. The only difference between these two sets was the method used to generate the income flow (INCOME); all other variables remained the same.

*Each set contained 1.2 million simulated capital expenditure projects.

Table 1: Comparison of Spearman Rank Correlation Coefficient Means ($\bar{X}_r$) using Constant Income vs Mixed Income Flow to Generate Investment Projects.

Cost of Capital		.10		.15		.20		.25	
Income Flow		Const	Mixed	Const	Mixed	Const	Mixed	Const	Mixed
Range		$\bar{x}_r$	$\bar{x}_r$	$\bar{x}_r$	$\bar{x}_r$	$\bar{x}_r$	$\bar{x}_r$	$\bar{x}_r$	$\bar{x}_r$
NPV/IRR	high*	.681	.673	.797	.789	.866	.859	.904	.900
	low	.633	.622	.738	.744	.820	.816	.861	.857
NPV/ROR	high	.670	.693	.796	.792	.864	.853	.904	.879
	low	.611	.625	.719	.739	.814	.801	.859	.834
NPV/RI	high	.943	.929	.956	.928	.949	.916	.935	.890
	low	.903	.889	.913	.880	.911	.876	.882	.843
NPV/SCP	high	.315	.270	.488	.457	.619	.601	.701	.692
	low	.265	.231	.423	.412	.548	.535	.636	.611
NPV/PYB	high	.328	.269	.500	.450	.633	.598	.731	.708
	low	.269	.222	.430	.403	.562	.526	.668	.617
NPV/PI	high	.835	.839	.890	.890	.923	.924	.944	.944
	low	.784	.793	.828	.846	.884	.884	.884	.911

*High: Each coefficient $\bar{x}_r$ listed is the highest mean value of the twenty possible combinations for each value.k. (The 20 combinations are the product of 5 IRR x 4 CFD).
Low: Each coefficient $\bar{x}_r$ listed is the lowest mean value.

The table shows means for the constant income flow method compared to the means of the mixed income flow method, for the six criteria pairings. The fact that the data is segregated by k illustrates the impact that the cost of capital has on the degree of relationship of the various criteria pairings.

Using the student "t" test to compare these results, the null hypothesis of no difference between constant and mixed flows was rejected in many cases. This would suggest that there are statistical differences. However, using a pragmatic approach the size of the greatest difference when these two are compared is not "substantive" in this researcher's judgment. For example, the greatest difference occurs between NPV/PYB constant income method coefficient .328 and mixed income method .269. The .059 difference would not be "substantive" even though a "t" test between the two coefficients would show a statistically significant difference, at less than a .01 level. Another important factor is that the distribution of the coefficients r under all possible combinations and pairings were approximately the same.

Because of the small differences found between the two income flow methods and the similarity found in the distribution patterns of their means it will be assumed that there are no "substantive" differences between the two sets of results, i.e. the two income

flow methods. Therefore, only the mixed income flow method will be analyzed and interpreted in this paper.

Analysis and Interpretation

Generally the interpretative value placed on any r_s is based on subjective judgment, and the acceptance or rejection of the value is at the discretion of the decision-maker. The importance or impact of the decision plays a vital role in determining just what value is accepted or rejected. In the analysis of the r_s values in this paper the rating scale in Table 2 was used to interpret the results.

Table 2:

r_s Rating Scale	
Correlation Coefficient	Rating
.90 and over	Excellent
.80 - .90	Good
.70 - .80	Fair
.50 - .70	Poor
Under .50	Very Poor

NPV/IRR

The paired criteria NPV/IRR are rated on the ranking scale (Table 2) from poor to excellent.

Table 3: Ranges for means x_r and standard deviations s_r of Spearman Rank Correlation Coefficients for NPV/IRR

Range of $\bar{x}_r$		ISS[b]		Range of s_r									
		10		20		30		40		50			
k[a]	high	low	high	low	high	low	high	low	high	low	high	low	high	low
.10	.673	.622	.249	.232	.163	.158	.130	.122	.113	.104	.104	.095		
.15	.789	.744	.188	.180	.123	.113	.097	.089	.084	.074	.077	.068		
.20	.859	.816	.152	.123	.090	.084	.069	.060	.061	.051	.049	.055		
.25	.900	.857	.116	.097	.059	.056	.047	.041	.035	.031	.034	.030		

a. includes all ISS and CFD b. includes all CFD

A detailed examination of all the results summarized in Table 3 shows that ISS and CFD had very little effect on the means ($\bar{x}_r$) for each level k. CFD had virtually no effect on the dispersion around the means but as ISS increased the standard deviations (s_r) decreased, for each level k. The major change in the results was caused by the cost of capital k. As k increased the ranking correlations increased, in fact at the .25 level all the means are in the high eighties which are rated good. Also as illustrated in Table 3 as k increased the standard deviations (s_r) decreased. It should be noted that most of the findings in the study will show k as having the greatest overall effect on the results but ISS will show in most cases to have a slightly greater effect than k, on s_r.

These two criteria are both discounted cash flow methods and deal with the same cash flow data. The only conflict between these

two criteria is that their future net cash inflows are assumed to be reinvested at different rates, NPV at the cost of capital k and IRR at the internal rate of return. Because of this assumption, the two criteria can give different rankings of investment proposals. Except for all combinations with a k of .10 the mean rank correlations do show from a fair to good rating.

NPV/ROR

The rankings of NPV/ROR are similar to those of NPV/IRR and in fact are rated exactly the same, poor to excellent. The distributions are also virtually the same and therefore, it is not surprising to find that the variables have the same effect.

Table 4: Ranges for Means $\bar{x}_r$ and Standard Deviations s_r of Spearman Rank Correlation Coefficients for NPV/ROR

Range of $\bar{x}_r$			ISS[b]		Range of s_r									
			10		20		30		40		50			
k[a]	high	low	high	low	high	low	high	low	high	low	high	low	high	low
.10	.693	.625	.246	.232	.163	.152	.127	.122	.111	.098	.099	.093		
.15	.792	.739	.191	.180	.123	.106	.087	.093	.083	.072	.079	.068		
.20	.853	.801	.150	.126	.090	.082	.067	.062	.056	.052	.049	.046		
.25	.879	.834	.115	.104	.064	.058	.046	.046	.038	.035	.035	.033		

a. includes all ISS and CFD b. includes all CFD

As illustrated in Table 4 again ISS and CFD at each level k had no substantive effect on the mean correlation coefficients ($\bar{x}_r$). CFD had also no substantive effect on the standard deviation (s_r) but as ISS increases a decrease is apparent at each level of k. In other words as the number of projects in the set is increased the dispersion around the mean decreases. As was the situation when analysing NPV/IRR the cost of capital k had the major effect. The association between the paired rankings NPV/ROR improved as k was increased and the s_r, which are virtually the same as NPV/IRR's decreased as ISS increased. At the .20k and .25k level all $\bar{x}_r$ are in the eighties and are rated good. The most important point to be noted about the findings for NPV/ROR is that NPV is based on the discounted cash flow method and ROR is based on the accrual accounting method.

As pointed out previously the distribution means and standard deviations for the various criteria ranking correlations have consistent patterns. These similar distribution patterns allow for a better comparison to be made amongst the varying results that were obtained when the variables were intermixed.

A comparison of Tables 3 and 4 points out the similarity of the NPV/IRR and NPV/ROR results and based on the r rating scale all these results can be divded into two categories: 1) all combinations of ISS, CFD with a k lower than .15 would be rated "poor". 2) All other combinations, other than those included in (1) above, would be rated as "good".

To summarize it could be stated that when the cost of capital is at least .20 there would be no substantive difference in the selecting of capital investment projects regardless of whether or not the NPV or IRR and NPV or ROR criterion was used.

NPV/RI

The results of all the ranked pairs of NPV/RI show very high correlations and the ratings for these are generally excellent. These results to some extent should be expected as both measures are expressed in terms of residual value. Again, the very important fact that criteria using the two different methodologies, discounted cash flow and accrual accounting, are correlating highly should be noted.

As was the case with the NPV/IRR and NPV/ROR results, and as illustrated by the high and low means shown in Table 5, CFD and ISS had no substantive effect on the various NPV/RI rankings $\bar{x}_r$. A further analysis of the detailed results disclosed that CFD caused virtually no change in the standard deviations (s_r) but ISS did show changes, this fact can also be seen in Table 5 below as ISS increased the dispersion rate decreased. However, all results show that k had a contrary effect on NPV/RI when compared to its effect on all the other ranked pairs. The cost of capital had caused only a slight change in the standard deviations and as k increased the means decreased slightly. This latter point is not a factor when interpreting the results unless the rate is exceptionally large, because when k is .25 all the $\bar{x}_r$'s are above the .84 level.

From the results presented it could be concluded that there would be no substantive differences whether or not the NPV or the RI criterion was used.

Table 5: Ranges for Means $\bar{x}_r$ and Standard Deviations s_r of Spearman Rank Correlation Coefficients for NPV/RI.

Range $\bar{x}_r$			ISS[b] Range s_r									
			10		20		30		40		50	
k[a]	high	low	high	low	high	low	high	low	high	low	high	low
.10	.929	.889	.098	.086	.054	.044	.040	.038	.033	.030	.028	.027
.15	.928	.880	.103	.087	.059	.049	.041	.036	.035	.031	.029	.028
.20	.916	.876	.112	.094	.073	.064	.056	.047	.047	.038	.039	.036
.25	.890	.843	.145	.112	.090	.080	.065	.057	.056	.050	.051	.047

a. includes all ISS and CFD b. includes all CFD

NPV/PI

The different means obtained when NPV or PI were used as the base criterion and the analysis of NPV/PI point out an interesting fact: the apparent influence that the relationship of the net cash inflow to the dollar size of the investment has on the decision criteria. This fact could have been hypothesized as the cause for

the differences in the rank correlations that were obtained when IRR and ROR were paired with NPV versus when paried with PI. The fact that NPV/PI results do not have perfect correlations, and the only differences between the NPV and PI criterion is ratio of cash inflow to the investment dollar size lends credence to this hypothesis. As pointed out previously both NPV and PI measures use the present value technique in their calculations, only the formula is different: NPV is expressed as a residual value and PI as a rate. PI could also be described as the residual value expressed as a rate of the present value of the investment. The rate, therefore, is directly related to the investment dollar size; the residual value is not.

Table 6: Ranges for Means $\overline{x}_r$ and Standard Deviations s_r of Spearman Rank Correlation Coefficients for NPV/PI.

Range of $\overline{x}_r$		ISS[b]	Range of s_r									
		10		20		30		40		50	
ka	high low	high	low	high	low	high	low	high	low	high	low
.10	.839 .793	.157	.149	.098	.094	.078	.073	.066	.060	.058	.054
.15	.890 .836	.137	.113	.082	.068	.058	.054	.051	.046	.045	.039
.20	.924 .884	.108	.087	.057	.053	.044	.039	.038	.032	.031	.029
.25	.944 .911	.077	.065	.042	.036	.031	.026	.024	.022	.022	.021

a. includes all ISS and CFD b. includes all CFD

A review of the results summarized in Table 6 shows that the correlation coefficients range from .793 to .944 or according to the rating scale, good to excellent. Again the three variables ISS, CFD and k, as illustrated in Table 6 have exactly the same effect on these results as they had on all the other ranked comparisons, except k in the NPV/RI pairing as discussed in the NPV/RI section.

The effect of k in this situation brings up an interesting observation. If the relationship of cash inflow to investment dollar size is the reason why the PI/NPV rankings are not perfectly correlated, then it could be assumed from the results that a k increases the effect of the magnitude of this relationship diminishes. If the trend were to continue there might be a value k that would completely negate the effect this has on the two criteria when compared.

From the data presented above it could be concluded that NPV and PI as ranking devices produce substantively the same result.

Payback Period Criteria

Theorists usually suggest that payback is a poor method of choosing amongst available capital projects. A review of all the results showed that both discounted payback period and payback period have generally low correlation coefficients. In other words, their rankings show poor relationship when paired with both NPV and PI. These results coupled with the facts that paybacks are

theoretically poor criteria would suggest that if any payback is employed, it be so with caution and with specific goals in mind. Further analysis of the payback results does not add to the paper directly but does help substantiate the findings of the paper because the variables ISS, CFD and k had the same effect on the NPV/payback results as was the case with the other NPV pairings.

Summary

Having generated 40,000 capital investment project sets (including 2.4 million projects) in a random manner by way of a computer simulation, calculating seven criteria for each, and applying the non-parametric statistical test, Spearman's r_s to paired rankings, it can be generally concluded that:

1) There is no substantive difference in results concerning "r" based upon mixed versus constant income flows. Thus one may not have to worry too much about assuming constant income flows in real life.
2) Both payback criteria produce substantively different rankings than NPV. Thus both paybacks are poor ranking devices in comparison with NPV.
3) NPV as a ranking device produces substantively the same results as IRR and ROR when k is equal to or greater than .20. Thus one could be indifferent between NPV versus IRR and ROR as ranking devices with k equal or greater than .20.
4) NPV as a ranking device produces substantively the same results as RI and PI. Thus one could be indifferent to NPV versus RI and PI as ranking devices.
5) Given 3 and 4 above one must question whether or not there will be differences in projects selected whether cash flow or accrual criteria are used. The comparison of IRR and ROR at all levels of k for NPV lends great support here as do the NPV/RI comparisons for all levels of k.
6) The cost of capital k, has a substantive impact on all decision criteria, i.e. as k increases $\bar{x}_r$ increases and s_r decreases for all criteria.
7) The number of projects in the investment set, ISS, has a discernable but not substantive effect on the decision criteria, i.e. as ISS increased $\bar{x}_r$ increases and s_r decreases for all criteria.
8) The size of the cash flow differential CFD has little if any effect on the decision criteria.

Many aspects of this part of the paper could be argued in spite of the size of the simulation, but within the framework of the model the conclusions do have validity.

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Models of Managerial Control

I The Cybernetic Model

According to many authors on the subject of "Management Control Systems", management control is the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of an organization's objectives. (e.g. Robert Anthony 1970 p. 414). Resources can be defined as a tautology, that is what ever can be used to achieve the organization's ends is a resource. Thus resources can include so called free resources such as air and water; the talent, imagination and effort of the personnell involved in the organization; as well as scarce resources, tangible goods and service of limited availability and generally assumed to be exchangeable on some proportionate basis for each other depending on their scarcity and the demand for them.

Just as resources can be a diffuse concept, the idea of an organization's objectives has sparked a great deal of unresolved controversy (e.g., see Ghorpade 1971). Regardless of whether the organization's objectives are viewed as being power moderated coalitions of the desires and objectives of the principal personnel or whether there can be said to be objectives of the organization as a total entity, there is little doubt that very often for organizations, objectives are multiple and multi-dimensional dependent on the future courses of events and capable of being articulated only as hindsight rationalizations. Thus looking back at the definition above of management control systems, the process of mediating resources to objectives in order to achieve efficiency and effectiveness encompasses broad fields of knowledge including virtually every subject area of a modern administrative studies curriculum.

Within all the possible approaches to managerial control the control aspect of management accounting occupies a unique and contentious position since it is presumed to provide an information system which measures the net effects of all decisions made in every area of the organization as to the overall use

of resources in achieving objectives. The effects of managerial decisions involving purchasing, production, personnel and finance are all considered to be subsumed within the information provided by management accounting reports. Moreover the information supplied is supposed to allow for critical evaluation of the quality of past decisions in each area and a sounder basis for further decisions which must be made. Given the complex nature of the task of management control the degree to which management accounting can achieve control is open to question. Certain simplifying assumptions about the nature of resources and the nature of organizational objectives are generally made which enhance the application of management accounting to control systems but at the same time limit its generality and usefulness.

With respect to objectives, if control is defined as the process by which management determines that the actions of the members of the organization conform to the plans and policies set forth by management there are a number of definitional mechanisms by which this can be achieved. Plans and policies must be formulated operationally in such a manner that there can be a measurement of the results of the process being considered in terms of quantities such as units or dollars. Managerial actions which do not result in changes to quantitative output are considered outside the scope of accounting control systems. In this manner concrete comparisons can be made between results and the original plans and policies. As in most management accounting articles, the circularity of planning and control is ignored. Suffice it to assume for the purposes herein, that the organization does have detailed objectives expressed in operational terms which will allow the determination of comparison between plans and actual for the purpose of control.

Figure 1 is a variant of the well-known cybernetic control model coupled with what might be described as a Dewey/Simon problem solving sequence. In the classic cybernetic loop, negative deviations which exist between predetermined standards and performance measures are automatically assumed to be corrected for the next iteration of the process by some predetermined correction mechanism. In a more realistic management control model the process is far more complex.

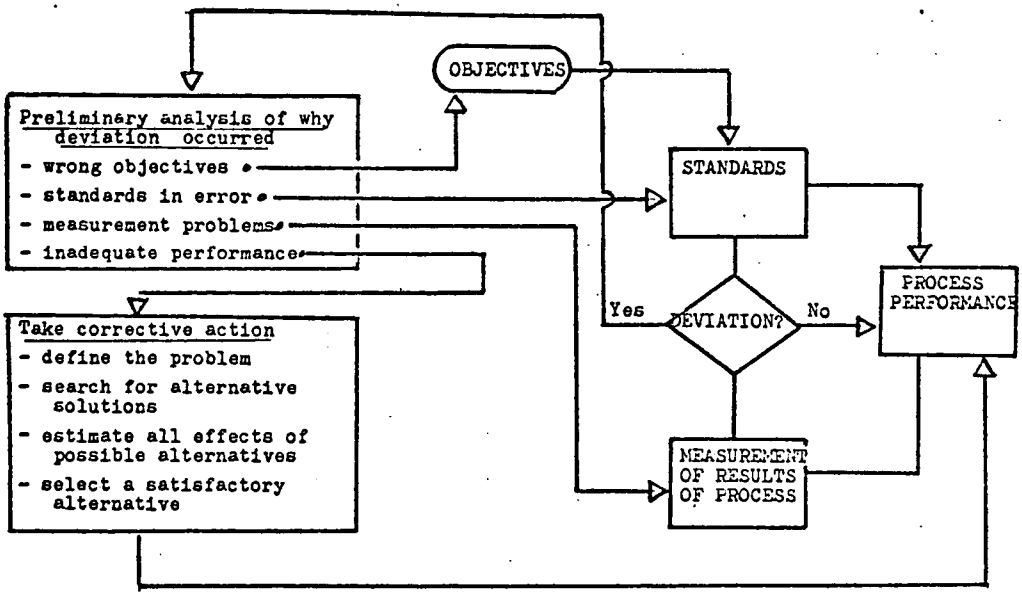

FIGURE 1

First some theories of human behaviour if they are valid would suggest that a number of the arrows on the cybernetic control model should be reversed. For example 'Aspiration theory' and McClellands achievement/power/affiliation-need theory would indicate that a manager's perception of performance would lead to the definition of standards of performance and the determination of objectives rather than the reverse.' Second, studies of the effects of accounting measurement suggest that the development or choice of measurement methods often defines performance standards and determines objectives. That is to say some changes in the derived statistics become ends in themselves. Thirdly the multidimensionality aspects of both objectives and process make it necessary to have many different standards and many kinds of measurements in order to control complex processes. When comparing these diverse standards to the various measurements of performance a whole range of conflicting signals about the state of the process may be generated.

Thus even the determination of the existence negative deviation in the cybernetic control model is a complex matter, without even touching on the problems of devising corrective action. In dealing with this problem classification of controls by which standards can be compared to measures of actual per-

formance can be suggested. A non-mutually exclusive list might include:

Control by reduction: if inputs, outputs and other aspects of performance can be broken into elemental parts, the determination of costs and quantities of these elements can be said to give a measure of control over the process.

Control by aggregation: the converse of control by reduction, all the elemental aspects of a process can be integrated within one overall check figure which is maintained at a stable level.

Control by comparison: measures of elements or units can be compared across time or to other similar units. Differences in these measures can be analyzed in order to maintain control.

Control by contrast: if slight variations exist between units then analysis of differences in results should yield control information.

Control by proportion or ratio: often the units or elements should bear a logical and or stable relationship with each other which should be maintained.

Control by prediction: perhaps one of the most common methods of control is control by prediction. If the results of a process can be predicted or predetermined accurately then the managers of the process can be said to be exercising considerable control over the process.

II The Matrix Model

In the annals of management accounting the earliest control systems were devised around adding up the market determined or opportunity costs of scarce resources expended in the productive process in such a way as to be able to compare the individual product or service costs to the market value of the various products or services which were produced in the same period of time. For example records of accounts of 1610-20 of an English Farmer named Robert Loder show a yearly attempt to calculate "Which of my lands yielded me greatest profit of those sowed with wheat or of those sowed with barley". According to R.H. Parker, even at this early date Loader understood the distinction between avoidable and unavoidable costs. His charges against profits included the

opportunity cost of the capital invested in the farm. (what he called the 'use of my stock which lay as dead')(R.H. Parker 1969, page 16)

The basic concept that the total cost of a product could be built up of discrete cost elements which were fairly stable in nature eventually led to the beginnings of cost accounting spurred by the exigencies of the industrial revolution. However, until well into the twentieth century cost accumulation and product costing were confined to the recording of historical financial events. The notions of cost control and accounting explicitly as a basis for future oriented management decisions seems to be a fairly recent phenomenon (Sowell 1973)

One of the first developments in managerial control of costs was the attempt to divide total costs incurred by an organization into what have been called, 'cost objects' - departments and/or units of product with indirect costs charged to departments often being reallocated to products (Horngren 1972, Ch. 4). This schema can be represented pictorially as follows:

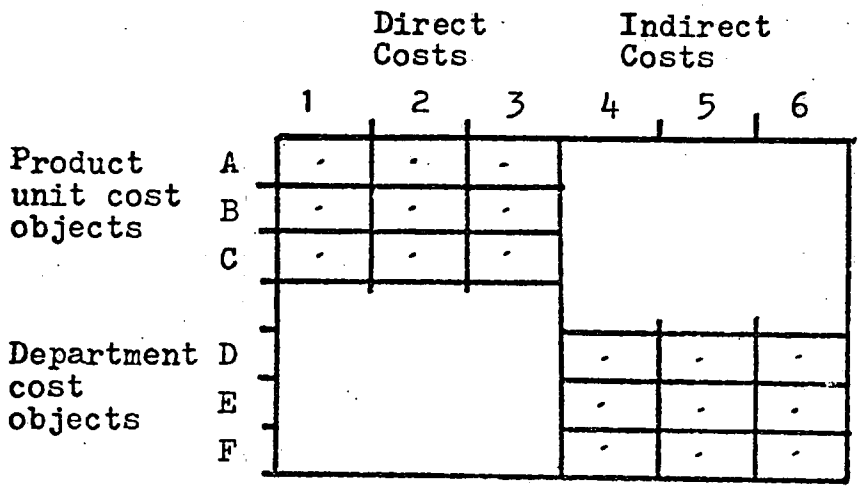

FIGURE 2

Control as represented here operates through comparing various combinations of resource inputs to outputs in terms of numbers of products or cost center activity levels. In order to do this, various standards can be devised for these cost objects according to the classifications discussed earlier in the paper: reduction; aggregation, comparison contrast, proportion and prediction. If performance is monitored, measured and compared to these kinds of standards, deviations

can be analyzed (Figure 1) and corrective action taken. Much of the study of management control has centered around this view of cost control.

As useful as this approach is for many managerial decisions including pricing, make or buy cost volume profit analysis and general cost control it has two basic flaws, first the difficulty of allocating indirect costs and second the assumption which is not necessarily valid, that deviations between standards and actual performance will be acted on by someone in authority within the organization. It is management and decision makers in general that make an organization successful or not and the object control does not operate directly on decision makers.

A recent development in management accounting which attempts to mitigate this latter deficiency of object costing has been called 'Responsibility Accounting' (Higgins 1952). The difference between object accounting and responsibility accounting is one of focus and there have been attempts to reconcile the two (Ferrara 1967). Responsibility accounting segregates the costs of resource inputs as to whether they are controllable or uncontrollable by an individual and fixes the responsibility for the controllable costs on the appropriate person with an organization. Presumable then the success of individuals within the organization hierarchy in minimizing resource inputs while at the same time increasing output or performance can be tied to a reward system so that decision makers are motivated in the direction of making the organization more efficient and effective.

Both object cost control and responsibility cost control assume a fairly stable technology for the process by which resource inputs are converted to outputs. In this view continuous information with respect to resources used and output achieved and the comparison of standards to actual performance in these areas will lead to improved performance. For the manager, however, there are important intervening variables between resources and objectives. These variables are composed of the actions or activities which he takes by which resources are translated into outputs. It is these activities their nature and improvement which form the focus of his concern. Thus information about his activities and their relationship between resources and output is most valuable to him.

The management control theoretician tends to see improvement in output performance as a matter of altering resource inputs to a standard process. The managerial decision maker tends to feel that by altering this process, i.e. his activities he can have the most significant effect on output. Of course activity costs such as the cost to have a one page letter typed and mailed or the cost of using a square foot of plywood can be calculated at various time intervals by restructuring basic cost data collected for other purposes. But what is suggested here is the continuous monitoring of activity costs so that standards can be set and measured against performance according to the cybernetic control model discussed earlier in the paper. Such an approach to management accounting control has been called by George Staubus, 1971, 'Activity Costing' According to Staubus: "From the point of view of accountants, the failure of many accounting systems to develop unit costs of using various resources that are routinely used in the entity and unit costs of doing things that are common activities of the entity should be cause for considerable embarrassment".

III Conclusion

To this point this paper has discussed a general cybernetic model of cost control and then the development and description of three approaches to cost disaggregation. These three approaches are not mutually exclusive and indeed it can be argued that the ideal in managerial cost control is to devise a method of coding individual expenses so that the total cost of an operation can be broken down and reassembled along all three dimensions as shown below:

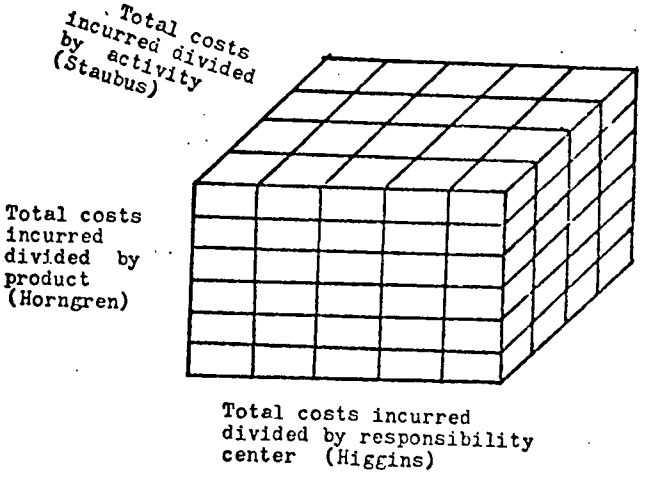

FIGURE 3

Naturally sound managerial practice will dictate that where possible all three dimensions be superimposed on each other. That is to say to the extent possible a single individual should be responsible for a limited activity which is a definable part of a product. Seldom of course is this possible to a major extent in a complex organization especially at higher levels in the organizational hierarchy.

Measurement and comparison of input, throughput and output along each of the three dimensions described (object, activity and responsibility) can be analyzed by reduction, aggregation comparison, contrast, proportion and prediction and the results applied to the cybernetic model (depicted in Figure 1) will foster an opportunity for greater managerial control.

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A TEST OF THE EFFICIENT MARKET HYPOTHESIS USING AUDITOR CHANGES

Abstract

It is often alleged that firms shop for auditors to obtain an unqualified opinion not obtainable from current auditors. This allegation is difficult to confirm or refute since firms would not admit it if the allegation were true. However, if there is any value in changing auditors, an efficient market would incorporate this into the stock price as soon as the change became known. This change would be the market's evaluation of the effect of the change.

All NYSE firms which changed auditors between 1954 and 1968 were examined and 152 changes with adequate data for analysis were found. The subsample which changed from one Big 8 auditor to another and the subsample which changed organization were also examined. A sample of firms matched by industry and annual report date was also gathered. An Abnormal Return Index was computed for 12 different periods relative to the time the annual report was released. For each period, 2 different market models, 2 different estimates of market risk, and 2 methods of aggregating residuals were used. In each case, the population of Abnormal Returns was compared with the corresponding returns for the matching sample using a nonparametric Mann-Whitney U-test.

A small market inefficiency significant at the 95 percent level was detected for the 113 firms which changed auditors but did not change organization during the period from 1954 to 1968. These firms had a negative abnormal return of about 5 percent during the period from 3 to 6 months after the first annual report was released by the new auditor. No inefficiencies were found for the total sample of auditor changes or for changes involving only Big Eight auditors. No abnormal return was found before the change indicating that the information that companies change auditors is not of significant value to the market and no adjustment is made when the information becomes available.

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STOCHASTIC COMMODITY ACCOUNTING

Introduction

Several years ago Professor Paton in the opening paragraph of his well known text clearly put forward the fundamental problem of accounting in the following way:

> "In a broad sense accounting has one primary function: facilitating the administration of economic activity. This function has two closely related phases: (1) measuring and arraying economic data; (2) communicating the results of this process to interested parties. It follows that the job of accounting is being well done when those concerned are being supplied with significant, essential data, presented and interpreted in such a manner as to promote understanding and a realistic, constructive pattern of decisions. ..... Accounting, like other fields, is plagued with fetishes and sacred cows, and it is high time that homage be shifted from these to the underlying objective. ..... What is really needed is a clear perception of the basic function, and a willingness to review conventional ideas, terms and techniques in the light of such function." (Paton, 1949)

About two decades after this advice Ross asks the following questions: How far do we fall short of this good advice? How far do we allow ourselves to become absorbed in paying homage to our sacred cows-to the neglect of our primary function of "facilitating the administration of economic activity"? As an aswer to these stimulating questions he mentions that somewhere along the profession has got off the track and it has come to think of good statements as statements conscientiously prepared according to rules which are put forward by the profession. In his opinion the troubles started when the profession tried to come to grips with the elusive concept of value-so completely basic-along with what should be closely related concept of profit. (Ross, 1966)

This pressing need for a clear perception of the basic function,

an a willingness to review traditional ideas, terms and tools in the light of such a function has been felt very strongly by many researchers. However, it seems that much remains to be done. As an example, recent writings by Ijiri, Chambers and Sterling can be shown. Particularly Professor Sterling in discussing theory construction and verification clearly points out the current obstacle for progress:

> "Theories are restricted to certain subjects or certain kinds of phenomena. Although generality is desirable, there is no general theory of the general scheme of things; instead each theory is limited to a particular subject matter. One of the difficulties encountered in accounting theory construction and verification is that different accounting theories are often theories about different subject matters. The problem is not so much that there are conflicting theories about the same subject matter as it is that the various theories are concerned with different subject matters. It is to be expected that different subject matters will produce different theories." (Sterling,1970)

Sterling in reviewing some of these theories gives three interpretations:

a. Anthropological interpretation,
b. Model-of-the-firm interpretation,
c. Psychological interpretation.

The anthropological interpretation deals with the principles of accounting as determined by accountants. Therefore the test of an anthropological theory of accounting is the observations of the actions of accounting man. On the other hand model-of-the firm takes the accounting system as a model of the firm in much the same way that a planetarium is a model of the sky. His main objection basically rests on the verifiability of outputs of present accounting theory under the light of present auditing techniques. Finally, the model-of-the-firm is broadened to include the receivers of the accounting reports. Under this interpretation the financial statements are not the final outputs of the theory; instead they are inputs to the receivers. (Sterling, 1970) What he really argues is accounting ought to be a measurement-communication process.

This paper represents the second interpretation with the belief that these two processes can not be separated. By introducing the concept of stochastic commodity decision theory and accounting can be merged at least in theoretical sense. As it will be seen at the end of this paper even in the theory stage there are several points that require careful research.

Stochastic Commodity

The concept of a stochastic commodity has its origins in thoughts of a philosophic sort-- it stems from the observation of human experience:

The nature of reality is unknown to mortals. Though there is a basic agreement here with Carr's "Proposition: Reality is a subject for philosophers, not scientists," (Carr, 1964) the authors would prefer to state it thus:

> Proposition: Speculation as to the nature of reality is a fit activity for philosophers (and theologians, who affix to reality the name of "God") but not for scientists.(Gearing,1966)

Though no claim of special insights into these difficult questions is being made here, it is true that the keystone of this paper is the fact of the inscrutability of reality. Furthermore, the assertion is being made that this is a subject which appropriately calls for recognition an reflection by non-philosophers, particularly scientists (social scientists included), as it suggests something important about human conduct. Specifically, the suggestion here is that humans are able to function by making assumptions or hypotheses about reality that lures behind other people and things in their environment. This insight into the relationships between people was given most sensitively by a well known writer in his short story "The Minister's Black Veil" (Hawthorne, 1935) wherein the black veil, which is never lifted, symbolizes that which obstructs the view of one human into the true "self" of another.

In the physical world, the reality of a physical object is similarly veiled. Though man's knowledge of the "earth", for instance, has advanced considerably since the days in which the popular conception (assumption) was of a "triple decker universe," for every mystery that is seemingly"solved", there are multitudes of new ones revealed; and man has no hope of complete knowledge of this earth.

Most economic models used in the theory of the firm follow the lines of Samuelson' Foundations of Economic Analysis and contemporary works on theory of value. In so doing the models do not include some topics of considerable interest to the applied scientist. Many models begin by assuming a state of inputs (or outputs) to be representable by a vector of real numbers, each component of the vector representing a quantity of some commodity. In applying such a theory, however, the applied scientist must decide upon a means of classifying objects into commodities, and then defining a measure over the classes. (Colantoni, 1968) It is also an intent in this paper to offer an assistance to the applied scientist in this regard.

Another objection to many economic theories is that they assume perfect knowledge about the commodities exchanged. On the contrary all human experience takes place in the midst of uncertainty about the true nature of things, and it is appropriate that an economic model take account of it. This is done here through the concept of a "stochastic commodity," which recognizes that along with a description of an object there need be explicitly identified the uncertainty that the object is in fact consistent with what it's conceived of being.

A simple definition of a stochastic commodity by using minimum number of notations can be given in the following way:

> A stochastic commodity can be symbolized by an ordered pair $(D(\gamma), p)$, wherein the $D(\gamma)$ represents the actual description of the entity and the symbol p is a probability assignment representing the relative likelihood that the object or entity is in fact what it's conceived of being.

If the (unrevealed) reality of an object represented by a complete description $(D(\gamma_N))$ and the conception $(\zeta(\gamma_N))$ of the (reality of the) object as a complete specification then the question, "Is the object what it's conceived of being?"is translated into, "Is it so that $D(\gamma_N) \varepsilon \zeta(\gamma_N)$?"

In view of the fact that in the real world one is restricted to finite γ, one thus can never answer affirmatively the question asked above, but is required to be content dealing with the question "Does $D(\gamma) \varepsilon \zeta(\gamma)$?"for some finite γ . Thus in order to deal with this question consideration is limited almost entirely to the events defined in a probability model of the following form:

$$\psi = (Z, \beta, P) \text{ where} \qquad (1)$$

(i) $Z = \{\delta_1, \delta_2\}$

$$\delta_1 \sim D(\gamma_N) \varepsilon \zeta(\gamma_N)$$
$$\delta_2 \sim D(\gamma_N) \notin \zeta(\gamma_N);$$

(ii) $\beta = \{E_1, E_2, Z, \phi\}$

$E_i = \{\delta_i\}$, $i = 1,2$;

(iii) $P : \beta \rightarrow$ is defined by

$$P(E_1) = p(\delta_1) = p$$
$$P(E_2) = p(\delta_2) = 1-p$$
$$P(Z) = 1$$
$$P(\phi) = 0.$$

The above definition leads us to a formal definition of a stochastic commodity.

Definition: The ordered pair $(D(\gamma),p)$ will be a stochastic commodity iff

(2)

(i) $D(\gamma) \in \zeta(\gamma)$ where $\zeta(\gamma) \subset \mathfrak{D}$ is a set of descriptions of commodities ; and

(ii) p is probability assignment to the "outcome" $D(\gamma_N) \in \zeta(\gamma_N)$ given in the probability system of Ψ.

A specification $\zeta(\gamma)$ identifies a set of descriptions, and it frequently is desirable to identify a commodity only by its membership in a set. This suggests the notion of a commodity class:

Definition: Let $\zeta(\gamma)$ be a given specification; then ℓ will be a commodity class defined by $\zeta(\gamma)$ iff

(3)

$$\ell = \{C = (D(\gamma),p : D(\gamma) \in \zeta(\gamma)\}$$

By this definition, then it is clear that any specification $\zeta(\gamma)$ defines a commodity class, ℓ , and it is in terms of this ζ that most economic references to commodities are made. Thus when a writer refers to a ton of steel, he does not have in mind a particular ton of steel but a specification which defines the class of objects, each of which would be identified as satisfying the specification "ton of steel"; i.e., he would have in mind a commodity class.

Once given a commodity class, ℓ, associated with the specification $\zeta(\gamma)$, it must be determined what probability assignment to make to each member $C \in \ell$. The assumption is made that it is not appropriate, for the purpose of this presentation, to attempt to distinguish between elements of ℓ, as far as the probability assignments are concerned.

Given the above definitions and assumptions it is possible to provide a model of the process which yields a stochastic commodity. This process is called a stochastic commodity process and can be informally defined as "that process by which stochastic commodities are combined to form new stochastic commodities."

One particularly important feature that results from this construction is that the randomness of a stochastic commodity is due only to the randomness of the stochastic commodities from which it is formed. This means that there is no randomness derived from the stochastic commodity per se but only derived from the stochastic commodities which are applied as "inputs" to the process.

By employing the above definitions and basic concepts it is possible to describe a complete production system by using continuous functions. (Gearing, 1966) In this system the information about the system exists in the form of continuous functions of time.

The planning horizon of the firm will be designated $T = (t_0, t_\tau)$ where t_0 is the present instant and t_τ is the final instant, where t_τ is displaced by τ units of time from t_0. An arbitrary instant in T will be designated $t \in (t_0, t_\tau)$.

A collection of objects, each of which is represented by an element $C \in \ell_i$, will be called a commodity population and denoted Λ_i. The composition of Λ_i may change over time, so $\Lambda_i(t)$ will represent the commodity population at time $t \in T$.

Definition: X_i is the i^{th} commodity stock level function iff

(4) $X_i : T \to R$ is a mapping defined by

$$X(t) = N(\Lambda_i(t)) \text{ for all } t \in T,$$

where $N(\Lambda_i(t))$ represents the count of Λ_i at the instant $t \in T$.

Without going in detailed equations and further assuming a stationary technology and designating $Z = \{Q_1, Q_2, Q_3 \ldots . Q_m\}$ as a complete production system it is possible to obtain a balance sheet in the following form.

Assets	Liabilities
$\rho_1(t)\ X_1(t)$	
$\rho_2(t)\ X_2(t)$	
.	Net Worth
.	$\sum_{i=1}^{m} \rho_i(t)\ X_i(t)$
$\rho_m(t)\ X_m(t)$	
$\sum_{i=1}^{m} \rho_i(t)\ X_i(t)$	$\sum_{i=1}^{m} \rho_i(t)\ X_i(t)$

In this balance sheet $\{\rho_1, \rho_2, \rho_3, \ldots, \rho_m\}$ represent a set of valuation mappings for a $Z = \{Q_1, Q_2, \ldots\ldots, Q_m\}$. It should also be noted that consideration is being restricted to assets for which positive valuation coefficients are assigned (by assumption); liabilities will not show up by virtue of assumptions that (i) all transactions are cash transactions, and (ii) instantaneous delivery and payment take place. It is also possible to define profit from t_a to t_b as the change in the net worth from t_a to t_b and expand the system to include the present value concept. As a result

the following relationships can be obtanied:

$$NW(t) = NW(t_o) + \int_{t_o}^{t_b} \Pi(u)du \qquad (5)$$

$$= NW(t_o) + PROF(\tau_{o,t}), \text{ for all } t \in T$$

and $$V_T(z) = V_{t_o}(t_\tau) \qquad (6)$$

$$= NW(t_o) + v_{t_o}(t_\tau)$$

$$= NW(t_o) + \int_T \alpha(t)\, \Pi(t)\, dt.$$

The notation $V_T(z)$ represents the discounted value of the complete production system as a functioning entity over the planning horizon T. α refers to a discount mapping.

In other words, if the vector of time paths of the rates of replenishment is determined or chosen, then the vector of time paths of commodity stock levels is determined. From this change the net worth and consequently the profit for the enterprise is determined. If the collection of time paths z_i were chosen or defined then $V_T(z)$ would be determined. The value added concept is employed in selecting the manner of specifying the valuation coefficients (which are in turn used to give a value of net worth),and the basic starting values are market-determined "factor prices".

In the later stage one of the commodities is introduced in the system as an exchange commodity. It is conceived of as a degenerate stochastic commodity, and this commodity stock joins the collection constituting the complete production system and allows it to be linked to its economic environment. Thus it is defined a <u>firm</u>. The model relates nicely to and supplements the analysis of Hurwicz whose attention is focused on the "cash account". (Hurwicz, 1946)

Concluding Remarks and Future Directions

Though for years economic models have been constructed which have given recognition to uncertainty,(Knight, 1921), by and large the attention has been focused upon the uncertainty associated with external features of the environment, such as prices, interest rates, whether and crops, technology, etc. This study stands in contrast, then, by its attempt to deal with the uncertainty which prevails at the most basic level, even within the "certain" features of the environment. Therefore, it is important for both auditing and accounting and it could be extended in both directions .(Colantoni, 1968). For an application of the above ideas readers should refer the Pine Straw Company in (Gearing, 1966).

There are a multitude of directions which future efforts to extend the ideas presented in this paper. Among these, there are few which suggest themselves as being particularly important. First, the means must be provided for explicitly treating the dual aspect of capital inputs: the required presence of a level of capital as well as depletion. At the same time the analogous problem of treating labor as a "commodity stock" and "commodity input" must be dealt with. Second, 100% inspection assumption needs to be relaxed, in two steps: (1) let "measurement error" be introduced in the inspection activity, and (2) allow inspection of inputs by lot sampling methods. Both of these modifications could be introduced through the probability model of inspection, ψ_I. Third, there is a need to provide for the "compacting of measurement points" in going from the specifications of the inputs to a process to the specification of the produced commodity. This last improvement would be an answer to Prof. Sterling's argument for verification in present auditing.(Sterling, 1970) (This is in keeping with the fact that physical changes occur such that the physical features of an input are no longer identifiable in the produced commodity. This appears to be primarily an engineering problem.) Fourth, the decision problems in order to answer Prof. Paton's argument need to be given more extensive treatment than it is presented here.

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CAAS 1975 Conference
The University of Alberta

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PRICE LEVEL ACCOUNTING IN A REGULATED UTILITY

First of all, I would like to emphasize that the views that I shall express in this most delicate area are my personal views and not necessarily those of Bell Canada.

Between 1964 and 1974, the costs for various products and services across Canada went up by widely varying percentages: electricity, 49.5%; fuel oil, 104.4%; postage, 63.0%; gasoline, 57.5%. In the same time frame, the basic monthly residence telephone service increased only 15.6%. Bell Canada states, in its advertisements, that the reason for this relatively better performance can be found in the Company's own productivity and efficiency; specifically, increases in productivity averaging 5% - 6% per year; approximately twice the national average.

In this paper, I intend to set the stage with respect to the existing regulatory environment and its implications, and then discuss whether price level accounting might be considered a tool to improve the situation.

Regulated companies such as Bell Canada continue to suffer from "regulatory lag". This is the delay in not being able to implement new tariffs in response to changing economic conditions, because of the lengthy period between rate applications and their eventual implementation. In a period of inflation, regulated companies, in particular those regulated on historic cost, may suffer further from what I should like to call "inflationary lag". This is simply the problem caused by matching out-of-date costs (the historic ones) against current revenues in the regulatory formula. For an unregulated company matching is important because it is fundamental to the determination of net income for the period. For a regulated utility, its importance goes beyond this, for in addition to determining current net income, it also affects future revenues. This is why accountants in the regulatory area are so concerned with the concept and fair application of the principle of matching.

In the unregulated sector of the economy, subject to the constraints imposed by market conditions, companies may reflect inflationary increases in their own costs in the prices they charge. This is not socially irresponsible, as some commentators have charged. The increased selling prices of these companies may simply reflect the current costs of replacing the inventories sold or of replacing the fixed asset capacity used up during the

the period. Such companies can do this without showing the true economic current costs in their published income statements, though indeed showing these increased costs (as a technique of inflation accounting would) would, in most cases bring their illusory profits down to a more realistic level.

However, for regulated utilities in Canada, the regulatory process is tied to the historic costs reflected in the audited financial statements. Given the highly capital intensive nature of utilities, and the long life of their assets (for example, Bell Canada plant has an average life of close to 20 years), the changing prices of assets in terms of current costs are not recovered from the subscribers. Instead, when an asset is replaced, any increase in the asset price must be financed by the utility. So long as the productivity and efficiency of a utility improved at a higher rate than inflation, the problem was obscured from the regulators as well as from the public view, and thus shielded from the subscriber. But even a productivity rate of twice the national average cannot cope with double digit inflation.

What I shall discuss in the next few minutes is the means by which a more realistic presentation of the financial position of utilities might be developed together with an appreciation of the tools available.

In order to finance the growth and replacement of assets, private sector utilities are continuing to increase their demands for funds on the market place at a time when the competition for those funds is continually increasing. As a corollary, the demand for internally generated funds becomes more urgent. Under historic cost concepts, those funds can only be achieved through greater profits or a lower dividend pay-out ratio, or both, raising every conceivable political spectre.

As innumerable authors and commentators over the years, and particularly in recent, inflationary times, have felt called upon to articulate, the burning question of the day is "do the historic accounting concepts result in an illusory statement of profit?"

The Canadian Institute of Chartered Accountants has not stated that historic-cost-based financial statements result in the presentation of misleading information. Instead, the Institute reports on a number of methods of overcoming the limitations inherent in historic cost accounting. Specifically, the Institute deals, in its Accounting Guideline of December, 1974, with the technique of general price-level restatement. The objectives set out in the Guideline for this technique did not set out to give answers to the question I have just stated, but rather to stimulate the kinds of discussions that are being held here today. It is necessary, however, to review this question in the circumstances of the regulatory environment.

A description of the regulatory environment in Canada is appropriate, and I shall use that applicable to Bell Canada. The rate of return on the Company's average total capitalization is used as a test of the justness and reasonableness of the rate structure as a whole. Revenue requirements for the Company are considered to be equal to the sum of Costs (which comprise Expenses plus Taxes) and Return on Capital. At this time, Bell Canada is regulated on what is known as an Average Total Capital Base under which, once the Costs have been determined, the return on the annual average amounts of total capital outstanding in the test year is examined. In computing the return on total capital, the regulatory process takes into account, for the debt component of capital, the embedded cost of debt.

Thus, the regulated utility is not in a position to earn revenues reflecting the current opportunity cost of debt capital, except inasmuch as it might be reflected in the return on the equity component of capital. Further, because the revenue requirements are based directly on historic costs, it may be said that the purchasing power invested in these costs (whatever the nature of the costs) is not being fully recovered from the current revenues. In inflationary times, the costs recognized in any one year will be measured in dollars representing a diversity of purchasing power. To the extent that revenues and costs are therefore not expressed in a single common unit of purchasing power, the profit or return for that fiscal period does not present a profit expressed in dollars of constant purchasing power relevant to the fiscal period concerned. To this extent that profit is illusory; the well-known analogies of the "rubber ruler" and "apples and oranges" apply.

In regulated utilities, the overall price for services is dictated less by market place considerations than by regulatory principles involving the concept of total cost recovery. It is within the context of the allocation of this total cost recovery that it is important to settle the question of the impact of inflation on the application of historic cost techniques to the problem of inter-generational equity. In determining the inter-period allocation of costs, therefore, not only the financial viability of the enterprise must be considered, but also the equity of costs charged between different generations of consumers of the utilities' services. This is more of a concern in regulated utilities than in the non-regulated sector of industry, because of the requirement to charge rates to consumers that are just and reasonable.

Given, then, the regulatory environment I have described, and given that the profit based on historic costs is more "illusory" than "real" in terms of purchasing power, then I think that by deferring the impact of inflation, the present practices, based on historic costs, of achieving inter-generation equity between the consumers of a utility's services are placed in jeopardy.

While this most contentious point must be developed further through research by economists and accountants, it appears that the subscribers of tomorrow could be financing the consumption of assets by the subscribers of today.

The question then arises of whether there are available to utilities, and ultimately the regulatory authorities, techniques by which the situation might be corrected. For utilities, being capital intensive, the cost of depreciation generally assumes a far greater importance than is the case in most unregulated industrial groups. The precision, not to say accuracy, with which depreciation charges are computed by utilities is dazzling to those unfamiliar with the process. Given reasonable currency of other costs (including a relatively small amount of consumable inventories) utilities may be forgiven for addressing themselves therefore, to the problem of reflecting the changes in price levels both in the assets, the costs of which they must recover, and in the base on which they are regulated.

The CICA Guideline sets out, as I have said, the technique of general price-level restatement; as an "objective" of this technique, the Guideline says that "[the technique] indicates whether the general purchasing power of funds invested by shareholders, as represented by the recorded amount of shareholders' equity, has been maintained". To the extent that the utility and its regulator are concerned with the maintenance of the integrity of the shareholders' equity, this technique would therefore appear to be appropriate. I shall enlarge on some of the problems inherent in this technique shortly; but first I would like to comment on the fact that, except by happenstance, general price-level restatement, while it may well result in the maintenance of the integrity of the shareholders' equity, will not result in the maintenance of the integrity of a utility's assets. And here terminology is against me, for in current accounting parlance, anything that is not general price-level restatement is defined as coming under the broad umbrella of current value accounting. The introduction of "specific indices" might cause problems, because the concept of "value" in accounting has not, to my knowledge, been accepted anywhere in regulation in Canada.

I would now like to examine some of the constituent parts of the general price level restatement technique as it is presently propounded not only by the Canadian, but also by the American and British professional institutes. Basically, the techniques are the same, with some classification differences with regard to segregation between monetary and non-monetary items. However, in the United Kingdom, there is an example of a "quasi-regulated" utility setting rates with some regard to general price-level restatement techniques in the British Post Office, (B.P.O.). For some twenty years, long before the issuance of the British Institutes' professional statement on general price-level accounting, the B.P.O. has developed "supplementary depreciation"

charges in its income statement which reflect depreciation on its base of fixed assets (excluding certain assets, on a judgemental basis, such as land and buildings) adjusted for changes in price-levels. However, this is the only adjustment that the B.P.O. has made to date. No other part of the general price-level restatement technique has been adopted.

We have already seen that the current costs of assets are not reflected in the present method of determining revenue requirements. This problem may be alleviated somewhat by the use of general price-level accounting, but perhaps more accurately corrected by some form of current value accounting.

To reflect the current cost of debt is a much more difficult problem because of the question of reflecting price-level or purchasing power gains on long term debt. This is the flow of purchasing power from the holder of debt to the issuer, attributable to inflation having reduced in real terms the principal value of the debt that the issuer has to repay.

The first problem in dealing with the purchasing power gain is that of settling the continuing debate of whether the gain is realizable at all, let alone establishing when it is realized.

The second problem is how to measure the purchasing power gains. Interest rates are viewed as having three components: the basic risk-free real rate, the risk component, and the compensation for the expected inflation. Some of the apparent purchasing power gain, therefore, may not be a gain as such, but rather a gain that was anticipated by the bondholder and built into his required interest rate as an extra component when he initially purchased the bonds.

The third problem, which is particularly the concern of regulated utilities, is the question of how to account for the purchasing power gains and at the same time ensure the inter-generational equity in the rates charged to subscribers. By this I mean that a gain taken into account in determining revenue requirements in the regulatory process in any given year will benefit only subscribers in that year; but the equivalent restatement of assets in that year, will impact on revenue requirements in that and all the subsequent years in which depreciation, on the restated assets, is brought into account. If, however, the purchasing power gain were to be tied to the depreciation of assets, then the effect of inflation on both depreciation and on purchasing power gains and losses, are recognized in the same time frame. This then achieves the objective of inter-generational equity.

In considering how the gain in purchasing power might most appropriately be dealt with, it would be worthwhile considering what accounting treatment should be given to the interest adjustment which would result from the indexation of the capital

amount of debt. Would this amount be treated as a time period cost to be included in income or would it simply be treated as a movement within the overall restatement of the financial statements? Whatever the answer to that question, the full amount of interest, albeit fixed in rate, would be increasing as the capital sum increased and would be charged in full in the income statement.

I consider that the basic philosophies of general price-level restatement accounting have been well-developed, but the effect or impact of their application to actual cases will reveal that further empirical research is necessary to fully demonstrate the validity of the technique.

While the general price-level restatement technique may well be the proper tool for measuring the maintenance of the integrity of equity capital, the application of this technique to the measurement of the maintenance of the integrity of the assets of a utility is less certain.

As I have noted before, the conventional wisdom is that anything that is not general price-level accounting is labelled as being current value. However, I would submit that there might be an intermediate step, between general price-level accounting and full current value accounting, which would be to employ indices specific to a corporation or industry to restate the assets of a corporation in terms of the trends of the costs tied up in existing plant. Under current value accounting, including replacement cost accounting, there is a conceptual need to redesign the entire plant, in terms of current technology, in order to arrive at the appropriate numbers. Clearly for a utility this would be a most difficult task. The intermediate step that I would suggest is at least worth more detailed examination than it has hitherto received in Canada; in effect, it would restate the assets of a utility by restating the input component costs by specific indices. The problem remains of dealing with the impact of technological change. However, I do not consider that this would be beyond the ingenuity of economists and engineers to solve; if such indices are required for effective use of price-level accounting for regulatory purposes, they will surely be developed.

However, until further research has been done, I am not certain whether the employment of a number of indices, with different bases, in a single set of financial statements would cause as many problems as it solves.

In summary then, the use of price-level accounting in regulation is directed towards two objectives, the measurement of the maintenance of shareholders' equity and the achievement of inter-generational equity in the establishment of the appropriate inter-period allocation of costs. The tools to achieve these are conceptually available; the practical

application of these tools will require considerable experience in their use, and the development and improvement not only of the techniques but of the conceptualization necessary to evaluate definitions of costs, returns and profits that will result from the use of the techniques.

Hitherto, we as accountants, have been tied to the security blanket of historic costs on the basis of their objectivity and verifiability. Others have questioned this basis for security. Movement to general price-level restatement, while perhaps not a conceptual step towards the use of specific indices and value concepts, is at least a great psychological step away from historic costs, while retaining the characteristic of perceived objectivity of historic cost concepts. The application of general price-level restatement techniques will undoubtedly lead to a questioning of the results therefrom. If this results in further development of accounting procedures, whether for regulation or otherwise, the work will have been well spent. If it further brings out into the public view the limitations of historic-cost-based profits that are the result of the application of present accounting procedures in regulation which defer the impact of inflation on revenue requirements, with a resultant increase in internally generated funds, then utilities will survive a little longer.

Oscar Wilde said that the definition of a practical scheme was either one that was in place or one that could be put in place in existing circumstances. Many people have said that the use of price-level accounting in regulation is impractical, or even impossible. I think we have become aware in this second half of the twentieth century that nothing is impossible, and that the improbable is right around the corner. I consider that we should work towards the successful application of inflation accounting, whether using general or specific indices, with that idea in mind.

CAAS 1975 Conference
The University of Alberta

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PERCEPTIONS OF IMPORTANCE AND VARIABILITY

Introduction

For accounting communications to be effective accountants must have a knowledge of the information needs, and therefore the decision models, of the users of accounting information. Furthermore, the users of the information must have a knowledge of the activities of accountants.[1] This paper presents two studies that explore these issues.

Study 1

The accounting numbers that appear in published corporate annual reports are subject to a degree of variability. This variability can be caused by measurement error and, more significantly, by the measurement diversity which exists within the generally accepted accounting principles. This study determines whether financial analysts perceive accounting numbers as being determinate or variable.

Method

The participants were given an instruction sheet, a set of consolidated financial statements and a response questionnaire. The financial statements included, the Statement of Financial Condition, the Statement of Income, the Statement of Changes in Financial Position, Notes to Consolidated Financial Statements and the Report of Certified Public Accountants from the 1971 annual report of AKZONA Company. The name of the company and the name of the auditors were not revealed to the participants.

The participants were told that: the financial statements were extracted from the annual report of a large, public, diver-

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*This paper is an abridged version of a longer manuscript. The authors wish to thank Dr. Dave Jobson for his valuable assistance with the statistical analyses.

[1]This view is also expressed by Ijiri et al., 1966, p. 193 and American Accounting Association, 1969, p. 51.

sified corporation; they had been audited by a reputable CPA firm; they had been certified as conforming with generally accepted accounting principles.

The response questionnaire identified ten financial statement numbers -- current assets, cost of sales, current liabilities, depreciation and depletion expsense, total assets, interest expense, income reinvested, sales revenue, total liabilities and net income.

The participants were instructed to assume that another reputable CPA firm had been asked to prepare and audit another set of financial statements for the same year, using the same underlying data, in accordance with generally accepted accounting principles so as to present fairly the results of operations. Further, the second CPA firm had no knowledge of the accounting principles used to prepare the first set of statements and there was no need for consistency between the work of the two CPA firms.

For each of the ten financial statement numbers they were then asked for their personal estimate of the extreme upper and lower limits that the specified account balances could reasonably assume, when prepared and presented by the second CPA firm. The wording of each question was as follows:

> The reported (financial statement item) was (dollar amount). If another CPA firm was to prepare and audit these statements using generally accepted accounting principles, this figure could reasonably vary from:
>
> Minimum lower limit to maximum upper limit

The magnitude of the stated range was used as a statement of perceived variability in accounting data.

Participants

Four groups of volunteer participants were surveyed: thirty-five accounting majors (would be CPA's); seventeen finance majors (would be financial analysts); nineteen Certified Public Accountants; and eleven financial analysts. The student participants completed the questionnaire during regular class periods. Each professional was interviewed personally by the authors.

Results

Perceived variability was computed by subtracting the minimum lower limit for the financial statement number from the maximum upper limit. For each financial statement item a Kruskal-Wallis one way analysis of variance by ranks was computed to test the null hypothesis that the four samples were drawn from the same population. Significant ($p < .05$) differences were observed for current liabilities and sales revenue (Table 1).

Using ten per cent variation as a cut-off, all financial statement items, except sales revenue, were perceived to have a large degree of variability (Table 1).

Discussion

All groups perceived the measurement error or measurement diversity which exists within generally accepted accounting principles. Using CPA's estimates of variability as a standard, other groups have a fairly accurate knowledge of variability in accounting reports. In both cases where differences between subject groups exist, financial analysts perceive the greatest variability.

Study 2

In Study 1 we are concerned with the decision makers' knowledge of the accountants' activities. In this study we investigate the accountants' knowledge of the elements of a decision makers' decision model. Certified Public Accountants are asked to judge the importance of eight dimensions of a commercial bank industrial term loan decision. Their judgments are compared to those of bankers, the decision makers who make lending decisions.

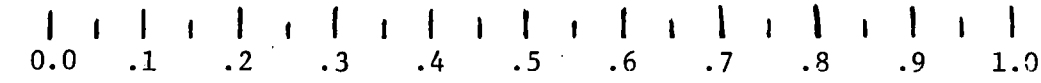
Method

A positive heuristic simulation model of bank procedures for analyzing business loan applications has been developed by Cohen, Gilmore, and Singer, 1966. This model identifies the dimensions of the loan decision. The eight dimensions used in this study were: expected profitability to bank of customer relationship (X_1); management competence (X_2); outside credit rating (X_3); bank's share of risk (X_4); firm's solvency (X_5); firm's profitability (X_6); ratio of requested loan to firm's total assets (X_7); and purpose for which loan is requested (X_8).

Each participant was given detailed instructions, an answer sheet and a deck of eight four-by-six cards with one dimension per card. They were asked to play the role of a senior loan officer with a large commercial bank and to imagine that they were approached by a Mr. Erasmus with a request for a $25,000 term loan for LCB Incorporated (a ficticious company). They had full authority and responsibility for deciding whether or not to grant the loan. All they knew about the company or Mr. Eramus was that:

1. Mr. Erasmus was the executive officer and manager of the LCB Company. The company was legally incorporated.
2. The LCB Company had been in operation for the past seven years.
3. Mr. Erasmus maintained his personal savings and chequing accounts and the chequing account for LCB with their bank.

The answer sheet contained eight of the following 0.0 to 1.0 scales:



The value of 0.0 meant no importance, 1.0 meant most important and 0.5 meant medium importance. The participants used these scales to assign a measure of relative importance to each of the dimensions of the loan decision.

The participants were told to rank order the dimensions in terms of the importance of each to their decision. Then they judged the relative importance of the eight dimensions. The eight dimensions were in random order in each deck of cards.

The judgment of relative importance proceeded as follows:

1. The most important dimension was assigned a measure of 1.0.
2. The importance of the least important dimension was judged relative to the most important. If this dimension was assigned a value of 0.0, meaning no importance, the second least important dimension was assessed.
3. The remaining dimensions were judged relative to both the most important and the least important.

The participants proceeded through the experiment at their own pace.

Participants

Four groups of volunteer participants were used: fourteen Bankers; nineteen Certified Public Accountants (CPA's); twelve undergraduate students majoring in finance and twelve undergraduate students majoring in accounting. The student volunteers were paid two dollars each. The experiment was administered in groups which varied in size from one to eleven people. Each session took about one hour.

Results

Table 2 presents the mean importance judgments for the four groups of participants for each of the eight dimensions of the term loan. Using a multivariate one-way analysis of variance a significant difference was found in the judgments of the four groups ($p = .02$). A univariate analysis of variance was then applied to each of the eight dimensions. The only dimension for which a significant difference among the four groups was observed was dimension X_7, ratio of requested loan to the firm's total assets, ($p = .04$). Relative to the bankers and the finance majors, the CPA's perceived this dimension to be more important. The accounting majors perceived it to be less important.

Discriminant analysis was used in an attempt to differentiate among the four groups with respect to their responses. A statistically significant difference in group discriminant score means occurred only with the first discriminant function ($p = .036$.) The function follows:

$$\bar{z} = .196X_1 + .222X_2 - .194X_3 + .489X_4 - .279X_5 + .517X_6 - .526X_7 + .120X_8$$

Dimensions with the largest absolute value for their discriminant coefficients have the greatest ability to discriminate among the four groups of subjects. X_7, ratio of loan to total assets, and X_6, firm's profitability, have the largest discriminant coefficients.

The sign of the discriminant coefficients is critical to the interpretation of group discriminant scores. Groups that score high on dimensions with positive discriminant coefficients and low on those with negative coefficients will have a relatively high group discriminant score ($\bar{z}$ value). The discriminant score means for the four groups of participants were as follows:

CPAs	.45
Bankers	.61
Accounting majors	.70
Finance majors	.72

The lower score for the CPAs is mainly due to their relatively high assessment of the importance of X_7. Classifying the dimensions according to the sign of their coefficients did not permit a general characterization of the response of the four groups.

Discussion

The CPAs had a reasonably good perception of the importance of the dimensions of the banker's term loan decision. Their perceptions differed from those of the bankers only with respect to one dimension, ratio of requested loan to firm's total assets.

Summary

This paper presented two studies that examined users' and accountants' perceptions. Study 1 looked at security analysts' perceptions of the variability in financial statement numbers. They perceived accounting information to be highly variable and their perceptions were fairly accurate relative to those of CPAs. Study 2 investigated CPAs perceptions of the importance of dimensions of bankers' term loan decisions. Relative to the bankers, the CPAs had a reasonably good perception of the importance of the dimensions.

TABLE 1. Average Perceived Variability, Per Cent Variability and Observed H Values for the Financial Statement Numbers

Financial Statement Numbers		C.P.A.s		Financial Analysts		Accounting Students		Finance Students		Observed H^2
	Reported Value[1]	A[1]	B	A[1]	B	A[1]	B	A[1]	B	
Current Assets	188	30.7	16	33.6	18	34.4	18	38.2	20	.89
Cost of sales	337	37.8	10	42.3	11	55.6	15	38.8	10	.22
Current Liabilities	78	16.1	21	35.2	45	9.4	12	13.7	18	10.97*
Depreciation and Depletion Expense	20	10.9	53	9.2	45	11.6	57	9.0	44	2.10
Total assets	491	63.0	13	102.1	21	84.0	17	90.5	18	1.76
Interest Expense[3]	6	0.6	10	0.1	2	1.1	20	0.6	11	2.04
Income Reinvested	200	31.8	16	52.3	26	38.7	19	25.6	13	5.05
Sales Revenues	506	17.7	3	46.2	9	31.3	6	34.2	7	9.20*
Total Liabilities	491	52.0	11	74.9	15	86.6	18	57.3	12	1.52
Net Income	26	22.8	89	15.5	60	16.7	65	13.6	53	1.94

[1]In millions of dollars

[2]Distributed as chi square with (k-1) = 3 d.f.

[3]Per cent variability was calculated before rounding

*Significant ($P < .05$)

A = Mean variability

B = Per cent variability

TABLE 2. Mean Importance Judgments

	Dimensions of Term Loan							
	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
Bankers	.59	.91	.43	.64	.86	.81	.40	.77
CPAs	.33	.78	.47	.64	.81	.86	.60	.71
Accounting majors	.46	.81	.57	.75	.80	.90	.29	.73
Finance majors	.56	.86	.25	.77	.74	.82	.39	.68

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A NATIONAL DREAM - ACCOUNTING STYLE

Introduction

This paper examines two concepts which, combined, become one man's vision of a National Dream - Accounting Style. Neither of the ideas is new, but it is felt worthwhile to resurrect them once again, in the hope that some fresh insights and additional prodding will bring them closer to fruition.

Accountancy is the only major profession in Canada, and elsewhere, that does not present a united front to the public. There are three major organizations with different rules and regulations, different educational requirements, and this coupled with a certain amount of internecine rivalry leads to confusion to outsiders and harms the image of the profession. The first proposal, therefore, is that the three professional accounting associations in Canada amalgamate under one banner.

The second proposal, to inaugurate professional schools of accountancy, will complement the first, but, more importantly, may very well be the catalyst required to implement amalgamation. This proposition has not been discussed to any great extent in Canada, but has received the support of the AICPA (Journal of Accountancy, 1973) and several prominent American universities, e.g. University of Missouri, are close to operational.

Merger

Rationale

Some progress has been made towards developing an integrated international accounting profession (CA, June 1974), but it is felt that more rapid advancement is being impeded by the fragmentation of the profession in each country. If the various accounting bodies in one country cannot resolve their differences, how much more difficult will it be to obtain any substantial agreement on an international basis! In Canada, several attempts have been made towards union at both the national and provincial levels but to date all have been aborted. (President's Message, 1974).

At the present time, there are approximately 20,000 Chartered Accountants in Canada, but only about 50% are in public practice. The balance work in industry, government or education. Most of the, roughly, 6,700 Registered Industrial Accountants are employed as management accountants in industry. The membership of about 4,400 Certified General Accountants are, also, primarily employed in industry or government, but some are in public practice. As is evident from the work performed, there is no rationale for the account-

ing bodies as they are presently constituted.

The current organizational setup also leaves much to be desired in that it is uneconomical and dissipates the limited human resources available to the profession. There are three national offices, three regional offices in most provinces, three sets of national examinations and three magazines to serve the 32,000 members, as well as considerable redundancy in the preparation of candidates. A consolidation cannot help but eliminate this seeming proliferation of bureaucratic and financial extravagence. By the same token, one strong accounting body would tend to have more influence at the governmental and educational levels.

Although the above considerations may be reason enough for a merger of the accounting bodies, greater advantage would accrue to both the public and the professional. The public does not readily recognize the differences, which are not too obvious, between the three designations and are confused by the proliferation of titles. This can only downgrade the image of the accountant as a professional. More importantly, though, is the individual who tends to see himself as a CA, an RIA or a CGA and not as a professional accountant. This seems to be the greatest shortcoming of the present system. In the other professions, it is the doctor, lawyer or engineer that is recognized as the professional, but in Accountancy, it is the organization that is recognized. Only when this situation is rectified will accounting take its rightful place amongst the other professions.

Barriers

It may well be asked why a merger has not been consummated with all the seeming advantages and few, if any, disadvantages. Some of the reasons may be deduced from a recent position paper prepared by the Professional Corporation of Industrial Accountants of Quebec (1975), setting forth their logic for withdrawing from a committee looking into the question of merger. The negative reasons are listed and answers are provided below.

Ethics. The obligations of the public accountant to his client are different from that of the management accountant to the firm at which he is employed.

This argument is difficult to accept if it is appreciated that a properly trained individual is a professional first and foremost. An analogy can be drawn between the professional engineer who very often is employed by a firm but is considered as professional as his confrère in public practice.

Denominations. This refers to different groups with the same designation having different rights and obligations, with one having the right to public practice and the other not so permitted.

This reservation can be resolved by requiring a common body of knowledge to acquire the professional designation. (A designation

that should be different from any of the present ones.) Additional training would be necessary for one to become a specialist in a particular area. This position is consistent with the other major professions. (College of Physicians, 1973, Law Society, 1972, Association, 1973). Furthermore, an individual would be able to recycle himself to change his specialty by taking additional courses and training. This is in line with the present trend towards professional development brought about by the constantly increasing and changing body of knowledge.

Diploma giving access to the profession. The educational requirements for acceptance into the student body of the various organizations are different. The CAs require a university degree while the RIAs and the CGAs are content with a Collegial Diploma (in Quebec).

In spite of the seemingly wide divergence, from a practical viewpoint, the variance is not actually too great for many students. In fact, many RIAs and CGAs do take their courses at a university and would only require a few additional ones to complete the undergraduate degree. With the proposal for professional schools of accountancy (see below), this apparent difficulty would automatically be resolved.

Apprenticeship. Different structures of supervision are required for the two main areas of activity, management accounting and public practice.

Apprenticeship as known today may be a vanishing concept. Several American states grant the CPA certificate without experience with formal schooling (Moonitz, 1973). Nevertheless, if the experience requirement is deemed necessary, it could be implemented at the specialist level after the basic designation has been earned.

National affiliation. Due to the reciprocity within each organization and between the provinces, it is felt that a unified profession in only one province would cause difficulties for those wishing to move out of that province.

This is seen as a valid criticism, if merger takes place in only one province. It is, therefore, suggested that negotiations be conducted at a national level simultaneously with those at the provincial levels. It is appreciated that this is not easily accomplished, particularly with the jealously guarded prerogatives of the provinces in educational matters. It is worthwhile noting, however, that the other professions have no difficulty with reciprocity, barring the special considerations of law. A doctor is a doctor anywhere in Canada, as holds true for the engineer and the dentist.

Synopsis

For accountancy to take its place amongst the other great

professions, it is essential that the individual be recognized as the professional rather than the organization. Merger of the existing associations would be an important step in this direction, and merger could become a reality if the positive rather than the negative aspects are emphasized. All that is required is the will to sublimate the status quo for a much greater potential future. Furthermore, Canada, with its relatively small population and the high expertise of the three associations, can prove to be the innovator in this area with this model acting as a guideline for other countries in similar situations.

Professional Schools

Unification would be a useful but not a necessary condition for the second part of the national dream to become a reality. The case for and against professional schools has been documented quite extensively, so this section is primarily a review of the literature.

A good overview of the whole subject of education for the accountant is given in an Appendix to a proposal for a school of professional accounting at North Texas State University (Education for the Accounting, 1974). The paper looks at the changes in educational requirements for the professional accountant over the years with the emphasis on the CPA designation. Various reports are examined which indicate the ever increasing academic requirements necessitated by the constantly expanded body of knowledge required by the accountant. After examining this evidence, the paper concludes that, although accounting as a profession can conceivably exist without professional schools, there is strong support from various sources endorsing these schools.

It may be appropriate to introduce one factor not mentioned in this paper which should be considered. When accounting was first introduced into the university, it formed only a small part of a liberal arts curriculum. As the body of knowledge for accountants increased, accounting courses supplanted liberal arts courses as required, since business-type courses were virtually non-existant. Over time, however, the other business disciplines such as finance, marketing, operations research and management began to creep into the curriculum and a Bachelor of Commerce degree was instituted, consisting of a few of these courses plus a majority of accounting courses. The expanding sophistication of the other areas of business after World War II rapidly used up all available spaces in the curriculum with insufficient room to accomodate the needs of the accounting profession thereby encouraging the establishment of professional schools of accounting.

Buckley (1970) writes from a background in consulting and education. In a stirring plea for change in the accounting curriculum, he states:

> "Accounting alone of the major professions pursues its destiny within an increasingly academic structure in the

> hope that it can benefit from close interaction with other business disciplines. The cost benefit of this association in the interest of the accounting profession requires a long overdue appraisal in terms of both positive and negative considerations".

Miller (1966),a long-time respected acamedician, emphasizes the interrelationship between accounting educators and the profession and ends his article with the following very significant quote.

> "It seems to me that if any profession settles for the "how to become" phisosophy as the contribution expected from collegiate education, it will sooner or later need to support some kind of professional institute or acknowledge that it isn't a profession at all" (italics added).

Savoie (1971), a vice-president of the AICPA, examines the advantages and disadvantages of professional schools and concludes that a few select universities could attempt to establish them. His view is strongly endorsed by no less an authority than Professor Paton (1971).

Lamden (1974) adds his voice to the call for professional schools from the viewpoint of the profession. He quotes from the Report of the American Accounting Association Committee on Professional Programmes (Accounting Review, 1968). Five points are summarized as follows:

1) Promote recognition of accounting on a par with law and medicine.
2) Effective control of curriculum.
3) Provide espirit de corps for students.
4) Would attract larger numbers and better qualified students and faculties.
5) Support financial and otherwise, from accounting firms and industry.

The next paper was part of a proposal to establish a School of Professional Accounting at the University of Texas at Austin. It provides a comprehensive view in favour of the schools. Many of the aforementioned points are reiterated by Summers (1974) and he adds the "functions of the transfer of knowledge from research and application in other disciplines (as well as in accounting) to accounting practitioners" as an important facet of schools of accounting. He feels that this function is not performed by present departments of accounting and only to a limited extent by the large firms and the professional organizations. Although a major portion of this paper is devoted to possible administrative structures for the potential school, Summers also lists and answers to his satisfaction the following possible objections to the schools:

1) The professional who fears a curtailment of new entrants to the profession.

2) The accounting faculty who fear the possible narrowness of the curriculum or their status if they cannot join a professional school.
3) The business faculty who fear a reduction in students, budgets and faculty, if they lose the accountants.
4) The university administrators who in general seem to fear change.

Conclusion

This abbreviated review has covered a wide spectrum of opinion on schools of professional accounting having regard to academe, the professional organization and the practitioner. The predominance of this opinion is that an attempt should be made in this direction, albeit with caution. Even Guy Trump (1972), as vice-president of the AICPA, in a well-thought out paper prepared for internal information, although recommending endorsement of the concept to the institute, only requests a task force to examine the question further.

The situation in Canada is quite similar to the position in the U.S.A. It seems inevitable that these schools will be established in the U.S.A., as several have already indicated that they are going in this direction; so there is no doubt that with the appropriate time lag, they will be established in Canada also. It is averred, however, that the need is greater in Canada and, therefore, they should be instituted here without delay. It seems axiomatic that, to allow for adequate preparation in accounting, the support of the profession and the organizations is required. Due to the relatively small size of the Canadian accounting population, very little support is offered by the accounting firms to the universities, but these accounting firms do quite a bit of training on their own. It may be possible for the schools to undertake some of the training presently done by the accounting firms. Because of the fragmentations of the professional organization, the same holds true in that area. One merged organization would be able to offer some support to a few select universities across Canada, and the professional schools would be able to supply the research facilities so desperately required by the profession.

Canada can lead the world in establishing professional schools in accounting aided by advice, faculty and funds from the profession and one strong unified accounting association. A combination and realization of these two proposals would help to fulfil a National Dream - Accounting Style.

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THE CONCEPT OF EFFECTIVE CONTROL AS A FINANCIAL REPORTING CRITERION

Introduction

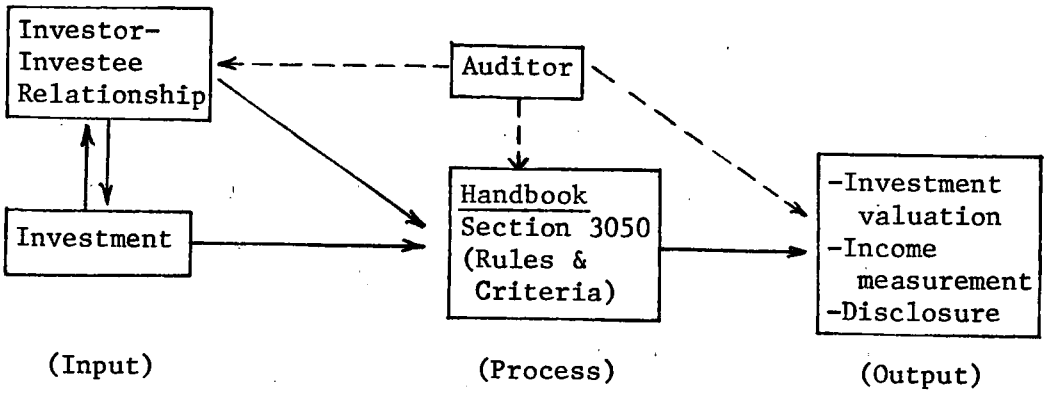
The accounting problems which this paper discusses became obvious in the development of an internal training course for Touche Ross on accounting for long term inter-corporate investments and business combinations. The concept of effective control (or significant influence - we will use these terms synonomously) is a central criterion for the choice of accounting treatment in inter-corporate situations. That is, the degree to which one company influences the management of another is the criterion which decides which method of accounting will be used to record the inter-corporate investment income in the books of the investor company. It is also the criterion which determines whether a business combination can be pooled. But the concept is not clearly defined in the professional literature and doesn't appear to be clearly understood by practitioners.

The problem is important in two major respects. First, there can be large differences in the income of the investor company, depending on whether the cost or equity method is used. Secondly, the equity method raises difficult auditing problems, chief among them being reliance on accounting numbers in investee financial statements. The discussion in this paper will follow this sequence:

- The usefulness of the professional literature to the practising accountant.
- Needs of users, the organizational behaviour aspects of effective control and a definition of it to help accountants apply the concept.
- The problems and opportunities for the practitioner applying the concept.
- Some problems which need to be researched.

The Professional Literature

Section 3050 of the CICA Handbook (CICA, 1972) deals with several methods for accounting for long-term inter-corporate investments. The decision process faced by the auditor in applying the Handbook can be represented by the following diagram:



We see that the inputs to the decision process are the nature of the investment and the control relationship between investor and investee as perceived by the auditor. The model also indicates that judgement has to be applied by the auditor in determining the appropriate accounting method. This application of judgement produces the possibility of differences in recommended accounting treatment from auditor to auditor. It also emphasizes that auditors must be able to assess the relationship between the investor and the investee in deciding both a) the appropriate generally accepted accounting principles to be used and b) the fair presentation of the investment.

In this paper we shall discuss the CICA recommended decision process for choosing between accounting methods. We will not be discussing the fairness of the income figures as measures of per-performance or asset valuations.

The CICA contemplates at least three types of investee-investor relationships. These are:

1. The investor has voting control over the investee.
2. The investor has influence in operating and financial decisions of the investee.
3. The investor has no influence with the investee.

The Handbook suggests at least two interpretations of inter-corporate influence. Consider Section 3050.18:

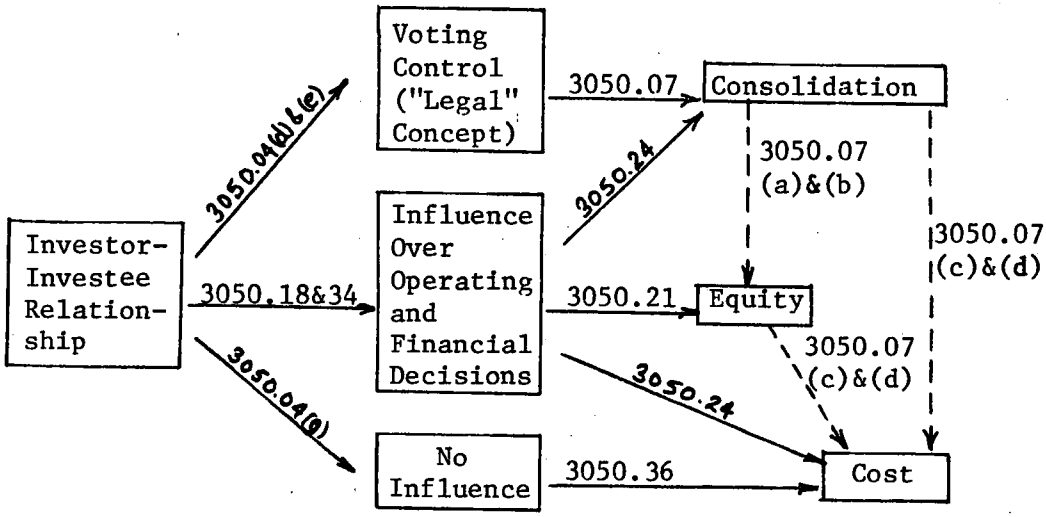
> The equity method is generally most appropriate if an investment enables the investor to exercise effective control over the operating and financial decisions of a non-consolidated investee. The investor then has a degree of responsibility for the return on its investment, and it is appropriate to include in the results of operations of the investor its share of income or losses of the investee. (CICA, 1972)

This paragraph implies that if the investor has control over the decision-making of the investee then it has a degree of res-

ponsibility then it should use the equity method which allows the investor to be held accountable for the profits earned by the investee. It is also interesting to note the use of the words "most approriate if an investment enables the investor to exercise effective control over the operating and financial decisions of a non-consolidated investee". This suggests that effective control is not a legal concept but a behavioural one when dealing with influence over the investee decision making. We shall now contrast this definition with the formal definition of an effectively controlled company presented in Paragraph 3050.04 (e);

> An effectively controlled company is a company which, though not a subsidiary of the investor, is effectively controlled by the investor. Whether a company is effectively controlled is a matter to be determined in the particular circumstances. Examples of circumstances entering into the determination may include:
>
> 1. continued ability to obtain proxies from other shareholders;
>
> 2. ownership of voting shares by officers, employees, nominees, or other persons having subordinated interests;
>
> 3. inactivity of minority shareholders who do not attend shareholders' meetings or do not give proxies;
>
> 4. possession of a lease or other contract which carries with it the virtual ownership of assets without formal ownership of a majority of outstanding voting shares;
>
> 5. holding of rights, options, warrants, convertible debt or convertible preferred shares, the exercise of which is a reasonable possibility and would result in a controlling interest in voting shares.

Here we find a circular definition of effective control and one which needs to be interpreted in the light of particular circumstances. The circumstances suggested in the Handbook represent a legalistic notion of control, focusing as they do on such things as potential voting control and ownership of assets through contracts. In 3050.04(e) we thus have a quite different notion of investor control over the investee. The control relationships suggested in the Handbook and resulting accounting treatments can be portrayed as follows:



<------ indicates contingencies forcing the income accounting to be placed on a more conservative basis, e.g. problems with repatriation of earnings.

The "voting control" situation, which includes both potential and actual voting control, usually presents no problem to the auditor. This case is easily diagnosed and verifiable evidence usually will exist upon which the auditor can base his decision. The "no influence" situation does not usually present a problem unless the investor has potential influence over the investee. The middle case presents most of the interpretation problems. The phrase "effective control over operating and financial decisions" is sufficiently vague to permit a wide range of interpretations. Moreover, problems of definition occur frequently in practice. Consider, for instance, the step-by-step purchase situation in which effective control over decision making probably occurs before the investor obtains voting control.

The lack of guidelines in the Handbook enabling auditors to assess whether an investor is exerting influence over the decision-making of an investee present important implementation problems for this Section. We shall now consider the position taken by the Accounting Principles Board in Opinion No.18 (AICPA, 1971)

> "The Board concludes that the equity method of accounting ... should be followed by an investor whose investment in voting stock gives it the ability to exercise significant influence over operating and financial policies of an investee even though the investor holds 50% or less of the voting stock." (Paragraph 17)

This opinion goes on to propose what is in effect a behavioural concept of effective control - in their terms, significant influence - which focuses on an investor's influence over an investee's operating and financial policies. But the APB provides helpful guidance to practitioners by identifying six possible

indicators of significant influence:

- Representation on board of directors
- Participation in policy making processes
- Material intercompany transactions
- Interchange of managerial personnel
- Technology dependency
- Concentration of share ownership relative to other shareholders (Paragraph 17)

These indicators suggest to the auditor that significant influence can occur from several different sources in the investee-investor relationship. However, the Accounting Principles Board was apparently concerned that implementation of this concept might be too difficult for accountants in practice and adopted a "fallback" criterion:

> "In order to achieve a reasonable degree of uniformity in application, the Board concludes that an investment (direct or indirect) of 20% or more of the voting stock of an investee should lead to a presumption that in the absence of evidence to the contrary an investor has the ability to exercise significant influence over an investee. Conversely, an investment of less than 20% of the voting stock of an investee should lead to a presumption that an investor does not have the ability to exercise significant influence unless such ability can be clearly demonstrated"
> (APB 18: Paragraph 17)

By stating an arbitrary rule based solely on a percentage of inter-corporate shareholdings, the APB has effectively discouraged the auditor from assessing inter-corporate influence. It would be difficult for an auditor to argue that a client with 30% of an investee's shares did not have significant influence when the client can point to the rule-book. This in turn witholds from the reader information on influence relationships which exist between investor and investee companies. Others will argue, however, that the APB rule is easy to apply in practice and does ensure consistent application. The APB's approach has recently been followed by the International Accounting Standards Committee in its exposure draft on the equity method. Paragraph 15 of this draft defines significant influence in these terms:

> "Significant influence is participation in financial and operating policy dicisions of the investee but not control (as defined as Paragraph 7) of those policies. The exercise of significant influence may be achieved in several ways, for example, by representation on the board of directors, participation in policy making processes, material intercompany transactions, interchange of managerial personnel, or dependency on technical information. If the investor holds less than 20% of the voting power of the investee, it should be presumed that the investor does not have the abi-

lity to exercise significant influence, unless such ability can be clearly demonstrated." (IASC, 1974)

Here we see the same fear perhaps, that accountants cannot in practice assess the control relationships. This IASC draft is particularly concerning because it threatens a Canadian accounting practice in a number of ways:

1. It reinforces the notion that an easy crutch is available to the practitioner when he is faced with the difficult problem of assessing inter-corporate relationships.
2. This crutch becomes particularly attractive not only because of the difficulty of the task but because control relationships in Section 3050 are inadequately defined and explained.
3. The relationship of the IASC to Canadian practice is unclear at this point in time.

Our conclusions to this point can be summarized as follows: effective control or significant influence is a concept requiring explanation in behavioural terms; it is not an accounting or legal concept. Accountants, if they are to apply this concept in practice, must understand the behavioural underpinnings of inter-corporate influence.

The Concept of Significant Influence

A basic assumption of this paper is that the purpose of financial statements is to help users predict performance of enterprises. Since corporate performance is what people do, under managements, we have made another assumption: the performance of one (or all) of the companies in a related set will be partially determined by the nature of the inter-corporate relationships which exist. Neither of these assumptions are counter-intuitive, but they need to be stated.

In the case of inter-corporate investments, and from the point of view of users trying to predict corporate performance, the more financial reporting can disclose the actual inter-corporate relationships the more useful it should be for predicting performance. Therefore, as between the equity and cost methods of accounting, the choice of method should be able to tell the statement reader something useful about the inter-corporate relationship to help him or her make that performance prediction. Specifically, if the equity method is used it should indicate that the influence relationship is of a particular nature, and if the cost method is used, it should mean something else.

If we want to make the statements useful in this way, we need a criterion for the choice of method which makes the choice reflect as closely as possible the actual situation. We therefore should have some idea of what organizations tend to do under

different types of circumstances. That is, we need a contingency theory of organization action.

What theoretical frameworks do we have? When we turn to the organizational behavioural literature, we find that writers have dealt with the behaviour of single organizations, either relating to their environments or organizing and controlling themselves internally. Some of the better known writing which has emerged in this area has been done by Thompson (1967), Cyert and March (1963), Lawrence and Lorsch (1967), Simon (1957), Anthony (1972), and Dalton (1971). Since the scope of this paper cannot embrace the theories and organizational propositions of each of these writers, we will attempt to generalize with a single common denominator statement:

> Organizations seek to structure their environments and/or themselves to reduce uncertainty and conflict.

An assumption in most of the literature, and in this paper, is that organizations operate under norms of rationality, that is, external pressure for results. From the various propositions advanced by these writers on organizations and their environments we can formulate more specific propositions relevant to intercorporate relations:

Proposition 1:

> If long-term contracts cannot be negotiated or do not sufficiently reduce perceived environmental uncertainty, an investor company will seek influence through investment in a strategically-important investee.

Proposition 2:

> Where an investment is sought primarily as a source of income, the investor company will tend to invest in a company which represents a set of variables similar to its own (i.e. industry, technology, management style, etc.).

Proposition 3:

> The investor company will tend to impose its own search and decision patterns on an investee, i.e. extend its own "standard operating procedures".

Proposition 4:

> An investee, if it cannot "co-opt" or otherwise obtain a relationship with an investor which allows it to retain its own standard operating procedures without anxiety or debiliting conflict, will tend to adopt those of the investor.

Proposition 4 must be held suspect, however, because while leader chrisma, reward-system and "expert power" influences (French and Raven, 1959) may operate to induce acceptance of an investor's norms, factors such as cultural differences, reward-systems, resistance to control (Dalton, 1971) or need for organizational differentiation (Lawrence and Lorsch, 1967) can operate

against adoption of norms.

At this stage we might make the observation, "what does it say that a smart cookie manager wouldn't already know?" One thing that the organizational literature would say is that legal relationships are not everything. This is important because, as we have seen, public accountants may be prone to think too much in terms of legalistic relationships. But one variable which a "smart cookie" manager would consider, and which is not dealt with in the organization/environment literature, in our opinion, is the goals, motivations and value systems of the chief executive officer, his top management group and members of the Board. The extensive research literature on leadership alone would suggest that these will affect the type of inter-corporate investment made and the nature of the resulting relationship. Thus the literature focusing on organizational motivations would not necessarily explain investments, conglomerates, or mergers created to satisfy the personal achievement or power needs of a chief executive officer or top management group.

But from the organizational literature and what else we can add intuitively, we can conclude that organizations will tend to influence others through investments and other means, and that investee organizations will be influenced. We can also safely say that, depending on the nature of the influence, performance of an investee will alter, and quite possibly that of the investor also, depending on the commitments it makes. The statement user will therefore want to know whether an investor company's involvement with an investee is likely to cause a difference in performance of the investee, which in turn makes a difference to the investor's financial performance. If the choice of an investor's accounting method is designed to indicate whether the investor is making this type of impact, we need a criterion which will suggest what to look for in order to tell if the relationship actually makes a difference. As the famous psychologist Tolman put it, "A difference is not a difference unless it makes a difference". So we will now offer a definition of significant influence, but we will use the terminology "effective control" because that is the terminology of the CICA Handbook.

Effective control is that state of intercorporate influence which causes current or potential management activities of an investee to be altered significantly.

By alteration of management activities, we mean that the investee's performance options have been altered from what they would have been at a lower level of investor involvement or with no involvement, and by performance options we mean such factors as the investee's corporate strategy, business investments, financing, capital budgeting, technology development, transfer pricing, supplier or customer decisions, staffing, or promotions and other reward systems. In other words, we are interested in those management-activity factors which are important for the performance

of the investee.

"Significant" means that, in total, the options of the investee company are changed by the investment in such a way that a knowledgeable statement user, looking at each company in a "before" condition, would likely make different investment decisions from those he or she would make in an "after" condition.

If we can have the choice of accounting method disclose situations of significant influence, what it says to the user is:

> "Pay attention: the investee's options have been altered because of this investment and you should consider the impact of this in predicting performance."

Now, how do we translate this into choice of accounting method, operationally? We propose that we should consider four basic conditions of inter-corporate relationships, that is, for simplicity we will force relationships into one of four different conditions.

Condition 1:

> Investor intends influence and evidence suggests that the investee is significantly influenced.

Condition 2:

> Investor intends influence but evidence suggests that the investee is <u>not</u> significantly influenced.

Condition 3:

> Investor has potential influence but is passive. Yet evidence suggests that the investee <u>is</u> significantly influenced.

Condition 4:

> Investor has potential influence but is passive, and evidence suggests that the investee is <u>not</u> significantly influenced.

These conditions, and the choice of accounting method, can be shown schematically as follows:

DETERMINATION OF ACCOUNTING METHOD

	Evidence Suggests Investee Significantly Influenced	Evidence Suggests Investee <u>Not</u> Significantly Influenced
Investor Intends Influence	(1) Equity	(2) Cost
Investor Has Potential Influence <u>But is Passive</u>	(3) Equity	(4) ?

Condition (1) would signify the equity method, and there should be no quarrel with this; it is what the organizational literature would point to, and practitioners would accept it as the main condition of effective control.

In Condition (2), the investment could make a difference eventually, but is not influential at the moment. For instance, we could have a situation in which an owner-founder owned 60% of the shares and an investor company had 40%. The owner-founder might be totally unmoved by the recommendations of the investor company as to strategic options, capital expenditures, etc. Or, we could have a situation in which the investment in an investee was received with hostility by the investee's top management.

In Condition (3), the investment makes a difference but we have to look closely at the investee's behaviour to assess it. An analogy would be the case of a person who assumes control over the salary and career options of a subordinate. Immediately, the subordinate's perceptions of his desired behaviour alter to accomodate what he thinks his superior wants, without the superior having to do anything in particular. The same condition could apply to corporate managements.

For Conditions (1) and (3), it could be argued that investor performance should be measured against what the investor management intended to accomplish, and therefore a passive investor condition should not produce effective control regardless of how the investee appears to be reacting. However, it is likely that the shareholder or analyst judging performance would incorporate the opportunity costs of inaction by an investor company when it has an investee which responds in an influence setting.

Condition (4) is perhaps the most interesting case. The question is whether condition (4) should constitute effective control, since knowledge of potential external influence of the investee could alter a user's performance predictions through probability assessments. In other words, the investor company may not be exerting on influence today, but it could next Monday morning. Our tentative conclusion here is that deeming condition (4) to be effective control is not feasible because of the measurement problems it involves. It is difficult enough for the auditor to know the minds of the investor client's top management and Board - although he should - let alone the investee, with whom he may have no association. Also, it is likely that knowledgeable users tend to confine themselves to actual current relationships in making performance predictions.

To sum up, the auditor should be able to assess whether conditions (1), (2) and (3) obtain, but the assumptions necessary to include condition (4) as effective control may not be verifiable. If we then have a definition of significant influence in terms of the needs of users, we are still faced with the problem of applying it.

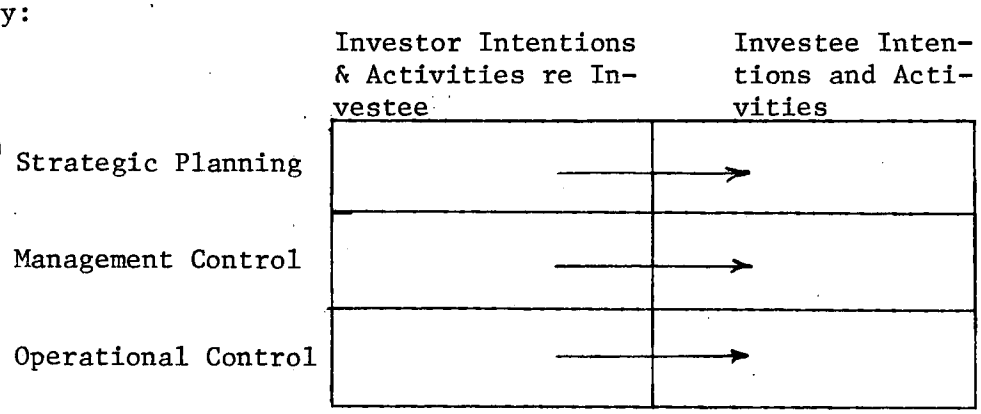
This is an audit fieldwork problem for the public accountant and we will now discuss what problems are presented for auditors in assessing inter-corporate relationships and how they might be overcome.

Applying the Concept of Effective Control

We suggest that the proposed definition of effective control is superior to the various CICA Handbook notions in a number of ways.

1. It is compatible with the notion of responsibility as expressed in 3050.18. That is, if the investor is able to change the options in management of activities, then he should be responsible for the outcome.
2. The definition demands that the auditor obtain a thorough understanding of the investor's intentions with respect to the investment.
3. The definition focuses the auditor's attention onto investee management activities as well, which should be capable of assessment through observation and inquiry. Knowledge of the investee(s) adds to the knowledge of the client investor.
4. The definition highlights the investor "passive" case as well as the situation where the investor actively exerts influence over the investee.
5. Application of this definition to practice should help produce accounting methods which convey useful information to readers of financial statements concerning the control relationships between the investor and the investee.

Although this definition points us in the right direction, we still have problems of implementation. These problems can be outlined by reconsidering the matix in Section II. The auditor's problem is to determine which quadrant best represents the investor/investee relationship. To do this he must be able to identify how the investor exerts influence over the investee. We suggest that the Anthony (1972) three-level model of management processes is one useful way of analyzing this problem. Diagramatically:



The rows in the above diagram represent the three levels of management planning and control which exists in every corporation. The first column represents the investor's intentions towards the investee and the second column represents the activities of the investee. For example, an investor may make a decision to protect a source of supply by taking a 40% shareholder investment in an investee. This decision may have implications for the investee's strategic planning process in that the investor may influence the long-term planning decisions of the investee re new product development research and development programs, etc. which will be congruent with the investor's objectives. Similarly, the investor may undertake specific management control procedures to protect its investments such as imposing the same annual budgeting and promotion control procedures on the investee. At the operational level we can have such factors as maintenance of inter-corporate purchase transactions.

We have used the Anthony framework simply to show that it is possible for auditors to construct their own frameworks to analyze the intercorporate relationship in terms of key "nerve-points" of influence. Knowledge of an investee company may be very imperfect, but there are various sources of unobtrusive measures which auditors can use, such as financial press or trade publication data, Board makeup, personnel transfers, ability of the investor to obtain financial information or dividends from the investee, etc.

Areas For Research

Although we feel the approach to effective control advanced here will help users, we are aware that it is not without significant implementation problems. Some of the problems which should be addressed jointly by academic and practicing accountants are:

1. Training in the audit function as provided by CA firms and business schools does not provide adequate skills for assessing inter-corporate incluence, something auditors must now do. Curricula should be re-examined in the light of the need for those skills if auditors are to press for and verify better financial reporting for intercorporate situations.

2. Given that auditors develop standard measures to assess intercorporate relationships, their assessments could provide valuable research data for investigators seeking to build contingency theories of intercorporate performance.

3. Throughout this paper we have confined ourselves to situations of intercorporate shareholdings. What is the best accounting treatment if management in one company exerts significant influence over the management in another company but has no inter-corporate shareholdings? What does this imply for the definition of the reporting

entity?

4. Subject to further research on user needs, disclosure requirements should be strengthened to provide additional information which allows the knowledgeable user to compute income from major investments on bases not used on the income statement itself. Readers of investee statements should also be told what investments in that company constitute significant influence. Further, consideration should be given to disclosure requirements which would give investor company statement users information on the nature of the relationship with respect to at least the six factors set out in APB18, Paragraph 17 for both investee and investor.

5. The last suggested area for research is that of user needs:

   (a) Is the investor-investee influence relationship important to those who make influential investment decisions in Canada?

   (b) What do analysts think about the relative usefulness of equity, cost and market methods in various circumstances?

However the underlying issue, which become apparent as soon as we started to explore the equity-cost problem and which is fundamental to all reporting problems, is whether the accounting profession knows who the key users of financial statements are in Canada, what their needs are, how they seek and process information and what their competence is. The Trueblood Report (AICPA, 1973) in effect ducked the user issue, and research to date is neither extensive or conclusive on user needs. Yet it seems less than satisfactory for the accounting profession to continue to base pronouncements and recommendations on <u>intuitive</u> assessments of user needs in the particular reporting areas subject to pronouncements. From interviews with ten financial analysts in Montreal and Toronto, conducted over the last year by one of the authors of this paper, we offer the following tentative observations:

1. It would appear that the more senior the analyst, the less use he makes of financial statements relative to other sources of information.

2. Some analysts may be doing what amounts to a "ritual dance". There seem to be significant differences in analysts' skills and approaches, although their professional development courses are improving at an increasing rate.

Efficient market hypothesis research is undoubtedly fruitful (for a summary and example, see Beaver, 1972; Ball, 1972) but circumvents the black box of user processes. Yet if we want to have information which allows us to <u>predict</u> what kinds of buy-

sell recommendations with significant economic impact in Canada will be made under various types of circumstances we must know why investment decisions are reached as they are. This need for explanatory contingency theories is in common with all areas of organizational behaviour research.

A review of the research which does try to find out what is important to users (as examples see Barrett, 1971; Mlynarczyk, 1969; Singhvi and Desai, 1971) suggests that in-depth interviews with senior analysts are needed to design research which the investment analysts will consider both realistic and important enough, to them, to support. In Canada, the key or influential users in fact might be a very small number for any particular industry, unlike the more complex situation in the United States. Research to find out how and to what extent financial statements are used is probably of manageable proportions in Canada, given that the accounting profession considers it important.

CAAS 1975 Conference

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INDUSTRY SECTOR ESTIMATES OF PRICE-LEVEL ADJUSTED EARNINGS

Introduction

After years of discussion it is likely that financial statements adjusted for general price level changes will soon appear in Canada and elsewhere (C.I.C.A. 1974, FASB 1974, ICAEW 1974). Some firms are beginning to publish selected items of financial information on a price level adjusted basis. In the early stages it will be difficult to interpret and absorb this new information as it does not fit neatly into established modes of thought and analysis. The purpose of this paper is to present a macro view of the impact which general price level adjustments are likely to have on the reported profitability of the industrial sector of the Canadian economy. It is not the purpose to argue either for or against general price level adjustments but simply to estimate the magnitude and direction of such adjustments.

Most of the available reports on implementation of price level adjustments emphasize the higher cost of goods sold and depreciation expense measures. This is particularly so of those results published in the financial press. Seldom is the impact of inflation on net monetary position mentioned nor the results of measuring sales revenue in higher year end dollars. This study began with the hypothesis that, contrary to conventional wisdom, price level adjusted earnings of the industrial sector would be higher than historically reported net income. The industrial sector is a net debtor and would show significant price level gains on net monetary debt. This should more than offset the higher measure of depreciation. Rolling forward sales revenue into year end dollars should be as large an adjustment as rolling forward cost of goods sold. While inventory costs are "older" sales revenue is larger.

The hypothesis was not established but rather was refuted (see Exhibit 2). The gain in monetary debt did not quite offset the increased depreciation and the adjustment to sales revenue and other items did not offset the inventory adjustment. The detailed results are presented in the remainder of the paper. The reader is cautioned that the crude estimation methods which must be employed when working with aggregate data can yield little more than general relationships.

The Industrial Sector: Year To Year

Exhibit 1 presents condensed Income Statements for the Total All Industry sector [1] for 1972 and 1973 on both a historical and a price level adjusted basis. Some common ratios and relationships derived from these comparative statements are also presented. Of particular interest is the impact on return assets employed. The asset base is increased by price level adjustment while, for this sector, the profit before interest but after taxes is decreased. Both of these changes serve to reduce the ratio from its counterpart on a historical dollar basis.

Sub Sectors and Causal Analysis

Exhibit 2 presents a breakdown of the Industrial sector by subsectors as well as in terms of the main items of expense or gain affected by general price level adjustments. It also presents the same data expressed as a percentage of reported net income.

The adjustments for each subsector (mining, manufacturing etc.) were independently derived for that subsector from the financial data for that subsector. At the same time the adjustments for the Industrial Sector as a whole were derived from the aggregate data for the total sector. The discrepancy between these two sets of estimates was only 2.5% in total although the discrepancies on inventory and current year items were larger but offsetting.

The largest impact on net income of price level adjusting is the inventory adjustment. The inventory costs deducted as an expense on the historical income statement are not necessarily very old but they are a large item of expense. The price level adjustment to inventory costs reduced net income by $6,239 million or 82.9% of reported net income (Exhibit 2). Naturally the inventory adjustment had the largest percentage impact on the wholesale and retail subsectors, and the lowest in the transportation, communication, and utilities subsectors.

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[1] Source: The historical data is summarized from Statistics Canada quarterly data Industrial Corporation Financial Statistics. The price level adjusted data has been derived working from that data base. At the time of writing the 1974 fourth quarter data was not available. If the 1974 data becomes available in sufficient time you may find 1974 data presented in Exhibits 1 and 2B even though there is no reference to such data in the text. A technical note on the estimation procedures appears at the end of the paper.

TOTAL ALL INDUSTRIES

CONDENSED COMPARATIVE INCOME STATEMENTS
($000,000)

Exhibit 1

	As Reported			Price Level Adjusted In End 1974 $		
	1972	1973	1974	1972	1973	1974
Sales	126,087	151,698	186,177	160,067	178,861	194,062
Cost of goods sold and operating expenses	(112,841)	(134,409)	(164,247)	(144,380)	(160,479)	(174,456)
Depreciation, depletion and amortization	(4,198)	(4,747)	(5,230)	(7,078)	(8,265)	(8,900)
Interest	(1,810)	(2,118)	(2,949)	(2,299)	(2,498)	(3,069)
Exploration and development	(351)	(403)	(468)	(446)	(476)	(488)
Other income	1,341	1,661	2,111	1,701	1,956	2,199
Gains (losses) on sale of assets	150	121	124	-	-	-
Price level gains (losses) on net debt				1,605	2,805	4,414
Pre tax net income	8,378	11,803	15,518	9,170	11,904	13,762
Income tax	(2,986)	(4,198)	(6,217)	(3,790)	(4,945)	(6,485)
Extraordinary gains (losses)	(136)	(76)	(75)	(170)	(97)	(75)
Net income	5,256	7,529	9,226	5,210	6,862	7,202
Net income expressed in end 1972 $				4,181	-	-
Net income expressed in end 1973 $				4,567	6,013	-
Ratios and Relationships						
Change in sales revenue from previous year		+ 20%	+ 23%		+ 12%	+ 8%
Net income - previous year		+ 43%	+ 23%		+ 32%	+ 5%
Net income - % of sales revenue	4.2%	5.0%	5.0%	3.3%	3.8%	3.7%
Income tax as a % of pre tax income	35.6%	35.6%	40.1%	41.3%	41.5%	47.1%
Return on assets employed (income after tax; before interest ÷ assets at beginning of year)	7.2%	9.1%	10.2%	4.8%	5.9%	5.8%
Price level adjusted income as % of historical				79.5%	79.9%	78.1%

IMPACT OF PRICE LEVEL ADJUSTMENTS TO INDUSTRIAL SECTOR NET INCOME CANADA 1973 Exhibit 2

		Price Level Adjustments Increasing (Decreasing) Net Income					
	Reported Net Income	Current Yr Items	Inventory	Depreciation & Amortization	Gains (losses) Monetary Position	Other	Price Level Adjusted Net Income
Measured in $000,000	Historical $						end 73$
Total mining	$1572	$ 210	($ 218)	($ 470)	$ 301	($ 13)	$1382
Total manufacturing	3732	2463	(3251)	(1102)	872	(60)	2654
Transportation	378	45	(32)	(246)	361	(30)	476
Storage	37	21	(51)	(11)	40	(1)	35
Communication	285	33	(20)	(189)	274	(11)	372
Utilities	142	24	(10)	(95)	226	(1)	286
Wholesale trade	672	747	(1014)	(72)	131	(3)	461
Retail trade	435	697	(1073)	(114)	296	(17)	224
Community, business & personal service	276	66	(76)	(92)	116	(13)	277
Total of separate subsectors	7529	4306	(5745)	(2391)	2617	(149)	6167
Estimation discrepancy		577	(494)	(106)	(159)	28	(154)
Total all industries	$7529	$4883	($6239)	($2497)	$2458	($121)	$6013
Expressed as % of reported net income							
Total mining	100%	13.4%	(13.9%)	(29.9%)	19.1%	(.8%)	87.9%
Total manufacturing	100	66.0	(87.1)	(29.5)	23.4	(1.6)	71.1
Transportation	100	11.9	(8.5)	(65.1)	95.5	(7.9)	125.9
Storage	100	56.8	(137.8)	(29.7)	108.1	(2.7)	94.6
Communication	100	11.6	(7.0)	(66.3)	96.1	(3.9)	130.5
Utilities	100	16.9	(7.0)	(66.9)	159.2	(.7)	201.4
Wholesale trade	100	111.2	(150.9)	(10.7)	19.5	(.4)	68.6
Retail trade	100	160.2	(246.7)	(26.2)	68.0	(3.9)	51.5
Community, business & personal service	100	23.9	(27.5)	(33.3)	42.0	(4.7)	100.4
Total all industries	100	64.9	(82.9)	(33.2)	32.6	(1.6)	79.9

IMPACT OF PRICE LEVEL ADJUSTMENTS TO INDUSTRIAL SECTOR NET INCOME CANADA 1974 Exhibit 2B

Measured in $000,000	Reported Net Income	Price Level Adjustments Increasing (Decreasing) Net Income: Current Yr. Items	Inventory	Depreciation & Amortization	Gains (losses) Monetary Position	Other	Price Level Adjusted Net Income
	Historical $						end 74$
Total mining	$1812	$ 329	($ 366)	($ 698)	$ 545	($ 9)	$1613
Total manufacturing	4848	3771	(5285)	(1569)	1532	(43)	3254
Transportation	422	272	(261)	(344)	579	(38)	630
Storage	48	45	(123)	(15)	99	-	54
Communications	279	76	(59)	(296)	493	(1)	492
Utilities	139	25	(23)	(107)	320	(1)	353
Wholesale trade	870	1182	(1689)	(143)	281	(9)	492
Retail trade	516	1043	(1608)	(190)	633	(32)	362
Community, business & personal service	292	64	(67)	(139)	206	(6)	350
Total of separate subsectors	9226	6807	(9481)	(3501)	4688	(139)	7600
Estimation discrepancy		758	(728)	(169)	(274)	15	(398)
Total all industries	$9226	$7565	($10209)	($3670)	$4414	($124)	$7202
Expressed as % of reported net income							
Total mining	100%	18.2%	(20.2%)	(38.5%)	30.1%	(.5%)	89.0%
Total manufacturing	100	77.8	(109.0)	(32.4)	31.6	(.9)	67.1
Transportation	100	64.5	(61.8)	(81.5)	137.2	(9.0)	149.3
Storage	100	93.8	(256.3)	(31.3)	206.3	-	112.5
Communication	100	27.2	(21.1)	(106.1)	176.7	(.4)	176.3
Utilities	100	18.0	(16.5)	(77.0)	230.2	(.7)	254.0
Wholesale trade	100	135.9	(194.1)	(16.4)	32.3	(1.0)	56.6
Retail trade	100	202.1	(311.6)	(36.8)	122.7	(6.2)	70.2
Community, business & personal service	100	21.9	(22.9)	(47.6)	70.5	(2.1)	119.9
Total all industries	100	82.0	110.7	39.8	47.8	(1.3)	78.1

The second largest adjustment is to "current year items". Sales revenue and routine operating expenses are measured quarter by quarter in historical dollar terms. When these are expressed in year end dollars it gives rise to an upward adjustment to net income of $4,883 million or 64.9% of reported net income. This adjustment is most significant in the wholesale and retail subsectors (see Exhibit 2). In those subsectors net income is a very small percentage of sales so any adjustment of the sales revenue will loom large when expressed as a percentage of net income.

The upward adjustment of depreciation and amortization expense was naturally most significant in the fixed asset intensive sectors such as transportation, communication, and the utilities (Exhibit 2).

The one item that appears on the price level adjusted income statement and not on the historical statement is price level gains and (losses) on net monetary position (monetary liabilities less monetary assets). The industrial sector is consistently a net debtor and all subsectors reflect gains. The gains are particularly significant in transportation, storage, communications, and utilities.

Winners and Losers

Undoubtedly inflation and deflation have an impact on the productivity of the economy. However revising our measurement scale to report on goods and services in common dollars is largely a zero-sum game. The real goods and services are simply being reported about in different numbers. If it is a zero-sum game there are still winners and losers. While the industrial sector as a whole is a loser (price level adjusted income 80% of conventional historical income in 1973) there are some subsectors that are winners. The transportation, communication, and utilities subsectors show higher reported net income on a price level adjusted basis. Even though they have a higher depreciation expense they have low inventory adjustments and significant gains on their net monetary debt position.

Preliminary results from a similar but as yet incomplete study of the financial institution sector indicates that sector too is a loser. The big winner in the inflation game is the governmental sector. It has large outstanding monetary debt while its income tax revenue automatically grows as conventionally reported net income is inflated. Government could take steps to moderate inflation or it could revise its taxation base to allow for price level adjustment. If it is the major beneficiary are such steps likely?

Proponents and Opponents

Change is disruptive of established modes of thought. Moves toward general price level adjustments have received a mixed response. Both proponents and opponents of the proposal argue in terms of cost, confusion, usefulness and other defensible criteria. A cynic may be tempted to believe that proposals which result in the "right kind" of numbers will be advocated. For example, the large manufacturing subsector is likely to be very ambivalent about price level adjustments. Adjustment is likely to reduce reported net income which may soften criticisms of profiteering and strengthen their arguements about high taxation. On the other hand it will not be pleasing to shareholders and will tend to increase the cost of capital and thereby constrain growth. The utility sector should clearly be against price level adjustment for it will seemingly result in significantly higher reported net income. Can requested rate increases win approval under such circumstances?[2] Thus the utility sector will almost certainly be against price level adjustments or will adopt variations that "better meet the needs of our industry".

Partial Application

In view of the above analysis it seems inconsistent to find within the utility industry strong advocates of and even users of price level adjustments. Perhaps the most notable is Indiana Telephone Company, widely regarded as a pioneer in price level accounting. As described by the Wall Street Journal (Feb. 7, 1975)

> "In the company's 1973 report, earnings under conventional accounting (column A) were reported as $2.3 million, or $4.55 a share. In contrast Column B, adjusted for inflation, showed net at $1.5 million, or $3 a share".

Our sectoral analysis (Exhibit 2) would lead us to expect utilities to report higher net income on a price level adjusted basis but here is a utility that reports sharply lower earnings. Can we rest assured when the auditor reports:

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[2] The Financial Post reported (April 12, 1975)

> "At one time, Bell Canada did seem to be taking the price level route, but now may have changed its mind....that 'considerable research' wasn't enough it seems. 'There are so many questions unanswered,' a spokesman says, suggesting the company may be having second thoughts on the efficiency of price-level adjusted statements."

Bell Canada would almost certainly report higher net income if it followed the C.I.C.A. December 1974 Guideline. Is it surprising Bell "may have changed its mind"?

> "In our opinion, however, the accompanying financial statements shown under Column B more fairly (emphasis added) present the financial position...and results of its operations..."

Careful reading of a footnote reveals that the corporation has recorded the price level losses on its monetary assets but not the gains on its monetary debt. The price level gains on monetary debt are reflected only as the debt and callable preferred stock is retired. Thus using some rough and ready estimates we can add net income C for Indiana Telephone.

A.	Net income under conventional accounting (as reported)	$2,312,169
B.	Net income "restated to reflect purchasing power of 1973" (as reported)	1,557,541
C.	Net income under thorough going price level adjustment, (my estimate)	2,517,097

Mirror mirror on the wall if B is fairer which is fairest of them all?

Conclusions

Sectoral estimates of price level adjusted earnings help place the proposal for adjustments in perspective. There will be winners and losers. While the industrial sector as a whole is a loser there are some subsectors that will report higher net income on a fully price level adjusted basis.

Adoption of general price level accounting will probably be selective depending on how the results serve the self interest of those who make the decision. Variations on general price level adjustments are likely to be developed which will allegedly "better meet the need of our industry". Such variations should be treated with healthy skepticism.

The data presented in Exhibit 2 provides a rough benchmark against which we may compare reports of price level adjustments as they are reported and particularly as they are summarized in the financial press.

References

Canadian Institute of Chartered Accountants, "Accounting for the Effects of Changes in the Purchasing Power of Money", Accounting Guideline, December 1974.

Financial Accounting Standards Board, "Financial Reporting in Units of General Purchasing Power" proposed statement of December 1974.

Institute of Chartered Accountants of England and Wales, et al, Accounting Standards Steering Committee, "Provisional Statement of Standard Accounting Practice No. 7,"May 1974.

Technical Note on Estimation Procedure

The depreciation adjustment assumed straight line depreciation. Gross fixed assets divided by depreciation and depletion expense gave an estimate of amortization period. The depreciation expense was estimated to be expressed, on average, in dollars of one half the amortization period. For example the all industry aggregate yielded an estimated amortization period of 19 years and depreciation expense was estimated to be expressed in dollars 9½ years old. Intuitively this seems somewhat too long especially as some proportion of the firms will be using accelerated depreciation. A sensitivity test revealed that if depreciation were assumed to be in 5 year old dollars the depreciation adjustment will decline by $836 million (from $2,497 to 1,661) and price level adjusted net income would rise to $6,849 million or to 91% of conventionally reported net income rather than the 79.9% reported in Exhibit 2.

The subsector estimates of age of depreciation expense dollars are

Total mining	10 years
Total manufacturing	9½ years
Transportation	20 years
Storage	15½ years
Communications	9½ years
Electric power, gas, and water utilities	23 years
Wholesale	6 years
Retail	9½ years
Community, Business and Personal Services	5 years

The inventory adjustment proved to be the most vexing. Only the wholesale and retail subsectors reported separately a "cost of goods sold". In the other subsectors the inventory consumption was included in "all other operating expenses". A fifo cost flow was assumed. For the total all industry estimates cost of goods sold plus all other operating expenses were considered inventory consumption. This yielded an inventory turnover of 7 times per year which seems reasonable despite the use of a procedure which would seemingly overstate inventory turnover. The explanation is that the total manufacturing subsector is far the largest subsector and within that sector most operating costs would indeed flow through inventory in the normal cost accounting routine. The $494 million discrepancy (see Exhibit 2) between the subsector estimates of inventory adjustment and the independent estimate for the entire sector is largely the result of aggregating cost of goods sold and other operative expenses and treating it all as inventory flow. Fortunately this procedure is somewhat self correcting by an almost offsetting discrepancy in current year items of $577 million (see Exhibit 2). Consider the labour costs in the retail and wholesale subsectors. When making the total all industries estimates the applicable price level adjustment would have been considered an inventory adjustment but in the subsector the labour costs would have been included with current year items.

The adjustment for current year items is the summation of the revenues and expenses of each quarter that are reported in dollars of the quarter converted to year end dollars. The dominant item is sales revenue. No attempt was made to adjust each current year item for each subsector although it was done for the entire total all industries sector (see Exhibit 1).

The final adjustment termed "other" in Exhibit 2 results from the elimination of gains on sale of assets. The proceeds from sale of assets are in average dollars of the year but the (amortized) cost is likely to be in very old dollars. It is entirely arbitrary to assume such gains on a price level adjusted basis would be zero and then that the reported extraordinary losses (see Exhibit 1) would be only modestly inflated. Fortunately the magnitude of these items is relatively insignificant.

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ARE DEFERRED TAXES CAPITALIZED INTO SHARE VALUES?

To be more precise this paper should be entitled: "The Extent to Which Funds Accountants Allocate to Deferred Tax Reserves Tend to be Reflected in the Market Value of Common Shares". Even that monstrosity needs a correction from "tend to" to "tended to" - during the bygone days of 1968-72 when stock prices reflected something else than the general gloom of more recent vintage.

Deferred tax credits occur when income tax payable is less than the tax allocations for a period. Throughout this paper it is assumed that all deferrals are depreciation-related and genuine, in the sense that they result from tax depreciation which is too fast not from accounting depreciation which is too slow in comparison to the true value-loss of the fixed asset base.

A Theory of Deferred Tax Valuation

Deferred tax can accumulate from year to year and attain considerable importance in the over-all capitalization of firms. It represents neither an ordinary liability nor ordinary retention of earnings but by exaggerating its resemblence to one or the other a "debt view" and an "equity view" of its valuation may be distinguished. In developing the two models I shall attempt consistency with the principles expressed by Miller and Modigliani (1958, 1960, 1961). The M&M framework provides a basic valuation theory which requires no re-statement here. Only one modification is needed: M&M assume the absence of corporation taxes whereas I assume only that interest is not tax-deductible. This makes it possible to value tax deferrals without immediately complicating the issue with the pro-interest bias of the existing taxation method.

A. The debt view. The deferral of a current tax creates a governmental claim to future profits which is not fixed contractually but, in a practical sense, resembles a maturing liability. If so, then the use of deferred tax financing should be considered as an interest-free alternative to conventional debt.

Suppose that a corporation has a value of A dollars of which D is debt financed at a rate of interest i. By M&M proposition I the market value of the common shares, S, is the difference between the value of the firm and the value of the debt. The latter may be perceived as the discounted sum of the interest payments to year n and a terminal value:

The author wishes to acknowledge the cooperation of the Financial Research Institute in providing the data tape used for this study.

$$(1)\quad S = A - Di(1-(1+i)^{-n})/i - D(1+i)^{-n}$$

$$= A - D(1-(1+i)^{-n}) - D(1+i)^{-n}$$

This firm now becomes eligible for a tax deferral in the amount of D for n years. Retiring the existing debt with a view of re-acquiring it when the deferred tax "matures" makes it possible to save the interest outflow represented by the middle term of equation (1), and the market value of the shares becomes:

$$(2)\quad M = A - D/(1+i)^{-n}$$

$$= S + D(1-(1+i)^{-n})$$

So long as $D>0$ and $i>0$, $M>S$; i.e. the deferred tax financing raises the market value of the common shares. The appreciation per dollar of deferred tax predicted by equation (2) is a function of i and n. It can be conveniently read from a present value table by subtracting from unity the appropriate discount factor. For example, with a rate of interest of 8 percent the aggregate share value will rise by 7 percent of the tax deferral if n=1, by 32 percent of the tax deferral if n=5, by 54 percent of the deferral if n=10, etc. As $n\to\infty$, $M=S+D$; implying that a perpetual tax deferral will be fully capitalized into the share price just like an ordinary retention of earnings would be.

As a valuation model equation (2) has intuitive merit. It makes sense that a tax deferral should become more valuable to the shareholder as its anticipated "maturity" recedes further into the future, and should gradually approach the value of equity funding. However, recognition of the real-life tax-deductibility of interest complicates the picture.

It is the well-known result of the M&M theory that the share value of levered firms contains the capitalized future tax savings due to the tax-deductibility of interest. This benefit gets lost when deferred tax financing replaces interest-bearing debt:

$$(3)\quad M = S + D(1 - (1+i)^{-n}) - Dit(1 - (1+i)^{-n})/i$$

$$= S + D(1-t)(1-(1+i)^{-n})$$

where t = the marginal rate of the corporation tax.

Equation (3) completes the "debt view" of deferred tax valuation and brings into focus its internal contradiction. According to this model even a perpetual deferral will raise the share price by only (1-t) times its amount, a limitation not applicable to ordinary retention of earnings to which a perpetual deferral must be equivalent. The difference is caused by our assumption of debt replacement.

The M&M theory becomes fuzzy in explaining what stops firms from acquiring extreme debt-equity ratios, given the tax benefit of debt to the shareholder. They refer to "institutional constraints" which presumably relate to lenders' risk and the amount of interest deductions the government would be willing to allow. A perpetual tax deferral would not

bear upon these constraints and therefore it would not reduce capacity for ordinary debt; a rational corporation would use it as an alternative to equity funding. Hence, at least when $n \to \infty$, equation (3) must be rejected.

B. The equity view. Once we take into account the prior claim of creditors to the government it becomes dubious that even a temporary tax deferral would reduce the firm's capacity to carry ordinary debt. From the lender's viewpoint a "maturing" tax presents no risk since interest will be deducted before any taxes are paid. From the viewpoint of the shareholder some financial risk is involved since the government's claim precedes their own claim to corporate profits. Yet there is an important difference from true debt: the expected future tax will be automatically further postponed if losses occur and will disappear in the case of prior bankruptcy. On these grounds we now ignore whatever debt-like features tax deferrals do possess and treat them as injections of equity into the corporate capitalization.

Suppose that the corporation of the previous examples uses the proceeds of the tax deferral, D, to temporarily reduce its existing equity base (pay more dividends) in the expectation to increase it (retain more earnings) when the deferred tax "matures" n years hence, and shareholders can earn Dr per year from risk-equivalent alternative investments. It follows that if the firm chooses to retain D then it must also earn on it Dr (r = equity capitalization rate), and the value of the shares will be:

$$(4) \quad M = S + Dr(1 - (1+r)^{-n})/r$$

$$= S + D(1 - (1+r)^{-n})$$

Equation (4), which represents the "equity view" of deferred tax valuation, is very similar to (2). The only difference is that since logically r must be greater than i, (4) predicts a larger increase in share price than (2) for finite values of n. When $n \to \infty$, the two models converge. In comparison to equation (3), there is the additional difference that the factor (1-t) does not appear and therefore the predicted share price increase is much more substantial at all values of n.

The "debt view" and the "equity view" of deferred tax valuation lead to similar results because in either case: (i) The market value of common shares is a positive function of the amount of tax deferred, holding all other factors constant; (ii) The strength of the relationship between the market value of common shares and the amount of the tax deferral critically depends on n, the number of years during which the tax savings are expected to be retained in the firm.

C. The horizon problem. The time pattern of deferred tax accumulation and diminution related to a single asset is mathematically quite complex when tax depreciation is by the application of a constant percentage capital cost allowance (CCA) rate to the declining balance of pooled assets, whereas accounting depreciation is straight line towards zero salvage. Usually (but not necessarily) during the early years of asset life the accumulated deferred tax increases, then declines to zero,

changes sign and turns into an accumulated prepayment which eventually diminishes towards a zero balance.

"Maturity" may be defined as the number of years during which the average dollar of tax deferrals accumulated to date is expected to remain in the firm. Table 1 shows a numerical example which illustrates that the maturity horizon so defined is a negative function of asset age and a positive function of the asset's original life expectancy, taking the CCA rate and the tax rate as fixed. Of course anticipated changes in these rates would also affect the perceived time horizon.

The "maturity" problem, however, is incorrectly defined if it is related to a single asset. Spreading the purchases and retirements of identical fixed assets evenly over the depreciation cycle would eventually bring about a steady state in which tax deferral credits and debits offset. For the firm as a whole the critical determinant of the maturity horizon is the volume of investment in depreciable assets. Ceteris paribus, if the investment volume is at least maintained then the accumulated tax deferrals will never "mature"; if the investment volume declines, the deferred taxes will decline as well and "mature" in the sense relevant to our valuation formulae given in equations (2) through (4).

In summary. The main conclusion is that the extent to which deferred taxes are capitalized into share prices depends on the maturity horizon of the deferrals which, in turn, depend on the degree of investor optimism relating to the volume of depreciable investments, tax and depreciation rates, as well as to the composition of the asset base with respect to economic life expectancy and age.

Empirical Findings

The Financial Research Institute's data bank of annual corporate statistics covered about 250 large corporations at the time my own computer file was set up; 134 of these, all classified to mining and manufacturing, constitutes the sample for this study. Table 2 shows the importance accumulated deferred taxes played in the capitalization of these firms during each of the study years 1968-72.

Two sets of cross-sectional regressions, each combining five years of data were run, utilizing the Statistical Package for the Social Sciences (Nie et al, 1970). In Set A the market value of common shares was regressed on the book value and accumulated deferred taxes, with the purpose of inferring from the sign and size of the respective coefficients whether the market valuation of deferred taxes was identical to that of "ordinary" equity. In Set B the market rate of return to one-period holders of the common share was regressed on the change in net income, respectively defined as net of (deferred basis) or inclusive of (flow-through basis) the one-period deferred tax. The purpose of these runs was to determine which measurement of income predicted better the rate of dividend-adjusted share price change.

TABLE 1
TIME PATTERN OF TAX DEFERRALS RELATED TO A SINGLE ASSET[a]

Year	Tax Savings Cash Basis	Assumed Asset Life: 10 years				Assumed Asset Life: 5 years			
		Tax Savings Book Basis	Tax Deferral In Year	Tax Deferral Cumulative	"Maturity" at Year End[b]	Tax Savings Book Basis	Tax Deferral In Year	Tax Deferral Cumulative	"Maturity" at Year End[b]
		($)	($)	($)	(years)	($)	($)	($)	(years)
1	1500	500	1000	1000	8.1	1000	500	500	2.6
2	1050	500	550	1550	6.3	1000	50	550	1.5
3	735	500	235	1785	4.9	1000	-265	285	1.0
4	514	500	14	1799	3.9	1000	-486	-201	7.8
5	360	500	-140	1659	3.1	1000	-640	-841	3.1
6	252	500	-248	1411	2.5	0	252	-589	3.1
7	177	500	-323	1088	1.9	0	177	-412	3.1
8	123	500	-377	711	1.4	0	123	-289	2.9
9	87	500	-413	298	1.0	0	87	-202	2.5
10	60	500	-440	-142	2.5	0	60	-142	2.5
11	43	0	43	-99	2.2	0	43	-99	2.2
12	29	0	29	-70	1.7	0	29	-70	1.7
13	21	0	21	-49	1.0	0	21	-49	1.0
14	49	0	49	0	-	0	49	0	-

[a]Assumptions are: Initial asset value is $10,000; book depreciation is straight line towards 0 balance; tax depreciation is 30% applied to the declining asset balance and arbitrarily terminated in year 14; tax rate is 50%.

[b]"Maturity" is defined as the average number of years for which the year-end cumulative tax deferrals or tax prepayments will remain in the firm.

TABLE 2: MARKET VALUE, BOOK VALUE
AND CUMULATIVE DEFERRED TAXES FOR 134 SAMPLE FIRMS, 1968-72

	1968	1969	1970	1971	1972
	Averages per firm, $ millions				
Market value of common shares[a]	136.4	149.5	135.2	130.0	145.3
Book value of common shares (year-end value)	86.8	91.5	95.3	98.6	104.1
Accumulated deferred tax reserve (year-end value)	11.4	12.2	12.7	13.3	14.6
	Percentage of all firms				
Accumulated deferred tax reserve as a percentage of book value of common shares:					
Zero	8.2	6.7	9.0	9.0	9.8
Up to 4.9 per cent	23.9	24.6	30.6	28.4	24.8
5 to 14.9 per cent	32.8	38.1	28.4	32.1	33.1
15 to 29.9 per cent	28.4	23.1	26.1	24.6	23.3
30 per cent and greater	6.7	7.5	6.0	6.0	9.0
Total	100.0	100.0	100.0	100.0	100.0

Source: Financial Research Institute, Canadian Corporations Annual Data File

[a]The mid-value of the high and low price in the year multiplied by the number of shares outstanding.

Set A regression (Table 3). The accumulated deferred tax has a highly significant positive coefficient which is 66 percent of the coefficient for the book value of equity. Such a high ratio is incompatible with the "debt" view expressed in equation (3) which, assuming a 50 percent tax rate, would allow the deferred tax coefficient to be at most half of that of the book value. Neither is it compatible with a contention that deferred taxes are capitalized just like permanent additions to the equity base because that would require the two coefficients to be equal.

The "equity" view with a relatively long time horizon appears to be the most likely correct interpretation of Set A results. For example, using equation (4) with r = .1 (assumed arbitrarily) would imply 11 years of expected "maturity" since $.66 = 1 - 1.1^{-11}$; but such specificity in estimation cannot be justified since the regression coefficients have fairly large standard errors and may be also subject to bias. The possibility of bias arises from the following problem. In the regression the book value of common stands for S of equation (4) and control variables are used to account for the differences - other than the deferred tax - between book and market values. There is no guarantee that all relevant factors were considered in spite of efforts to do so. At earlier stages debt ratio, the payout ratio, proxies for growth and risk, a set of industry and year dummy variables were all in the equation but most of these could be dropped without materially affecting either R-square or

TABLE 3: SET A REGRESSION
DEPENDENT VARIABLE: MARKET VALUE OF COMMON SHARES ($ MILLIONS)

R-square	.82	
Regression coefficients (with standard error):		
Book value of common, $M	1.28	(.07)
Cumulative deferred taxes, $M	.85	(.33)
Capital investment in year, $M	1.48	(.32)
Mining dummy	80	(20)
Forest products dummy	-48	(16)
Steel, metals dummy	-41	(18)
Constant term	-11	(7)
Minimum significance of partial F for variables listed	.02	

the size of the other coefficients. The ones which remained in the "final" version were three highly significant industry dummies and capital expenditures. The latter was included to avoid making the deferred tax into a proxy for "investment" and thereby over-estimating its net impact on the share price.

Set B regressions (Table 4). If shareholders regarded deferred taxes just like "ordinary" retained earnings then the market rate of return would be better predictable from a flow-through than from a deferred concept of income. Accordingly, two parallel regressions with an otherwise identical variables list were run for comparison. The results indicate that the deferred net income, which is the one firms actually reported, gave a slightly better prediction of the market rate of return than the recalculated flow-through income. This confirms the previous finding that shareholders do not value deferred taxes equivalently with permanent retentions of earnings, but leaves it unexplained how market prices eventually come to reflect the substantial proportion of the accumulated tax deferrals revealed in Set A.

TABLE 4: SET B REGRESSIONS
DEPENDENT VARIABLE: RATE OF RETURN TO COMMON SHAREHOLDERS
((Dividend (j) + Share Price (j))/Share Price (j-1))

	Deferred Basis Net Income		Flow-Through Basis Net Income	
R-square	.51		.49	
Regression coefficients (with standard error):				
Net Income (j)/Net Income (j-1)	.0097	(.0008)	.0074	(.0007)
Assets (j)/Assets (j-1)	.429	(.052)	.518	(.052)
Year dummy for 1970	-.212	(.037)	-.222	.038
Year dummy for 1972	.183	(.037)	.188	(.038)
Year dummy for 1969	.106	(.037)	.093	(.038)
Constant term	.613	(.061)	.528	(.061)
Minimum significance of partial F for variables listed	.004		.015	

Summary and Conclusions

Our theory predicted that accumulated deferred taxes affect share prices positively and that the strength of the association can be linked to the length of time the funds attributable to tax deferrals are expected to remain in the firm. Empirical tests conducted on a sample of 134 Canadian corporations confirmed the existence of a positive share price effect during the years 1968 to 1972. This finding was consistent with a finite but relatively long view of the maturity horizon. On the other hand, adding back the current tax deferrals and thereby developing a flow-through measure of net income slightly reduced the association between changes in income and the dividend adjusted change in share price.

This research neither supports nor disputes the current practices of tax accounting in financial statements. It seems that shareholders do make some distinction between "ordinary" equity and the tax savings accumulating on the deferred tax reserves and it is quite possible that current practices help them in making this distinction. At the same time the current practice has a tendency to understate the true value of the owners' interest in the firm due to carrying a large deferred tax item on the books much of which investors apparently judged as unlikely to "mature".

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THE DISTRIBUTION OF ORGANIZATION CONTROL

This paper explores the relationships between organization structure and budget-related behavior. Two major types of structure are identified; structured but decentralized, and centralized. Budget-related behavior is hypothesized to be contingent upon organization structure and the level of perceived control in the organization. Data were gathered from twenty-five business organizations in Canada and the United States to measure organization structure and from two hundred and eighty-seven individuals from within these organizations to measure budget-related behavior. Variables associated with an interpersonal, superior oriented style of budget-related behavior were found to be predominant in centralized organizations. Budget-related behavior in structured organizations is participative-subordinate oriented.

Theory

Budgets are a means of exercising control over individual behavior within organizations. Other means of exercising control are through interpersonal contact (i.e. leadership) and through the distribution of authority and work roles (i.e. organization structure). In contrast to other studies which have focused on the relationships between interpersonal variables and budgetary behavior, for example: (Hopwood, 1974), (Swieringa and Moncur, 1972), this study focuses on the relationships between organization structure and budgetary control.

Structure Control

Organization requires some ordering of work roles whereby authority and resources for decision making are distributed to defined positions. Structure is the internal pattern of organization relationships. Decision making authority can be delegated and control can be maintained to the extent that systems and procedures are developed to limit areas of discretion and provide information on role performance. A structured organization is one in which activities and procedures are standardized, formalized and specialized (Child, 1972). An alternative means of exercising

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control is to centralize decision making authority at higher levels within the organization. Centralization reduces the need for organization, systems of procedures and specialized personnel. Negative correlations between centralization and structuring have been shown in a number of empirical studies; (Pugh, Hickson, Hinings and Turner, 1969), (Child, 1972).

The choice between decentralization with structuring and centralization is limited by the size and technology of the organization. As organizations grow, diseconomies of scale limit the extent to which operating decisions can be centralized while simultaneously maintaining operating efficiency (Williamson, 1964). As organizations become more closely tied to the means for standardized mass production, role definitions are formalized and decision making authority is decentralized (Perrow, 1967).

In structured organizations legitimate organization activities are clearly defined and areas of responsibility and authority are delineated, therefore control is legitimized and non-personal. The organization is assumed to be relatively placid and conflict free. Since decision making authority is decentralized individual managers may feel that they, and others have a greater degree of control within their defined areas of responsibility. In contrast centralization, where authority is reserved for a small group near the top of the organization, reduces perceived control at lower levels within the organization. Whereas behavior within structured organizations is governed by formal rules, behavior within centralized organizations is not. In the absence of administration rules one may predict that behavior patterns in general will be based more clearly on interpersonal relationships.

Budgetary Control

In this study budget-related behavior is defined as overt activities by managers caused either directly or indirectly by the firm's budgeting system. Overt activities include the actions and interactions of managers with each other and with their tasks. Budget-related attitudes are defined as affective feelings of managers toward budgets and budget-related behaviors of themselves and others.

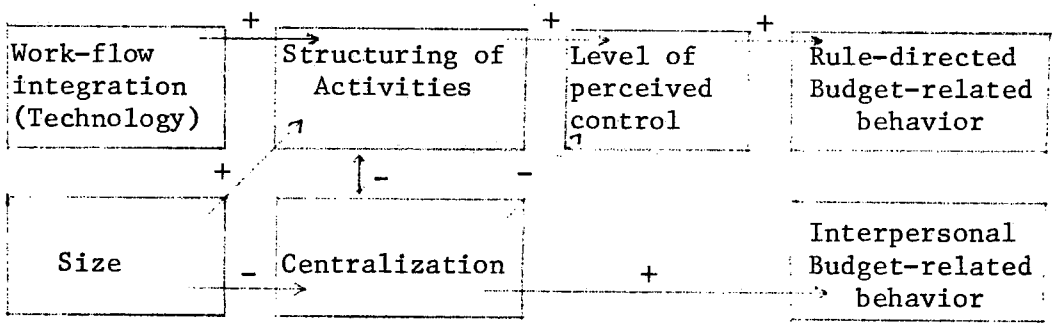
The nature of budgetary control is such that its effectiveness is dependent upon an ability to plan with a reasonable degree of certainty and to measure performance with a high degree of accuracy. Typically a budget not only specifies a goal (i.e. X units of production at an expected total cost), but it may also specify a means for accomplishing the goal (i.e. material, labor and other inputs at standard cost). In decision making terms budgets specify an objective function and a small number of alternatives. The budget may be seen as a means for decentralizing certain types of operating decisions and it provides a means for measuring role performance.

Since budgets tend to structure the firm's decision making environment they would appear to be particularly well suited for

use under the same conditions that are prevalent in structured organizations. Moreover the use of budgets for control purposes and structuring of activities may be mutually reinforcing since predictable task environments produce conditions amenable to the use of budgets, budgets produce pressures to further structure activities, and so on. We therefore predict that budgetary behavior will be quantitatively greater in structured organizations, that it will be viewed as more legitimate and that it will be task directed.

Since managers have less authority and perceive themselves as having less control in centralized organizations any attempt to hold individuals responsible for directly meeting the budget is not likely to meet with much success and is likely to produce negative attitudes toward budgets. To the extent that budgets are used as control devices in centralized organizations, they will be used in a more interpersonal manner than in structured organizations. Thus Argyris' observation that superiors may use budgets as a way of expressing their own leadership patterns may be more typical of centralized organizations than of highly structured organizations (Argyris, 1952). Figure 1 presents the relationships to be examined in this study.

Figure 1: Expected Relationships Among Organization Context, Structure and Behavior



Method

A survey research study was designed to test the relationships outlined in Figure 1. Twenty-six organizations, selected on the basis of geographic factors and diversity in size and technology, participated in the study. Organizations were defined to include corporate sub-units such as divisions. The research procedure involved an interview with the chief executive of each organization and mailed questionnaires to a number of managers from within each organization.

The Questionnaires

In total four different questionnaires were administered, three of which are relevant to this paper. Wherever possible questionnaires which had been validated through previous research were sought for reasons of practicality and to provide comparisons with

prior research. Descriptions of the questionnaires follow.

Organization structure and context. The abbreviated instruments developed by the Aston group were used to operationalize the concepts of organization context and structure (Inkson, Pugh and Hickson, 1970). Size was measured by the number of employees in the organization. Technology, work-flow integration, was indicated by the degree of automated, continuous, fixed sequence operations. Two organization structure variables were measured. The first, structuring of activities was measured on two scales - specialization and formalization - which were combined to form a single intra-organizational measure. The second variable, concentration of authority, was measured on two scales: autonomy, the extent to which authority for making certain decisions lies within or outside the organization, and centralization, the extent to which certain decisions are taken at higher or lower levels in the organization. This questionnaire was administered, in a standard interview format to the chief executive of each organization.

Perceived control. Tannenbaum's control graph questionnaire was mailed to a sample of 429 managers from within the organizations (Tannenbaum, 1968). The sample, composed of managers involved in either the planning of feedback aspect of budgeting, was identified by the chief executive of each organization during the interview. The questionnaire asked each respondent to indicate on a five point Likert scale how much influence each of six groups at different levels in an organization hierarchy has. For purposes of this study attention was focused on the total amount of perceived control in the organization; that is, the mean response per organization.

Budget related behavior and attitudes. The questionnaire used to collect data on budget-related behavior was originally developed by Fertakis (1967) and has subsequently been modified by Swieringa and Moncur (1975). The questionnaire incorporates forty-four items of budget-related activities and relationships which a manager could relate to his own budget situation. A continuous line response scale was used to measure the frequency (how often does it take place?), normativeness (how often should it take place?), and importance (how important is it to me?) of each of the activities to the respondent.

429 questionnaires mailed to the sample defined above yielded 284 usable responses for a response rate of 66 per cent. The data were reduced by factor analysis to uncover underlying patterns. (For a complete description of the factor analysis technique and factors, see Bruns and Waterhouse, forthcoming). Thirteen descriptive factors FD_1.....FD_{13}, were defined. In addition, attitudinal measures were computed by subtracting the normative value of each variable from the descriptive value and multiplying the absolute value of the difference by the importance value. Factor analysis of these data disclosed fifteen attitude factors, FS_1.... FS_{15}.

Four descriptive factors, FD_1, FD_7, FD_8 and FD_9 and three attitudinal factors, FS_1, FS_3 and FS_4 were shown through subsequent analysis to be significantly related to the structural variables. FD_1 describes the extent to which managers participate with subordinates, staff departments, and other managers of equal rank in budget planning. FD_7 describes the extent to which a manager's methods of reaching the budget are accepted by his superiors and subordinates, FD_8 describes the extent to which a manager is required to explain budget variances, and FD_9 describes the amount of interaction of a manager with his superior in planning and performing budgetary activities. FS_1 describes the attitude of a manager toward his superior's use of the budget to evaluate his efficiency. FS_3 and FS_4 describe managerial attitudes toward the usefulness and flexibility of budgets.

Factor scores were computed for each respondent and averaged across each organization because these variables were being studied as features of organizations, not as individuals. Product moment correlation coefficients were computed between the context, structure, perceived control and budget-related behavior and attitude variables.

Results and Discussion

Inspection of the data indicated that the organizations sampled represented a cross-section of service and manufacturing firms with structural features similar to those studied by other researchers (McMillan et al, 1973). The individuals sampled tended to be experienced and generally held middle management positions. On the whole very positive attitudes toward budgeting were expressed.

Table 1 presents the product moment correlation coefficients between organization context, structure and perceived control. Size emerged as a strong predictor of structuring of activities and centralization ($r = .65$, $p < .001$; $r = -.39$, $p < .10$). Work-flow integration was correlated with structuring of activities ($r = .41$, $p < .05$), and structuring of activities was found to be negatively correlated with centralization ($r = -.56$, $p < .05$). The data appear consistent with classifying strategies of control into two extreme types: decentralized and structured as might be found in organizations with a large number of employees, a larger number of functional specialists, formalized systems of procedures, and a more sophisticated technology; and administrative centralization which is more typical of smaller organizations which are dependent for decisions upon superiors and/or parent organizations.

Perceived control was hypothesized to be positively correlated with structuring of activities and negatively correlated with centralization. While the signs of correlation coefficients relating these variables were as predicted, only the correlation between structuring of activities and perceived control is statistically significant ($r = .39$, $p < .05$).

Table 2 presents the product moment correlation coefficients between structure and perceived control variables and the budget-related behavior and attitude variables. FD_1, participation in planning, was correlated with perceived control ($r = .64$, $p < .001$) and with structuring of activities ($r = .44$, $p < .05$). Holding the effect of perceived control constant yields a partial correlation of .26 between structuring of activities and participation in planning. It appears that a participatory mode of budget administration is more typical of highly structured organizations partly because individuals within these organizations perceive themselves as exercising more control.

FD_7, FD_8 and FD_9 all focus on the superior-subordinate relationships in budgeting. FD_7, acceptance of methods, correlates negatively with centralization ($r = -.39$, $p < .10$) and autonomy ($r = -.38$, $p < .10$) and positively with perceived control ($r = .34$, $p < .10$) indicating that as organizations become more centralized and less autonomous, individuals perceive having less independence and more interference from superiors on budgeting matters. This is consistent with responses to FD_8, required explanation of variances, which was correlated with lack of autonomy ($r = .39$, $p < .10$). Further, the relationship is not participative or advisory as revealed by the negative correlation of FD_9, interaction with superior, with lack of autonomy ($r = -.38$, $p < .10$). However, individuals surveyed do not report negative attitudes toward these superior subordinate interactions as witnessed by the negative correlation of FS_1 with lack of autonomy ($r = -.57$, $p < .05$).[1] But to further complicate these relationships, both FS_3, attitudes toward the usefulness of budgets, and FS_4, attitudes toward the flexibility permitted by the budget, are positively correlated with lack of autonomy ($r = .45$, $p < .05$); ($r = .40$, $p < .05$). Thus negative attitudes appear to be directed toward the budget and not toward the superior as suggested by Argyris (Argyris, 1952).

The results permit a partial characterization of organization control systems and their effect on budget-related behavior and attitudes. What may be termed an Administrative Control Strategy appears to predominate in large, technologically sophisticated organizations. Managers within these organizations perceive themselves and others as exercising a greater degree of control than managers within smaller, less formalized organizations. An Administrative Control Strategy elicits participative, subordinate oriented budgetary behavior. Moreover, budget-related activities focused more clearly on the planning aspects of budgeting. Managers within these organizations report neither positive or negative attitudes toward the budget.

The other major control strategy identified in this research, the Interpersonal Control Strategy, is typically found in smaller

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[1] Because of the scoring procedure a high attitude score implies a negative attitude.

organizations. Crucial decisions are centralized within the organization or referred to outside authority. Budget-related behavior within this type of organization is oriented toward a manager's superior, attention is focused on variances from budget, and managers are likely to experience more interference from superiors and subordinates on budget-related matters. Budgets within these organizations are seen as not being helpful in accomplishing one's job and they are seen as limiting flexibility and innovation. Managers did report positive attitudes toward their superior relationships on budget-related matters.

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INFORMATION SYSTEM EVALUATION - A "NON-BAYESIAN" APPROACH

Part I: Background, Issues, Prerequisites and Assessment

Information System Evaluation - The Organizational Setting

A point which occasionally escapes would-be information system designers/evaluators is that an information system, however defined, is a sub-system of an "organizational system". The organizational system can be defined as that set of processes, circumscribed by the organizational boundary, which dynamically interact in order to produce an organizational trajectory (the time sequence of organizational outcomes) which matches as closely as possible the preferred trajectory (plan) derived from the organization's objectives, goals and ideals.

Processes (or activities) are the consequence of the mapping of tasks to individuals, technological devices, or collections of individuals and/or devices. The meta-process of defining tasks and assigning tasks to the various organizational entities is termed organizational design; the result of the mapping is the organizational structure. The derivation of processes from task to entity assignment may be part of the organizational design although it is more commonly done by the entities themselves as one of their tasks.

The interaction between processes is accomplished by an organizational sub-system -- the communication sub-system. In principle, the communication sub-system should be designed with the same care accorded to the organizational design, resulting in two structures: organization and communication. In practice, however, both structures evolve over time, each constraining, to some extent, the evolution of the other. It is important to note the interdependence of the two structures representing the processes (organizational) and interactions (communication); changes in one structure (organizational or communication) does affect the operations of the other and, in turn, the outcome trajectory of the organization in general.

Examining more closely the communication structure, the elements of the structure are the point-to-point linkages or "channels" by which processes interact using "messages". With respect to a particular process, there are two classes of messages: input and output. Input messages can be typed as either triggering (initiating the process), observation (the recording and receipt of messages regarding attributes of specified events or measures of on-going activities), and/or co-ordination (messages which link sub-tasks in the pursuit of a common task). Output messages can be either co-ordination messages or action "directives". Directives are messages which indicate

intended actions and influence the actual action taken which eventually contributes to the organizational outcome trajectory.

The channels and the manner of generating and receiving messages can be quite ad hoc and informal, ranging from "face-to-face" observations, co-ordination, and directives to very formal methods for recording, communicating, and displaying messages. The "maturity" of a particular channel is a consequence of a number of factors. Maturity is necessitated by increasing physical and temporal distances between processes, and/or the need for greater efficiency (cost, time) or effectiveness (precision, accuracy, recency, timeliness, or relevance of the message). The degree of maturity (formality) is a function of how long the process has been defined and how recurrent it is.

Of particular interest to information systems designers is the case where maturity is required but presently unavailable. In these instances, several alternatives to a mature channel are employed. Surrogate data derived from a system employing formal data collection, processing and reporting can be used (e.g., the accounting system). Informal linkages to other observers closer to the source of the phenomena may be employed. Or, the process can rely on its internal memory (knowledge, or "gut-feel").

With the preceding background, the notion of an "information system" can formally be introduced. Information is essentially data (i.e., recorded symbols) which, as input, effects and/or affects the conduct of a process. Each channel or "link" which provides one or more effecting/affecting messages will be termed a data link. The operational embodiment of the data link is a data processing sequence; that sequence of activities which, in some combination, collects, records, transmits, processes, stores, retrieves, and displays the data image of the activity measured, event recorded, co-ordination initiated, or preferred action selected. It should be noted here that while all data links have some form of a data processing sequence, not all data processing sequences are data links as they may not effect or affect a process.

Commonalities in the collection, processing and/or reporting of data make it efficient to group data processing sequences and to speak of this grouping as a "data processing system" (e.g., accounting). Similarly, it is useful to group data links related to a particular process, task, or collection of tasks comprising an organizational unit and to refer to that collection of data links as the process, task or unit's information system. It is in this sense -- the collection of data links required by one or a collection of processes -- that the term "information system" will be used in this paper.

An information system, as defined above, can be studied either as a "given" or as a system subject to change. In either case, it is useful to have a means for describing the system, i.e., a model. If only one information system is to be studied, the model need only be descriptive, prescriptive, or normative. Alternatively, if alternatives to an existing information system are to be studied, then there

must be some means for evaluating alternatives to the existing system. Thus, an evaluative model is required. The remainder of this paper, then, is directed at this specific issue -- the requirements for and development of a modelling methodology which enables the description and evaluation of alternative information systems.

Some Preliminary Questions to be Addressed Regarding Information Systems Evaluation

Six questions germain to the problem of information systems evaluation will be posed and briefly discussed in this section. This is done so that a set of prerequisites for the development of an information system description and evaluation methodology can be derived.

What is being evaluated? In principle, alternative information systems. A system, however, is someone's selective mental perception of reality. Models are the embodiment of these perceptions and thus are the basis for evaluation, each model representing an existing or alternative information system. As information systems are no more than a collection of data links, alternative information systems, in the strict sense, are changes made in one or more of the data processing sequence elements. This, however, is too strict, since changes in the content or delivery of messages will cause changes in the using process. Furthermore, it is often necessary to concurrently consider changes in the processes or the organizational structure which are necessitated (or motivated) by the potential alternative information systems. Thus, what is required is a model representing the join of the organization and communication structure -- to be called a cyberstructure. It is alternative cyberstructure models, representing the details of both the data links, the processes, and their interactions, which must be assessed.

In what units? When one speaks of evaluation, it is common to suggest some standard metric (e.g., dollars, utils) for establishing the "value" of evaluation. Depending upon who is doing the evaluation and for whom it is being performed, both dollar (e.g., cost, profit) and non-dollar (quality of service, production variance) measures may be important. Furthermore, the evaluation process may not be one of optimizing but one of "satisficing". Because of the variety of possible metrics applicable to a particular evaluation, it would be presumptuous to build into the model itself a single unit of evaluation. Rather a more general approach can be taken, whereby, the model generates the outcome trajectory of each alternative cyberstructure model. In this manner, alternative cyberstructures can be assessed ex ante by all individuals concerned using their own metrics. Alternative trajectories can be assessed for value added by changes to the cyberstructure. These can then be compared to the costs incurred by the changes suggested in the alternative cyberstructure model (a secondary and separate assessment requiring a different type of model).

At what level? Level, in terms of the model, refers to the number of organizational processes jointly considered. The lowest level (also the simplest and most common) is a single process. As J. Forrester in

his work with systems dynamics has pointed out, however, changes in the information system for a single process can affect many other related processes and the outcome trajectory for the organization as a whole, sometimes in counter-intuitive ways. The whole is greater than the sum of the parts and, more importantly, the consequences of the whole are not necessarily the same as the "sum" of the presumed consequences of the individual processes.

Another reason for wishing to take a multi-process view even though only a single processes' information system is directly affected is because of the differing objectives which can and often do exist between individuals within an organizational unit. Thus, while the individual's presumed consequences and his evaluation of them may be sufficient for that individual's evaluation, the organization, or some unit within it which will invariably absorb the cost of such a change, will want to assess the impact of such a change on consequences important to that unit and in values appropriate to its objectives.

For what purpose? The presumed major purpose of constructing cyberstructure models for information system evaluation is to enable some individual or group to make rational choices between alternative models. The models developed, however, can serve a number of other equally (if not more important) purposes, if properly constructed. First, they help to organize and display the many facets of the processes under study. As such they can potentially raise questions and serve as a common basis for discussion. How useful the model is in this capacity is a function of: (1) how simple the technique used for obtaining the model analogue is, (2) the relationship between reality and its model counterpart (many-to-one versus many-to-many), and (3) the scope and logical consistency of the underlying model taxonomy or framework. Second, a model, properly constructed, can serve as a useable implementation tool. At a minimum, the model should provide unambiguous constraints to the detailed design process, permitting trade-offs in efficiency only (not effectiveness).

By whom? Ideally, the development and evaluation of alternative information system models is performed by the evaluation group. While this may be possible in some instances, it is more likely that the group is comprised of managers who have neither the time or skills necessary to collect the data and construct the models. Similarly, the individuals involved with the particular processes being modelled will likely lack the time and skills (and, perhaps, objectivity). For most cases, then, a third party will be involved in the development of the cyberstructure models -- a "modeller". As such, two issues are of concern. The first is that the methodology employed in the development of the model is within the modeller's skill set, be he an accountant, auditor, systems analyst, information analyst or management scientist. Secondly, and more importantly, the resulting model must have high face validity both for the individuals involved with the processes which are modelled and for the evaluation group, otherwise the models will not be accepted as surrogates for the existing and alternative cyberstructures and the evaluation will become "academic".

For whom? As indicated in the preceding discussion, there are three sets of individuals for whom the evaluation models are being constructed. The first is the evaluation group who seek high face validity and an ex ante method of evaluation. The second are the individuals responsible for the processes modelled who also desire high face validity. The third is the group responsible for the eventual implementation of the selected alternative. They seek a model which parallels as closely and unambiguously as possible the modelling techniques employed in the (re-) design process.

Prerequisites for an Acceptable Information System Evaluation Methodology

First, the methodology should be just that -- a methodology. It should provide a step-by-step approach for identifying and describing the elements to be included in the model, the use of the model in generating and describing alternatives, and a procedure for generating and interpreting alternative outcome trajectories. Furthermore, the methodology must be accomplishable by the modeller (e.g., avoid reliance on concepts such as "utility" unless a means for obtaining such utilities is clearly identified).

Secondly, the methodology should be general enough to treat more than one process, i.e., the common single process case should be viewed as a special case and not the other way around. As already noted, the treatment of the multi-process case must also be dynamic (multi-period). The number of processes or periods chosen should not significantly affect the modelling or evaluation techniques.

Third, the evaluation of the alternatives in terms of assigning an overall measure of performance to judge one alternative against the next should not be imbedded in the model. Instead, the model should identify the trajectory of outcomes associated with that alternative so that an ex ante assessment of each alternative can be separately undertaken permitting satisficing and group decision-making with inconsistent goals.

Fourth, the model(s) employed should be consistent with the needs and abilities of the four classes of individuals involved in the alternative generation and evaluation/selection process: the modeller, the individuals associated with the specific processes, the evaluation group and the detailed design/implementation group. As such the model must have high face validity, both statically and dynamically, it must relate to observable phenomena on a not-too-many-to-one basis, it should be unambiguous both in terms of reality-to-model and, for the alternative selected to be implemented, model-to-reality.

A fifth set of prerequisites concern the elements of the models themselves. With respect to the cyberstructure representation of organizational processes, the representation of the variety of procedures should be representable as procedures as well as more succinct representations, where applicable. The initiation of the processes in the model should permit all forms of aperiodic "triggering" (externally initiated, internally recalculated, random) as well as the more simplistic fixed interval method.

The data link representation should provide meaningful representations of the various user-oriented attributes of information (precision, accuracy, recency, timeliness, and relevance) in terms of the properties of the data processing sequences and organizational processes which affect these attributes.

Precision applies to the ability to discern between two items which may be reported as identical (e.g., 2.5 and 2.5 or Smith and Smith), but which are, in fact, different (2.51 v. 2.53 or J. Smith v. M. Smith). Its representation in the model must be in terms of the adequacy of description of data collection and storage/retrieval, and the type of aggregation of subsequent processing.

Accuracy is the extent to which the data image as received differs from reality at the time of recording. Accuracy is an outcome of the distortions (or lack of) in the data processing sequence at collection, processing and display, and may be random or consistent. The model through its representation of the components of the data link should be capable of generating differing levels of distortion at any one or combinations of the elements represented by the data link.

Recency refers to how recent the reported data is. If one receives a message in week four about an event in week three, that is more recent than a message about an event in week two. How recent the data is for a particular process is a complex function of the data collection interval, the length of time over which data is accumulated (processing cycle), the reporting interval, and the time at which the process is initiated, i.e., four interacting (non-linear) timing intervals. Each of these must be individually specifiable in the model.

Timeliness refers to the ability of the system to transmit an acceptably recent message within a given "time span". This time span is dictated by the temporal distance between process initiation and the need for the message. Thus, to represent the concept of timeliness requires that recency be measurable within the model that the process duration time be non-zero and specifiable, and that the process description include alternative courses of action if the condition of timeliness is not met.

Finally, relevance is a judgement which can only be made by the process based upon the content of the message as well as the acceptability of the previously discussed attributes. Its formal inclusion in the model itself requires that the process description permit a dynamic assessment of the message received in terms of its attributes and alternative behaviours specified if the message is judged "irrelevant".

A Brief Review and Analysis of Some Existing Approaches to Information Systems Evaluation

Data processing-oriented techniques. In reality, there are no existing data processing-oriented evaluation techniques in the sense that they have been discussed thus far. This is not particularly surprising because

of the manner in which these types of "information systems" are commonly developed -- from the "bottom up". Information requirements are taken as given, either by tradition, by specific requests or interviews, or by a system designer pre-supposing what an organizational process might require. These requirements are satisfied in the most efficient manner, subject to perceived constraints such as accuracy, recency or timeliness.

Evaluation, to the extent that it exists, is efficiency related; the objective is commonly cost-displacement. With the advent of inexpensive mass storage, spare CPU capacity and sophisticated software, it has become increasingly popular to store transactional data in a form which permits unanticipated information requirements to be met on a demand basis, provided that the "data base" contains the necessary data, that the using process is aware of its existence and the impediments to retrieval are minimized. The data base concept is the latest in a series of attempts to satisfy some information requirements while avoiding a head-on confrontation with the task of formal information system evaluation.

Bayesian approaches. The Bayesian approach to information system evaluation is perhaps the oldest and best known of the theoretical evaluation methodologies. Dating back to the 1940's, J. Marschak's "Information Economics" has evolved into a mathematically rigorous set of constructs which provides a useful conceptual model for seeing the problem and, through the incorporation of statistical decision theory, and networks of conditional probabilities, a means for evaluating alternative "information structures". It has also spawned several related developments, among them: "inquiring systems", "dialetic decision theory", and "adaptive information" economics, as well as a number of behaviourally-oriented studies and an extensive effort to apply its power to a number of problems in accounting.

In spite of its popularity, however, it scores poorly on the set of prerequisites summarized in the previous section. It does not provide a step-by-step methodology. Because of the mathematical complexities it is barely accomplishable as an evaluation methodology, especially in the multi-period, multi-process case. The extension from one to more than one process is hardly easy, and impossible without a number of simplifying assumptions which greatly weaken the applicability of the technique. The assessment of the outcomes is commonly built into the model in terms of expected value against utility or dollars. The model has very low face validity in the static case and cannot be verified in the Turing sense. The model is not consistent with the tools and techniques commonly employed by any of the potential information system designers. The model does not permit a variety of procedural representations nor does it permit general aperiodic initiation of processes. Precision and accuracy can be reflected as conditional probabilities only. Recency can be represented in terms of the total delay time, but not in terms of the contributing time elements. Timeliness is synonomous with recency using the available models. Relevance can be indirectly reflected in the various conditional probabilities only.

In short, the Bayesian approaches are significantly deficient in all major prerequisites for a useable evaluation methodology.

Systems dynamics approach. With the advent of "Industrial Dynamics",[1] J. Forrester awoke the world in a formal manner to the complex interactions between processes and information. Employing a modelling taxonomy consisting of levels, activities, physical flows, control processes and feedback/feedforward information flows derived from his extensive work with servo-mechanisms, Forrester demonstrated how an organization can be modelled using his construct and perhaps more importantly how changes in the information flows (specifically changes in delays) can have significant consequences in terms of organizational trajectories. Because Forrester's technique does include a means for assessing some of the interrelationships between information links and processes in terms of organizational outcome trajectories, it is a candidate for consideration in examining alternative information system evaluation methodologies.

In terms of the prerequisites given in the previous section, the systems dynamics approach is a step-by-step, accomplishable modelling/evaluation methodology. Furthermore, it is easily extendable to treat a number of processes. The outcome trajectory is separated from the assessment of the outcome. The model has a reasonable static face validity, especially with a modest amount of exposure to systems dynamics diagrams. The output is subjectable to a Turing test, permitting the establishing of dynamic face validity.

It is at this point in the list of prerequisites that the shortcomings of systems dynamics occur. This demise is directly attributable to three major shortcomings in the modelling methodology: (1) the assumption of continuous flow of information (as opposed to discrete messages); (2) no memory; and (3) the necessity to describe process descriptions as continuous processes using (approximating) difference equations.

As a result of these (and other) drawbacks, the model is not consistent with implementation design techniques. Nor does it permit general aperiodic initiation and description of processes. Most importantly, it only permits a direct representation of recency from the list of user-oriented information attributes.

Thus, while the systems dynamics construct has been used in several forms to statically model information systems in the prescriptive, descriptive, normative sense (the most notable example being Sherman Blumenthal's oft-cited MIS framework[2]), it is not commonly linked with information evaluation.

One-off simulation models. A discussion of competing techniques for evaluating alternative information systems would not be even partially complete without a brief discussion of some of the more commonly

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[1] Forrester, J. [1961]: Industrial Dynamics, M.I.T. Press, Cambridge, Mass.

[2] Blumenthal, S.C. [1969]: Management Information Systems: A Framework for Planning and Development, Prentice-Hall.

cited "one-off" simulation techniques. Foremost among these is the dissertation of C.P. Bonini.[1] Another work, appearing at about the same time is that of Boyd and Krasnow.[2]

Although both works are interesting as attempts to provide realistic "cyberstructure" models and to use them to assess alternative information system specifications, because they are "one-off" models, the step-by-step, extendable methodology prerequisites are not fulfilled. Simulation-based models generally permit the separation of the outcome trajectory from the evaluation (although it is built into Boyd and Krasnow's model). Because no explicit modelling framework is identified in either of the two models being discussed, one cannot determine the derivability of the model from the real-world. Presumably the approach taken: of developing a one-off model, was to obtain high face validity. The models themselves are somewhat consistent with the detailed design considerations employed by implementors; Boyd and Krasnow's model more so than Bonini's.

With respect to the representation of process elements, both techniques have some inherent restrictions (Boyd and Krasnow: what can be implemented in GPSS, the simulation language employed; Bonini: no explicitly stated restrictions but probably limited to difference equation-like representations). All types of process initiation timings can be included in Boyd and Krasnow's model; Bonini is restricted to fixed periodic. The user-oriented information attributes dealt with by Boyd and Krasnow include both accuracy and recency. Bonini, on the other hand, deals directly with relevance (via the "index of felt pressure") and only indirectly with recency.

Summary. There are a number of fields tangentially related to the problem of information system evaluation which have not been touched upon here, but have been examined in detail elsewhere. Although each of these fields has some contribution to be made to the information evaluation problem, none have developed a modelling/evaluation methodology which fulfills the prerequisites of the previous section.

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[1] Bonini, C.P. [1963]: Simulation of Information and Decision Systems in the Firm, Prentice-Hall.

[2] Boyd, D.F. and H.S. Krasnow [1963]: "Evaluation of Information Systems," IBM Systems Journal, Volume 2, Number 1 (March 1963), pp. 2-23.

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INFORMATION SYSTEM EVALUATION - A "NON-BAYESIAN" APPROACH

Part II: CYSDEM: A Non-Bayesian Approach

Introduction

The term "CYSDEM" is an acronym for CYberStructure Description and Evaluation Methodology. The approach, in concept, is much like Forrester's "systems dynamics" in that two stages are involved: a model description stage which results in a static (schematic and tabular) model description of the system being examined. This static model can then be conveniently mapped to a simulator (the CYSDEM simulator) which produces the outcome trajectories of alternative cyberstructure specifications. Here the similarities end however, as CYSDEM is discrete (not continuous), with memory, and provides for explicit (parametric) representation of process characteristics and procedures as well as user-oriented information attributes.

In the following sections, the description and evaluation methodologies will be highlighted and the results of some initial experiments discussed.

An Overview of the Cyberstructure Framework

There are three major element classes contained in the cyberstructure framework: data, processes, and data links. The first two classes can be likened to the notions of states and transformations respectively. The third class -- data links -- has no identifiable equivalent in systems modelling parlance. Within each major class there are two or more elements, each with a number of parameters which "particularize" that element to a specific modelling scenario. The "tree" of elements and paramters is given in Figure 1. In the remainder of this section, a brief discussion of the elements and their attributes by class will be given. A much more extensive discussion is available elsewhere.[1]

Data. Constant data are values which remain constant over the period of time that the model is said to be relevant. For a short enough period, all data is constant; for a very long period, all data is non-constant. The modeller must judge whether data, used by processes, is to be treated as constant in value or accorded one of the

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[1] Welke, R.J. [1975]: "A Conceptual Framework and Methodology for Describing and Evaluating Alternative Information Systems from a Managerial Perspective." Ph.D. Dissertation, State University of New York at Buffalo, May 1975.

The Cyberstructure Taxonomy with Parameter Groups

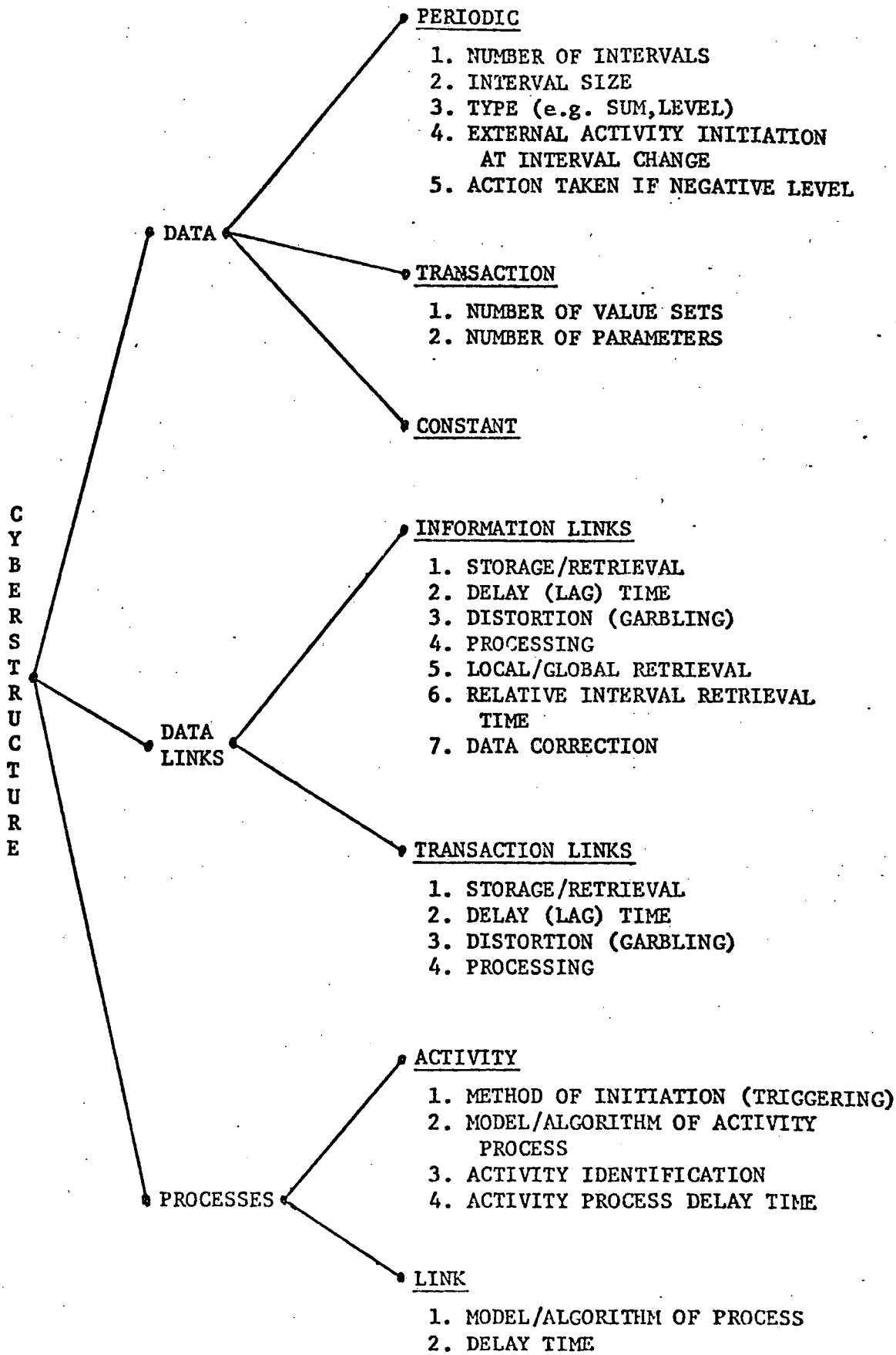

Figure 1

alternative treatments.

Transactional and periodic data are both derived from discrete messages generated by processes. Observational messages are generated by processes representing data collection activities. From a modelling point of view, some of these may be "meta"-processes such as sale transactions based upon a presumed demand function. Other observations are derived from processes operating within the organization, as are the other types of messages (co-ordination, directive, initiation). Messages which remain in their discrete form are termed transaction data. Messages which are aggregated in some manner (sum, level, largest, smallest, most recent) over a specified interval of time and are subsequently retrievable only in that form result in a time-history of interval values for that specific aggregation or periodic data. It should be noted here that in the generation of the message giving rise to the transaction or periodic datum, two images are captured -- the actual value and the recorded value. This permits subsequent adjustments to accuracy (e.g., error detection and correction) and a common base for various types of distortion and correction.

For transaction data, each message is maintained in a transaction data set which is created by the message generating process, moves along a pre-designated "transaction string", queueing at each process on the string, and is eventually destroyed by one of the processes on the string. The data set can be split, merged, altered, appended, or folded into a periodic data file by any process along the string. Its two major parameters indicate the number of attributes concerning the message to be carried with the transaction data set (both actual and recorded) as well as the number of system parameters to be maintained (e.g., generation time, to determine passage time).

Periodic (or "interval") data is maintained in periodic data files. Each interval, in addition to carrying the actual and data image values of the aggregated messages related to that interval, also carries the interval time (the time over which that interval acts as an accumulator of messages) and an access time (dictated by the time at which the most recent message is posted to that interval). Intervals which are incomplete (accumulations can still occur) are termed current accumulation intervals (CAI's). The modeller can designate the amount of history (number of HAI's) to be carried by a file, the width of the interval (e.g., daily, bi-daily, weekly, monthly), the type of aggregation of messages falling in the same interval (sum of all, largest of all, smallest of all, mean and standard deviation of all, sum carried forward from previous interval balance or "level", or value of most recent message). At the completion of each interval, a "push-down" occurs in which the oldest CAI becomes the most current HAI. When this push-down occurs, an opportunity for initiating a process occurs as well as the possibility of writing out the results for evaluation purposes.

Processes. A cyberstructure process is defined as any operation or sequence of operations whose consequence, action or outcome can be described in terms of data or changes in data. There are, of course,

a number of organizational (and environmental) processes which do not, in themselves, give rise to (changes in) data images. These processes are viewed, for purposes of cyberstructure modelling, as sub-processes of a larger cyberstructure process which does give rise to producing or altering data images.

As indicated in Figure 1, there are two types of processes: link processes and activities. Activities are the independent processes of the organization, link processes are subordinate to the data link (to be discussed next) that they are associated with. For example, a decision regarding the replenishment of inventory would normally constitute an activity. That activity would in turn call upon a data link to supply it with forecasted demand information. The data link would retrieve historical demand data from a periodic data file and then invoke a link process to extrapolate next period demand based upon historical demand.

Both types of processes have in common a delay time associated with the completion of their respective processes (fixed, dynamically re-calculated or random) as well as a process description. The process description can either be in decision table form, conditional probability form or in algorithmic form. The activity process, in addition, has an initiation specification associated with it indicating the manner in which the activity will be triggered. This can be on a fixed interval, re-calculated (by the activity) aperiodic, or random basis, or it can be triggered by events external to the activity (e.g., arrival of a transaction data set, a periodic data file push-down, scheduling by another activity, or "cascade" triggering).

Data links. All communication between activities and data images is done via data links. The two types of data links result from the two types of data images maintained (periodic and transaction). As noted earlier, data links are the embodiment of the data processing sequences and as such contain parameters and take actions attributable to the collection of operations associated with data processing sequences.

Communication with periodic data files is accomplished using "information links". For each information link, the modeller must indicate whether storage to or retrieval from the file is to be performed, the duration of that operation (lag time), the distortion characteristics of that link, whether the file is to be considered as local to that activity or maintained centrally (which in turn effects the recency of data accessed), whether (on retrieval) any correction to distortion in the file are to be diminished or removed (by edit, verification procedures), and, whether any link processing of the type discussed previously is to be performed. The data link, given this information locates the most recent accessable data image in that file given the time at which the link was initiated, the delay time of the link and the local/global specification. Then, using the relative interval retrieval time, retrieves either the most recent, second most recent, etc., value from the file and displays it to the process with the appropriate level of garbling and link pre-processing.

Transactions, as discussed previously, are generated by activities and retrieved by activities along a pre-specified transaction string.

At each activity on the string, they are queued in the order of oldest arrival first, newest last. An activity retrieving such transactions from its input queue, invokes a retrieval transaction link. This link removes the oldest transaction from the queue (pushing up the remainder, if any) and pre-processes according to the specifications of garbling and link processing. When an activity along the string has completed its processing of the transaction (changing existing values or appending new values), it invokes a "storage" transaction link, which, based upon processing and distortion parameters, modifies one or more of the output data images of the transaction and places it in the queue of the next activity on the string in accordance with the delay time specified. The link can automatically trigger the next activity on the string to coincide with the arrival of the transaction, if appropriate, under parametric specification.

Summary. In this section a very brief overview of the various elements of the cyberstructure framework have been introduced and discussed with respect to their operation and the major parameter groups controlling those operations. Although some of the terminology is new, the structure is derived from extensive experience with "real-world" data processing systems and their use, and from a number of frameworks which have been proposed over the past several decades to structurally organize and identify common elements in "real" information systems.

Schematic Representation of a Cyberstructure Model

Introduction. While it is possible to go directly from a real-world cyberstructure associated with an identified organizational unit to the simulation-based evaluation model, it is helpful to have an intermediate modelling stage which identifies the relationship among the cyberstructure elements for a given organizational setting without becoming immersed in the details of the simulation model itself. This "schematic" stage of model development is employed in "systems dynamics"[1] and GPSS and is recommended by Teichroew and Lubin in their paper discussing what a good simulator should have.[2]

The schematic description of a cyberstructure employs a unique outline for each of the elements given in Figure 1. They consist of outlines derived from a standard ANS flow-charting template (e.g., IBM Flowcharting Template GX20-8020-1) either directly or in combination. Figure 2 identifies the outlines for the various cyberstructure elements.

Construction of a CYSDEM schematic. The creation of a cyberstructure design and evaluation method (CYSDEM) schematic follows the same principles one would employ in developing a general "systems chart" for any systems study. To take an example, let us suppose that the information system to be studied is centered around the activity of inventory acquisition for a single item. The measures of performance for that task are seen by the unit to be the level of backorders and the level of inventory. An obvious place to begin the analysis is with acquisition decision itself. Based upon an analysis of how the decision is presently implemented, the analyst identifies that the activity re-schedules itself

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[1] Forrester [1961], op. cit.

[2] Teichroew, D. and J. Lubin [1966]: "Computer Simulation -- Discussion of the Technique and Comparison of Languages," Communications of the ACM, Volume 9, Number 10, pp. 723-741.

CYSDEM Schematic Outlines

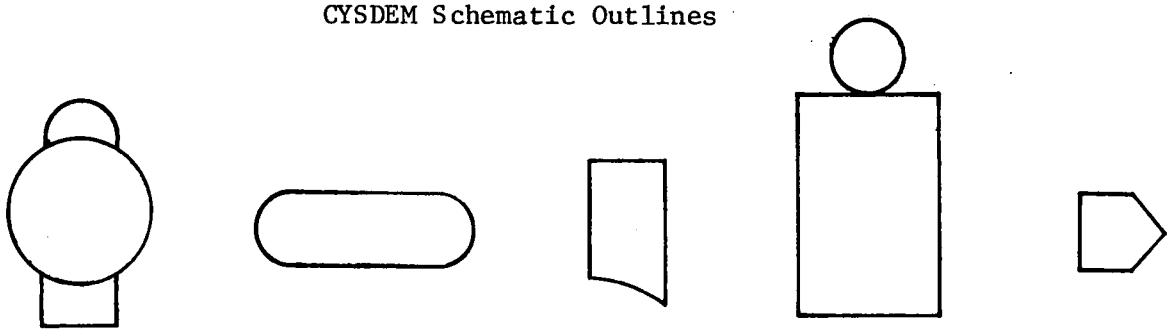

Figure 2

CYSDEM Schematic for Inventory Acquisition Activity

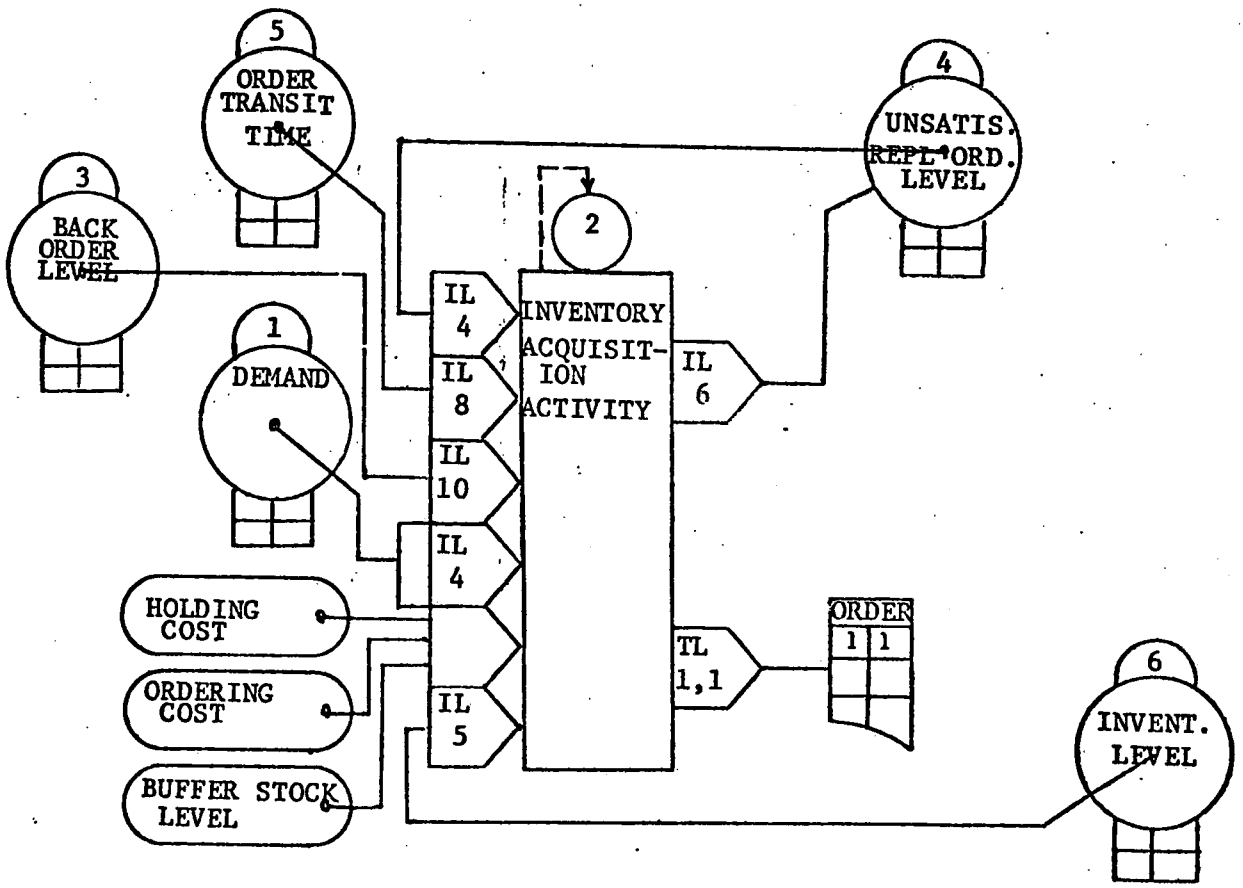

Figure 3

and that it requires the various inputs given by Figure 3 as the "inventory acquisition activity". Furthermore, it generates order transactions and updates a file indicating the current level of outstanding orders. Given this schematic as a starting point, it now becomes necessary to determine all of the other activities which affect the files or use the transactions identified. Figure 4 provides a complete CYSDEM schematic identifying all of the necessary activities to bring "closure" to the model. Depending upon the level of detail required for evaluating alternative cyberstructures, the schematic can be greatly expanded or reduced in scope. It should also be emphasized that the schematic is applicable to any organizational unit and task collection with any measures of performance. It has been used to represent models as diverse as Forrester's three sector industrial model[1], Bonini's production/sales firm,[2] and Boyd and Krasnow's information system evaluation model[3] (which used GPSS as its base) without loss of detail.

The CYSDEM Simulator

The CYSDEM simulator was developed from scratch to support the cyberstructure taxonomy introduced previously and to provide a simple transition from the schematic representation of the cyberstructure model as discussed above. This transition is accomplished by the use of specially designed forms which indicate either initial conditions and/or the parameter values for the various elements identified in the CYSDEM schematic. The process procedures can either be parametrically specified (if they are representable by decision tables or conditional probability matrices), or they can be coded (in FORTRAN) as algorithms.

The simulator itself is comprised of three separate programs. The first is a set of FORTRAN sub-programs which read in the specification sheets, check them for consistency, note errors, and print out tabular summaries of the input data for sight verification. The second is the actual simulator. Its internal structure is very much like GASP[4] in the sense that it is composed of a number of hierarchically related FORTRAN sub-programs which schedule events, initiate activities, maintain files and operate the data links. The user/modellers task with respect to the main simulator is to write the process (activity) sub-programs, to supply some basic details such as file size and to provide an overall structure. The output from the simulator (the data changes in any or all of the periodic data files, as specified by the user) can be printed out and/or directed to secondary storage. That which is directed to the secondary is then analyzable by the last of the three programs. This "back-end" program will, under parametric control, statistically analyze and/or plot the time series output of the periodic data in a number of ways.

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[1] Forrester [1961], op. cit.

[2] Bonini [1963], op. cit.

[3] Boyd and Krasnow [1963], op. cit.

[4] Pritsker, A. and P. Kiviat [1969]: Simulation with GASP II, Prentice-Hall.

CYSDEM DIAGRAM

INVENTORY ACQUISITION AND SHIPPING CYBERSTRUCTURE

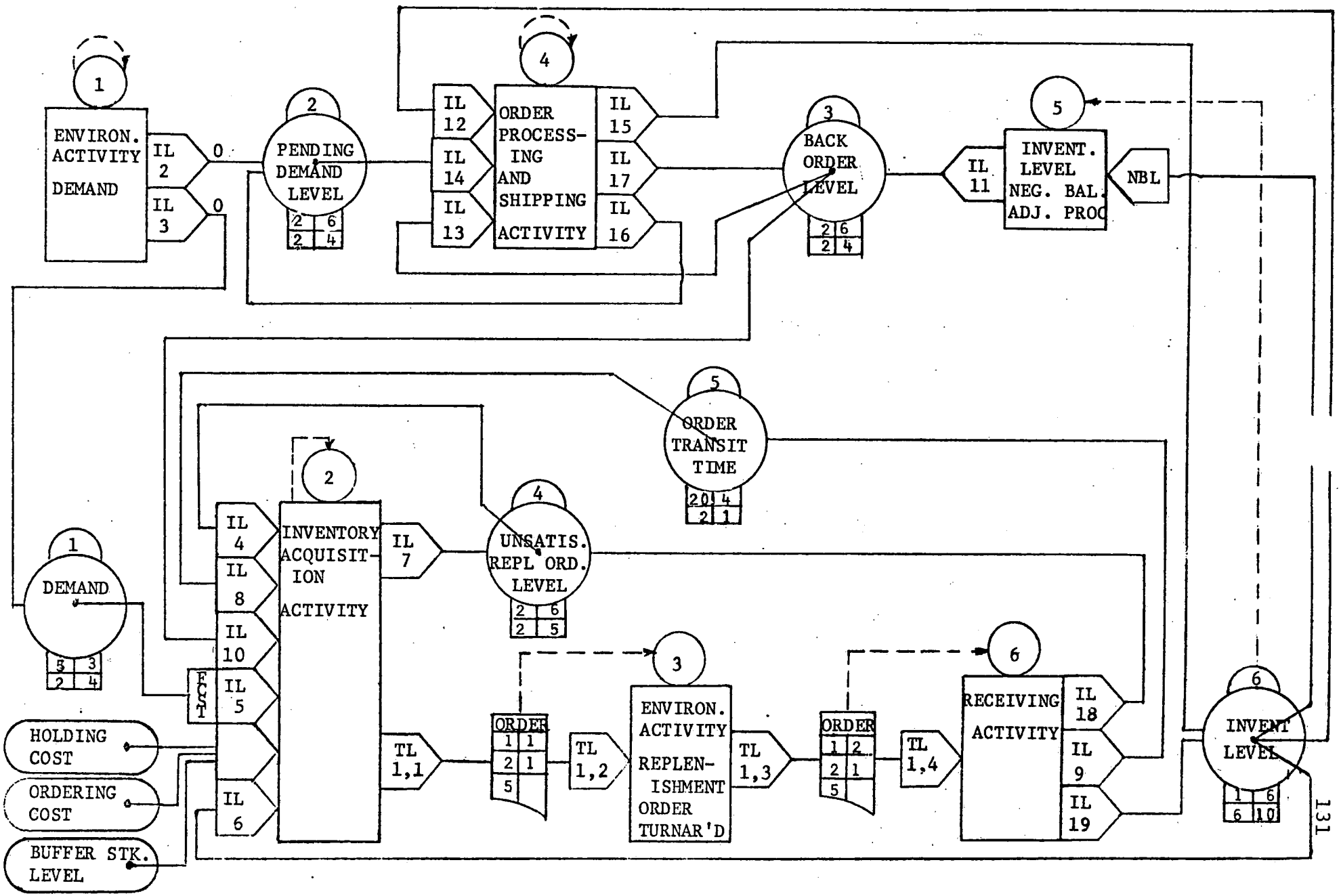

FIGURE 4

It is not possible in the space of this paper to go into the detailed mechanisms of the simulator itself, or of the mapping from the schematic to the simulator. Nor is it possible to discuss the theoretical underpinnings of processes operating within the simulator. This has been done elsewhere.[1] Suffice it to say that the simulator has been carefully evolved and checked, both internally and externally for logical consistency and validity of results.

Some Preliminary Results Using CYSDEM

A number of models have been extracted from the literature and represented in schematic form, primarily to determine what weaknesses, if any, exist in the CYSDEM technique in relation to other information system evaluation techniques. Of these, only two schematic models have thus far been "brought across" to the simulator and evaluated. The first, and most extensively tested, is the inventory acquisition and shipping cyberstructure. The second and more recent is the three sector industrial model used throughout J. Forrester's Industrial Dynamics book as an example.

For the inventory acquisition and shipping model, a number of simulations were conducted to determine the sensitivity of the outcome trajectories to changes in the various link, process, and data parameters. To do this a number of alternative cyberstructure specifications were examined and statistical testing employing analysis of variance and multiple statistical inference techniques. While the details of both the scenarios and the statistical analyses is presented elsewhere,[2] some general comments can be made. First, modest changes in the link lag times (compared to zero lags) produced significant changes in the outcome trajectories, even when the changes were limited to only one process, due to the interaction between acquisition and shipping activities. Changes in distortion along the links did not produce significant changes in the average outcome trajectories, but did result in noticeable changes in the variability of the outcomes over time. Changes in the designation of data as being "local" or "global" (within reach v. centrally stored) also had a significant impact on the outcomes.

One observation of general interest is that changes made in the random number generator to obtain "replications" for a given scenario, did not significantly affect the average values of the measured outcomes. This was somewhat unexpected and, if it persists for other implementations, will considerably improve the prospects for using monte-carlo simulation techniques for information system evaluation. As a final note, the cost for running each scenario (on a CDC 6400) was approximately $2.00 for 150 time periods including a fixed cost of $0.50.

The second simulation, that of the systems dynamics model, is still being explored. The first set of simulations were performed using the parameter values as specified (implicitly or explicitly) by J. Forrester.

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[1] Welke [1975], op. cit.

[2] Ibid.

This produced results identical in form and value to those published and discussed in Industrial Dynamics. This was gratifying although surprising owing to the major differences between the two simulators (systems dynamic's "DYNAMO" and the CYSDEM simulator). By mistake, a set of runs were performed using a non-zero activity time ("instant" activities are assumed by Forrester) which lead to considerably greater stability in the system outputs than is reported for the zero activity time case. No other scenarios have been explored thus far.[1]

Summary and Conclusions

CYSDEM is an outgrowth of a five-year examination of both what is needed and what was available from an information system design and evaluation point-of-view. Although there are a number of refinements which can and should be made to the methodology, it has been used successfully to emulate previous results, to examine some of a number of unresolved questions regarding information systems (e.g., reporting intervals, effects of lags) and to teach the complex inter-relationships between communication and organizational structures. Because each of the existing evaluation techniques is a subset of CYSDEM, it is possible to perform combined analyses -- for example the "Bonini model" cast in the "systems dynamics" framework with "Bayesian decision-making". It is also possible to compare alternative frameworks, both for design and evaluation. The modular approach taken in the construction of the simulator permits easy extensions and modification to both the simulator and the underlying framework (the entire transaction data set/link concept was appended to the original methodology in a month).

The final test -- CYSDEM's application to "real-world" problems -- has not, as yet, been undertaken, although several proposals are under consideration. One, however, can infer from the success of "systems dynamics" in a variety of applications, that this test can also be met.

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[1] It should be noted that the entire translation from the Forrester model representation to the CYSDEM schematic description and simulation was accomplished by a masters level graduate student, without prior training in CYSDEM, in the space of three months (part-time) working from preliminary users manual notes.