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ACCOUNTING / FINANCE

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**JOURNAL OF BUSINESS
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FROM THE EDITOR'S DESK

A reliable model of bankruptcy prediction has eluded researchers using existing modeling methodologies. **P.J. CYBINSKI** updates the new methodologies and technologies, and argues for formulation of dynamic rather than static models of firm failure.

Studies increasingly indicate positive correlations between employee job satisfaction and customer perceptions of service quality, and between favorable perceptions of service quality and customer satisfaction. **ROBIN SNIPES'** study tests these relationships in an unusual service industry venue: higher education. The study found similar positive relationships between faculty job satisfaction and student satisfaction.

Can a care-taker become a money-maker? That is essentially the question **GEORGE McMASTER** poses in his case study of the method used by a Canadian home health-care franchiser to enhance the entrepreneurial abilities of nurses who become CEOs of their own home care companies.

An Artificial Neural Net (ANN) is a form of artificial intelligence that facilitates forecasting by simulating the biological neural network found in the human brain. **OWEN HALL's** study of the effectiveness of an ANN for generating accurate product sales and returns forecasting found that it outperformed the standard regression model.

Databases are a critical element of virtually all conventional and e-business applications; nevertheless, many organizational database applications fail or are unusable. **JOHN HOXMIER** proposes additional dimensions to database designs that can improve their quality.

Franklin Strier
Burhan F. Yavas

THE PATH TO FAILURE: WHERE ARE BANKRUPTCY STUDIES AT NOW?

P.J. Cybinski*

Under existing modeling methodologies, a reliable model of bankruptcy prediction has eluded researchers. This has provided the impetus to search for either new modeling methodologies, or to use emerging technologies drawn from the artificial intelligence field and that of nonlinear dynamics to help model and explain the characteristics of financially distressed firms. This paper gives an update on some of this recent work and argues that the focus of the research ought to be on the distress continuum which requires the formulation of dynamic rather than static models of failure.

A major impetus for this work arose from the conviction that our insight into the process of firm failure can be enhanced by making more extensive and appropriate use of the internal financial histories of failed firms, along with the data that describes the external economic environment in which these firms operated. However, these data are often artifactual in nature and the notion of "failure" is, itself, subjective. At best, it can be measured on a qualitative or categorical scale as an event rather than as a process, given that failure is preceded by degrees of financial distress. Unfortunately, the data that we have are generally available for only a few discrete, and not completely regular, points in time and it is these data with which we are forced to work. We need new methodologies that better link our data with the realities of financial distress. Hence, it is argued that the financial distress prediction field as an area of research is still at a relatively formative stage, since no rigorous theoretically derived hypotheses have yet been formulated and tested within the existing methodology.

Despite the measurement problems referred to above, there has been strong and continued interest in the subject of bankruptcy prediction, because accurate instruments would benefit many interested parties, such as investors, lenders, auditors, management, employees and their unions. Using multivariate statistical techniques, early bankruptcy models have had varying degrees of success in classifying firms *ex post*, as bankrupt/nonbankrupt. These methods have usually employed an estimation sample that consisted of bankrupt versus solvent, usually strong, firms as the basis for discrimination.

* P.J. Cybinski is affiliated with Griffith University.

More recent research by Gilbert, Menon and Schwartz (1990) and by Flagg, Giroux and Wiggins (1991) have produced new insights into the finer distinction between distressed firms and failed firms.

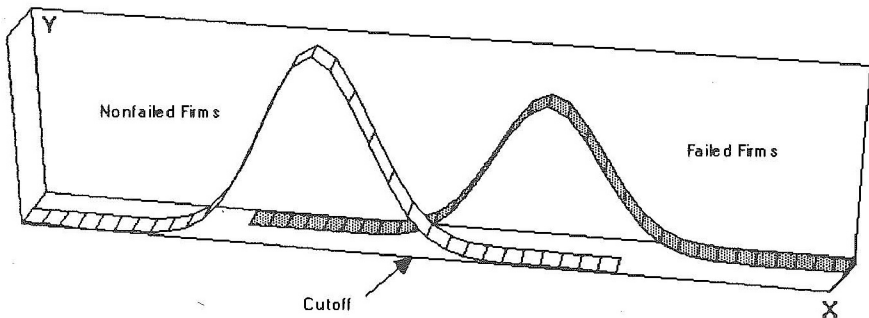
The work described here concentrates on (disequilibrium) dynamics and not state comparisons, because it is more likely that bankers and other resource suppliers need to assess the likelihood of bankruptcy for problem companies, not financially strong ones. What is needed are models that can either discriminate between "at risk" firms that survive and "at risk" firms that fail or that give an indication of which factors are involved when a firm that was surviving becomes one that is failing.

THE DISTRESS CONTINUUM

The major problem in bankruptcy research to date is highlighted in the exposition that follows:- that the nature of the dependent variable, "failure", is not a well-defined dichotomy as it should be for the types of modeling techniques that have traditionally been used to analyze it e.g. logit analysis or multiple discriminant analysis (MDA). Let us examine the basic bankruptcy problem as now embedded in the literature:

Discrimination on One Normally Distributed Variable

FIGURE 1



Consider a model developed on n variables to distinguish between two groups of failed and non-failed firms. This can be represented graphically on some $(n-1)$ -dimensional hyperplane. For instance, and for ease of exposition, Figure 1 shows the cut-off for discrimination between the two populations on only one normally distributed variable that has historically been shown to influence firm failure, as a point on the X axis. (Probability density shown on the vertical axis.)

In many studies of bankruptcy the reported misclassification rates have been relatively small, usually when the two groups of failed and non-failed firms are already well separated in multidimensional space, as in the illustrative diagram, Figure 1, but we are often interested in a much finer distinction. It is the area of overlap, or indecisive area which is most difficult to classify but which is also of most interest. The performance of a model is highly dependent on its potential to separate the groups in multidimensional space, i.e. to reduce this "grey" area to a minimum, which is in turn dependent on the sophistication of the modeling technique and whether the model is complete i.e. it includes the important explanatory variables and, more importantly, where the sampled firms lie on the success-failure continuum. It is not surprising that these model formulations are most successful when the data conforms to the expectation that the two groups are already well separated on the this continuum—i.e. a bankrupt group and a non-risky surviving group.

Gilbert, Menon and Schwartz (1990) provided evidence to support this logic by excluding obviously strong firms from the nonbankrupt portion of their estimation sample to conclude that ratio-based models perform poorly in identifying likely bankruptcies from a pool of problem companies. Flagg, Giroux, and Wiggins (1991) considered distressed firms exclusively and used four failure-related events in addition to standard financial ratios to predict which firms will ultimately go bankrupt. Both these studies used designs that represent a far more difficult predictive environment than previous studies but neither took into account the external influence of the macro-economy on the failure process. Neither did they veer from the traditional cross-sectional study, assuming stationary of failure models over time. What is needed are models designed to examine failure risk (and many attempt to predict it) that also incorporate appropriate lead-lag relationships among observed economic data series—a common feature of empirical economic research.

RECENT WORK USING EMERGING TECHNOLOGIES:

Artificial Neural Networks

When the distinction between survival and failure is a fine one, neural network technology, borrowed from the artificial intelligence field, may yet be a promising tool for solving the classification problem: the problem of classifying an entity into one of a finite collection of groups based on the attributes of that entity. Instead of a linear function, any response surface can be used to map the data, in this case for discrimination purposes, allowing the model to represent the complex relationships inherent in the interpretation of financial ratios. Hence, without a linear restriction, the model can be made to fit the data "like a glove." In addition, artificial neural networks can overcome the effect of autocorrelation which is often present in time series data and the technique tolerates data errors and missing values; problems not accounted for in multiple regression models.

Operation of a neural network occurs in two phases—learning and recall. The network is "trained" in the learning phase with numerous examples of entities as input; their attributes and, in the case of bankruptcy studies, their binary group membership as output. The method used for neural network prediction is called generalization (Dutta and Hekhar, 1988) in that once the network has been trained, new data is input for the network to predict the output.

De-Bodt, Cottrell and Levasseur (1995) provide an introduction to these new tools along with thirty applications in finance, including some in the domain of bankruptcy prediction. Predominantly, papers in this area have compared an Artificial Neural Network (ANN) with a published MDA model of failure prediction. (Odom and Sharda, 1990; Koster, Sandak, and Bourbia, 1990; Cadden, 1991; Coats and Fant, 1992; Lee, Han, and Kwon, 1996). Exceptions are Fletcher and Goss (1993), and Udo (1993), who compare a neural network with a logit model of bankruptcy. All show superior classification outcomes and have shown that, in essence, neural network models are easier to use, more robust, more flexible, and more responsive to change than a regression model. They appear, also, to be more robust on small sample sizes.

Until recently these models suffered from a lack of generalisability due to overfitting the ANN (as discussed by Koster, Sandak, and Bourbia (1990) and Fletcher and Goss (1993)), and were generally used to assist rather than become an alternative to traditional statistical and mathematical models. Yet, these authors appear now to have provided a principled mechanism for determining the optimal network architecture that mitigates against this problem, as their results have verified.

Hence, benefits from the implementation of this technology have aided researchers with the classification problem in bankruptcy studies but not with explanation of process. The most important problem is the "black box" nature of the ANN, i.e., we have no understanding or knowledge regarding how it solves a particular problem. The theory is highly mathematical and the application is essentially one of numerically solving sets of simultaneous equations, so no indications regarding theory are given to aid in the construction of hypotheses that can be tested to give meaning or explanation to this or any other area of research to which ANN is applied.

Chaos Theory

Another promising avenue of research that has shown some success in predicting firm failure comes from the field of non-linear dynamics. Non-linear dynamic models have proven quite successful in the prediction of certain endogenously determined catastrophic system failures, such as myocardial infarction and since a firm's principal investors and creditors would also consider firm bankruptcy to be a catastrophic event, then it should be possible to exploit the characteristics of chaotic behaviour in predicting this type of failure. Etheridge and Sriram (1993) argue that economics and finance researchers have already successfully used chaos theory to study systems such as the stock market (Peters, 1991), and that it is time for accounting researchers to begin using the methodology.

Lindsay and Campbell (1996) applied chaos theory to bankruptcy research with results that were consistent with Goldberger's hypothesis (1990) that healthy systems exhibit more chaos than unhealthy ones. They found that the returns of firms nearing bankruptcy indeed exhibited significantly less chaos than other, healthy firms. The amount of chaos was measured with Lyapunov exponents (Wolf et al, 1985) from which were constructed univariate and multivariate bankruptcy prediction models using industry match-paired data of 46 bankrupt and 46 non-bankrupt firms.

Dynamic Models

After Gilbert, Menon, and Schwartz (1990) provided the evidence that a bankruptcy prediction model developed along traditional lines would not be able to distinguish firms that fail from other financially distressed firms, a study by Hill, Perry and Andes (1996) employed a dynamic event history methodology to model this distinction. The event history analysis looks at the transitions to and from stable and financially distressed states and from these states to the bankrupt state (using longitudinal data). This contrasts with cross sectional analysis which uses a snap-shot focus assuming that each firm will remain in one state (since this type of analysis typically measures the financial state only once).

Secondly, the dynamic model also explicitly accounted for time-varying independent variables which may change over the observation period and included in their model a measure indicating whether a firm received a qualified account or unqualified audit opinion (one of the four events that Flagg, Giroux, and Wiggins (1991) used and postulated would signal that a firm is experiencing financial distress). The two macro-economic variables identified by Rose, Andrews, and Giroux (1982) as leading business failure, the prime rate and the unemployment rate, were also included in order to partly control for changes in the business environment. Since the model was successful in identifying significant explanatory variables that differ between financially distressed and bankrupt firms and also between industry classifications, the authors were able to conclude that the explanatory variables do, indeed, play a differential role in financial distress and bankruptcy as well as across industries

Another area that traditionally uses dynamic models is survival analysis in various health fields. The statistical techniques drawn from survival analysis lend themselves well to bankruptcy research knowing that the potential for a firm to fail always exists *ex ante*. Since these techniques require no specification of the distributions of the data set, models based on them overcome the problems of bias outlined by Zmijewski (1984). Many use the Cox (1972) proportional hazards model incorporating regression-like arguments into life-table analysis. A life table is a method of summarizing the results of a study by grouping the times to failure into time intervals. For each time interval the table records the number of firms which are still in the study at the start of the interval, and the number censored. The ability to use censored data (the time to failure is greater than the predetermined time horizon of the study) distinguishes this technique from other statistical methodology. The probability of interest is the conditional probability of an organization failing in the time interval, i.e., the probability of failure in the next period given survival to that period (the hazard rate or age-specific failure rate). Studies of financial distress incorporating these techniques include those of Crapp and Stevenson (1987), Eddey, Partington, and Stevenson (1989), who predict the timing and probability of takeover bid success, Kassab, McLeay, and Shani (1991), and Partington, Peat, and Stevenson (1991)—all concerned with financial distress.

Two other studies which focussed on the distress continuum are: the failing firm model of Flagg, Giroux, and Wiggins (1991) that included postulated events signaling that a firm is experiencing financial distress, viz., reductions in dividends, "going concern" qualified opinions, troubled debt restructurings, and violations of debt covenants; and the sequential dynamic failure prediction model of Thoedossiou (1991) using multivariate time-series which can detect the critical point at which a firm's financial variables shift from a "good performance" distribution to a "bad performance" distribution.

A new approach consists of the family of models, described below, that allows for a comparison of each firm with itself over time—from when the firm was surviving, or avoiding bankruptcy, to when it failed.

**A NEW STUDY DESIGN AND A NEW DYNAMIC MODELLING
METHODOLOGY**

If we want to examine the process of failure and since most distressed firms do not fail (become bankrupt), a critical examination of those that do may provide additional insights into the process. So the immediate real question of interest is how firms transform from surviving or even successful ones into failed ones. Presented is a methodology for examining the process of failure of firms rather than testing specific hypotheses. It therefore represents a break from the past in that it moves away from models that attempt to discriminate between failed and non-failed firms. For this departure it has employed, within the overall methodology, a sample set composed entirely of firms which all fail: the firm's earlier financial statements from its surviving years providing the data to compare with the data in the firm's final financial statements before bankruptcy or liquidation is imminent.

Work in this area is extended here, both in the formulation of a radically different failure model design and by incorporating an extensive investigation of the macroeconomic environment within which the firms operated over the 20 year period of this study. Specific models are tested empirically here using all sixty failed service industry firms from the COMPUSTAT database for the years 1971-1991 and examining the dynamics of the same firms over time in the periods (the last four years of the firm's existence) prior to failure.

This shift from models based on a single equation to a multi-equation structure incorporates the time factor as well as allowing for continuous dependent variables or jointly dependent variables to become the focus of research attention. Both single-equation pooled-time models of failure risk incorporating lagged estimates of failure risk are estimated as well as multi-equation models that treat as endogenous, some of the significant financial ratios that are collinear as well as the risk of failure itself. These give some insight into how the important correlates with failure risk change over this four-year window.

This work investigates the distress continuum with a design which is an improvement over past studies in model specification for relevance over time and for its ability to investigate the pattern of failure over time for firms that have eventually failed. Of immense methodological significance is the fact that a discrimination model is built on an estimation sample consisting of failed firms only; the firm's earlier financial statements from its surviving years providing the data to compare with the data in the firm's final financial statements before bankruptcy or liquidation is imminent. Each firm acts as its own control; its own surviving years providing the best match on all the non-important variables for a typical "case-control" study of failure risk. Though, if a comparison is to be made with a survival study in the health field, here we are more interested in the progression mechanisms of the "disease" once it is established rather than examining healthy versus diseased firms—or the probability of contraction.

The Time Dimension

It is known that the rate of corporate failures rises sharply during economic recessions. (Lev, 1974, pp.134-139). This fact helps in explaining the lack of consistency both in the values of the coefficients reported and the relative importance of various financial ratios across different bankruptcy prediction studies. Besides using different sets of ratios in their models, researchers typically pool data across different years without considering the underlying economic events in those years. Mensah (1984) states that while multivariate models of bankruptcy may correctly identify the more common characteristics of failing companies which make them susceptible to bankruptcy, the actual occurrence and its timing will usually depend on the coupling of these characteristics with certain economic events (external to the firm). Wood and Piesse (1987) have also suggested that data instability due to changes in inflation, interest rates, and/or phases of the business cycle may be responsible for the differences in the classification rates from estimation (ex post) to forecast (ex ante) time periods in past models used to discriminate failed and non-failed firms.

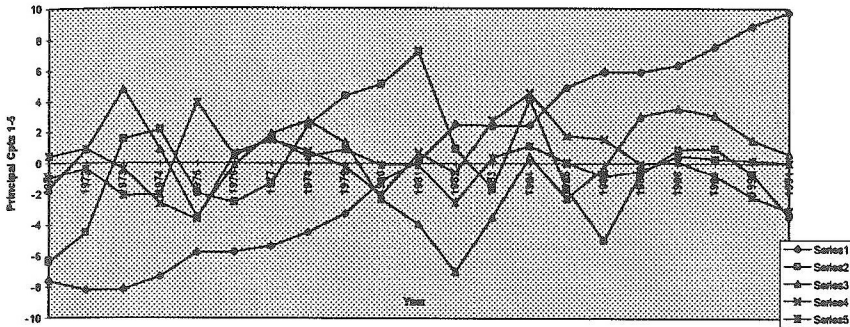
Since a purely ratio-based model may not show sufficient discrimination between the earlier "at risk" or distressed firm-years and the final bankrupt year, external factors relating to the macro-economy were included to help properly model both the external environment of the firm as well as the time dimension of the model. Johnson (1970, p.1166,1167) points out that "ratios to predict failure... do not contain information about the intervening economic conditions... the riskiness of a given value for (a) ratio changes with the business cycle." And Zavgren (1983) states that account needs to be taken of company soundness criteria, which will vary over the business cycle. In boom periods when failures are relatively rare, the empirical link between certain otherwise important indicators and the actual occurrence of failure will be weak.

In the research described here, the four years prior to the last audited statements of each failed firm were examined with respect to both the financial ratios deemed important in the financial accounting literature as well as various economic series taken from the *Abstracts of the USA*. (See Appendix A.) Since many of these series are serially correlated, they were first analyzed by the method of principal components which reduced the number of variables that represent the external environment of the firms from 43 economic series to only five orthogonal factors graphed over time in Figure 2, below. The five factors were identified, based on the series upon which each factor loaded as:

- The Level of Activity/Demand or Growth Factor
- The Cost of Capital Borrowing Factor
- The Labor Market Tightness Factor
- The Construction Factor
- The Expenditure (Private, Public, Business) Factor

Figure 2

Principal Cpts of USA Economy 1971-1991



Since it is expected that the macroeconomic variables will lead failure risk, these and their lagged values for up to three years were included for each year of data on the failed firms along with the values of the 23 financial variables. (See Appendix B which shows the full explanatory variable set)

A FAMILY OF MODELS FOR FAILURE RISK

The conceptual framework for any failure model must reflect the fact that in any economic process, of which the financial dealings of a firm are a part, all variables are interdependent. Marschak (1950) commented that “economic data are generated by systems of relations that are in general stochastic, dynamic and simultaneous.” Thus far bankruptcy prediction models have almost completely avoided coming to grips with this methodological problem. This further translates into the realization that economic data that are direct outcomes of an existing economic system should therefore be modeled as a system of simultaneous relations among the random economic variables, both current and lagged, internal and external to the firm. Marschak further noted that, although these properties of the data give rise to many unsolved problems in statistical inference, they constitute the basic ingredients underlying economic theory, and quantitative knowledge of them is needed for sound economic practice. What is intriguing about these comments is that they were written almost half a century ago, but such a vital problem as failure of firms has not yet been fully analyzed in any way approaching this manner.

Hence, critically, a modeling procedure is proposed where a family of models is explored—from the most general simultaneous set with non-linear form through the least general recursive system to single equation models of the simplest form. Only the last of these has, to date, been used exclusively in bankruptcy studies. As opposed to this, a model with simultaneity and timed variables may comprise a time series to predict a

vector of values for several financial variables at time t from their previous values at time $t-1$, and any other important exogenous variables such as macroeconomic indicators. The results from various equations can feed the full set of explanatory variables into a logit model where the dependent variable is the outcome (survival=0, bankrupt=1) at time t . Each firm will provide a number of rows to the data matrix depending on the number of years, previous to bankruptcy, that its financial data are available. This will be an intrinsically non-linear, simultaneous equation system which is, in principle, testable.

Consider the completely specified linear model which, using information from k prior years to failure, is specified as:

$$X_t = A_0 X_t + A_1 X_{t-1} + A_2 X_{t-2} + \dots + A_k X_{t-k} + B Z_t + e_t \quad (1)$$

where X_t is an $m \times 1$ vector of internal variables for the firm at time t , and Z_t is an $n \times 1$ vector of exogenous variables including macroeconomic indicators for the period (which may also be lagged). The matrices A_i and B are made up of the structural parameters for the model and e_t is the error vector. The A_i 's are $m \times m$ order matrices and B is $m \times n$. Here, for simplicity, these parameters are assumed to be fixed for all firms. The model is cast in a linear or log-linear form here purely for exposition but clearly it is more general for it to be non-linear form. Note that the internal variables in model (1) may include the outcome variable Y which is a 0/1 variable or, alternatively, the probability of failure in the next year, or the logit transformation of this probability. This is especially important as it has a significant impact upon model construction and upon the appropriateness (or lack thereof) of linear estimation techniques.

The reduced form of the structural model (1) is then:-

$$X_t = (I - A_0)^{-1} A_1 X_{t-1} + \dots + (I - A_0)^{-1} B Z_t + (I - A_0)^{-1} e_t \quad (2)$$

or

$$X_t = A^*_1 X_{t-1} + A^*_2 X_{t-2} + \dots + B^* Z_t + \epsilon_t \quad (3)$$

where $A^*_i = (I - A_0)^{-1} A_i$, $B^* = (I - A_0)^{-1} B$, and $\epsilon_t = (I - A_0)^{-1} e_t$.

The final model is a set of simultaneous equations which are linear in the parameters.

By ignoring the exogenous variables (assuming Z is constant) it is possible to reduce (3) to a first-order system in an augmented X -vector and examine the dynamic properties of the model, although this method has not yet been applied to financial distress models. The stability of the model can thus be determined by investigating the nature of the eigenvalues of the coefficient matrix of the reduced model. The theoretical aspects of the stability conditions can then be discussed in terms of the failed firm's internal dynamics.

Returning to the embedded logit form, if it proves difficult to incorporate the 1/0 dichotomous outcome directly into a limited dependent simultaneous model, as one of the elements of X , then the model can be recast, at least as a starting point, as a single equation such that the ratios vector X_t feeds recursively into a logit model of failure risk as in equations (4) and (5).

So for firm i :

$$p = F(X_t, X_{t-1}, \dots, Z_t) \text{ or just} \quad (4)$$

$$= F(X_t, Z_t) \text{ if lagging } X \text{ proves too cumbersome, or infeasible} \quad (5)$$

where p is the vector of risks p_t for the firm's risk of failure in the next year at time t , $t-1$, $t-2$ and so on, but is actually input as the event Y_t taking on values of 1 or 0, depending on whether t is respectively the year of failure outcome, or some prior year, and F is the logit link function (6):-

$$\Pr(Y_i = 1) = P_i = (1 + \exp\{-W_i\})^{-1} \quad (6)$$

$$\text{where } W_i = b_0 + \sum_{j=1}^m b_j X_{ij} \quad \text{and}$$

Y_i represents the outcome or dependent variable, for the i th firm in the next period: either

$Y_i = 0$ for the population of surviving firms, or

$Y_i = 1$ for the population of failed firms,

X_{ij} is an element of the matrix of explanatory variables - the value of the j th characteristic for the i th firm,

$b_0, b_1, b_2, \dots, b_m$ are constants of the model,

m = the number of explanatory variables, X_j , taken for each firm.

In the complete non-linear model, the probability of failure is embedded in the simultaneous form rather than recursive form ie. it occurs on both sides of the equation. This is important because financial distress can be expected to feed on itself, a form of positive feedback. An example would be the situation where the overall financial health of the firm, as measured by the probability of failure, will have an impact upon the ability to raise capital and so on.

The completely specified model may be empirically impractical to implement, e.g. through lack of appropriate data, and may need to be made less general, but the existence of the completely specified model gives a methodological basis for the more appropriate construction of smaller, more specific models. Thus, each smaller and less complete model can be fitted into an overall family of models. This also makes any weaknesses of the smaller, practical models more transparent.

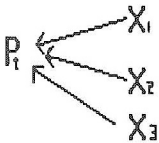
Specified next are a family of models, all of them related, for which implementable examples are given and for which the service industry data set served as a testing ground.

These models were used for estimating the risk of failure and are outlined here in order of increasing complexity and consequent difficulty of estimation technique. For ease of exposition, all error terms and residual terms have been omitted.

(A) Single Equation Logit (All Explanatory Variables are Exogenous)

$$\log [P_t / \{1 - P_t\}] = a_0 + a_1 X_{1t} + a_2 X_{2t} + a_3 X_{3t} \quad (7)$$

P_t is the relative frequency measure or other measure of risk of failure. The causal relationships can be represented as follows:

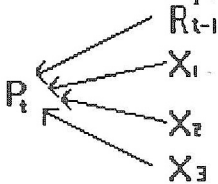


$X_{1,2,3}$ are the exogenous variables - three are used for exposition only, any number may be included. This model was estimated with the exogenous variables as the first five principal component factors and their one, two and three-year lags for the US economy incorporating economic series over a twenty-one year period. The model was estimated using observations on firms from all four lag periods before failure and matching the economic factors, X_{it} , on the appropriate year. The same model can be applied with the X 's taking on the values of the internal financial ratios of the firm, assuming that these are all independent of each other and also independent of the risk of failure (ie. exogenous with no causal feedback). This model was estimated using a stepwise logit estimation of risk regressed on 23 ratios, and again pooling observations for all four lag periods. Finally, the more useful combined single-equation model using both types of variables, internal and external to the firm, was estimated and also falls into this category.

(B) Single Equation Logit (All Explanatory Variables are Exogenous or Lagged Endogenous).

$$\log [P_t / \{1 - P_t\}] = a_0 + a_1 X_{1t} + a_2 X_{2t} + a_3 X_{3t} + b_1 R_{t-1} \quad (8)$$

R is an endogenous variable that could be, for example, the risk of failure or a financial ratio which is influenced by risk of failure. All the X are assumed exogenous. The causal relationships can be represented as follows:



(C) **Simultaneous Equations** (All Explanatory Variables are Exogenous, Lagged Endogenous and Current Endogenous Variables).

$$(i) \log [P_t / \{1 - P_t\}] = a_0 + a_1 X_{1t} + a_2 X_{2t} + a_3 X_{3t} + b_1 R_{t-1} + b_0 Q_t$$

(9)

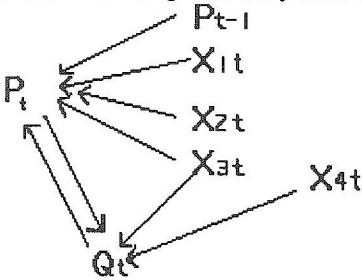
where, in addition, the following relationship exists:

$$(ii) Q_t = \alpha_0 + \alpha_1 \log [P_t / \{1 - P_t\}] + \sum_{j=1}^m a_j X_{jt} \quad (10)$$

or with a different functional relationship between Q_t and P_t :

$$(iia) Q_t = \alpha_0 + \alpha_1 P_t + \sum_{j=1}^m a_j X_{jt} \quad (11)$$

Q_t and P_t are current endogenous variables and the X_{jt} are exogenous (may be some in common with equation (i)). Q_t may be one of the internal ratios that has a two way (feedback) relationship with failure risk as in the diagram below. This model is linear in form as a simultaneous equation system. Equations (i) and (ii) cannot be estimated independently of each other. 2SLS cannot be used directly because equation (i) has to be estimated from original binary data so a logit form is required.



To perform the proper estimation of this simultaneous equation model firstly requires an estimation of the unrestricted reduced form equation for (i) providing a first-stage estimate of $\log [P_t / \{1 - P_t\}]$, or P_t as its inverse, using logit analysis, and secondly, an estimation of Q_t from the structural form equation for (ii) based upon the reduced form estimates. This eliminates the non-linearity of $\log [P_t / \{1 - P_t\}]$ in (ii). Then estimate the unrestricted reduced form for Q_t which can then be substituted into (i) and so on, as in 2SLS estimation.

(D) Seemingly Unrelated Regressions.

Consider the following equations, one for each lag time, one to four periods before failure:

$$(i) \log[P_t / \{1 - P_t\}] = \alpha_t + \sum_{j=1}^m a_{t,j} X_{j,t}$$

$$(ii) \log[P_{t-1} / \{1 - P_{t-1}\}] = \alpha_{t-1} + \sum_{j=1}^m a_{t-1,j} X_{j,t-1}$$

$$(iii) \log[P_{t-2} / \{1 - P_{t-2}\}] = \alpha_{t-2} + \sum_{j=1}^m a_{t-2,j} X_{j,t-2}$$

$$(iv) \log[P_{t-3} / \{1 - P_{t-3}\}] = \alpha_{t-3} + \sum_{j=1}^m a_{t-3,j} X_{j,t-3}$$

These equations are not simultaneous; each equation represents the same firms over different time periods but, since they are a combination of cross-sectional and time-series data for the same firms - a reasonable assumption is that the disturbances or error terms in different equations are correlated. Providing the initial estimates of the logit component are input into the algorithm to eliminate non-linearity, this set can be analyzed together using SUR estimation (incorporating generalized least squares.)¹

The $X_{j,t}$ may also include lagged endogenous variables (which are deemed to be predetermined) and still be treated as "seemingly unrelated" since no simultaneity is present.

RESULTS

Results for the most simple single-equation model within the family of models-Equation (7), estimated using the service industry data set are summarized below :

The effects of the economy and the effects of the financial variables on failure risk were found to be mutually reinforcing.

The effects of the important macroeconomic variables are more significant, statistically, than the effects of the important internal financial ratios to the risk of failure, at least as judged by their order of entry into a forward stepwise selection logit model² (See Appendix C for the parameter estimates and their statistical significance to the model)

The liquidity ratio, working capital to total assets, is statistically the most significant ratio to failure risk. In addition, when combined with the external variables, it vies with the external variables for early entry into the stepwise model. This is consistent with past studies of financial distress across different research designs and time periods in that, as this ratio increases, failure risk decreases.

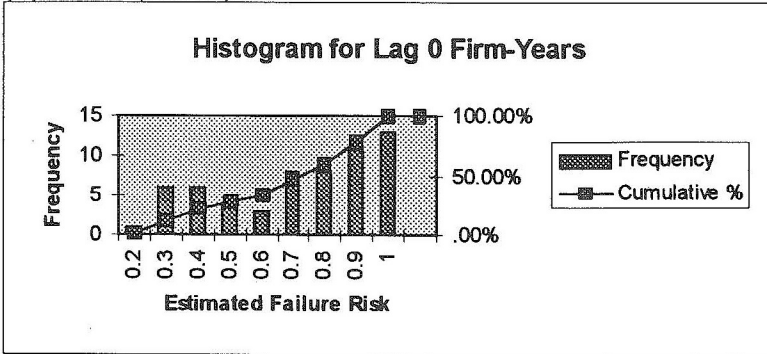
The effect of the "labor market tightness" factor, a complex external variable derived as a principal component, highly weighted (negatively) on the total number unemployed, and (positively) on the change in the size of the employed labor force, is the most significant variable ($p < .0001$), overall, to failure risk. Other external variables significant to failure risk ($p < .0005$) are the "private, public, and business expenditure" factor lagged one year (negatively, $p < .0001$), and the "cost of capital borrowing" factor lagged one year (positively, $p < .0004$).

Tentative interpretations of these effects are offered. As the labor market tightens ie. there are fewer unemployed, unions are stronger and the cost of labor increases, one would expect the risk of failure to increase. As private, public and business expenditure increases, demand for products and services is higher so one expects the risk of failure to decrease. As the short-term cost of borrowings increases, the costs of production are higher to service borrowings, so one would expect the risk of failure to increase.

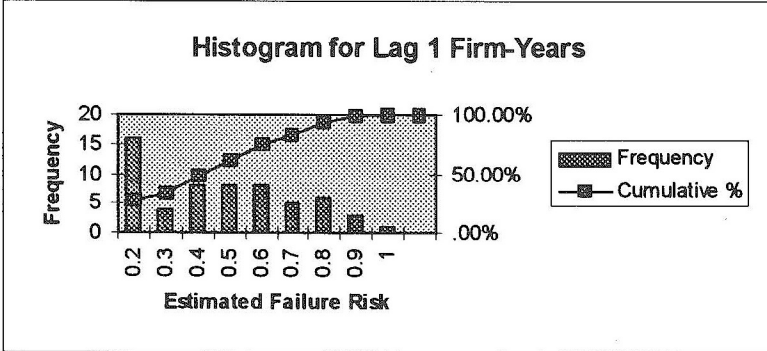
The logit model based on the variables statistically significant to failure risk used only a binary 0/1 input variable for the events "fails in the next year" / "survives the next year" and yet provided a good instrument for measuring failure risk at each period prior to failure. It not only has given a logical result that the risk of failure increases with each period but also that it increases quite markedly in the final three years before failure. This is illustrated in Figure 3 showing the histograms for the estimated failure risk separately for each lag year. The shape of the cumulative frequency ogive gets flatter going from figures A to D as more of the distribution of failure risks are concentrated at the lower end in the earlier years before failure. There is also an impressive modal shift from the highest risk category to the lowest in the first lag year, and there it remains for all lags.

Figure 3

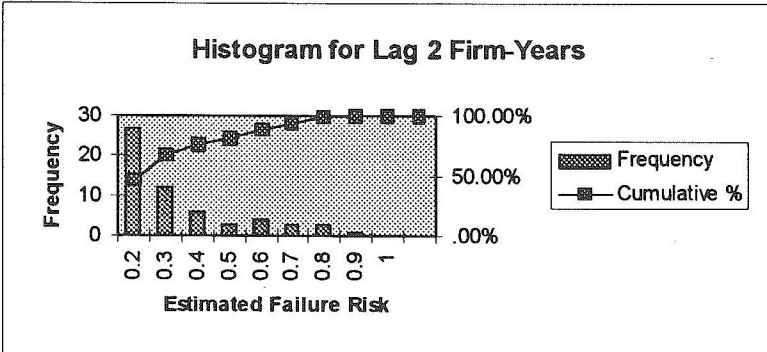
DISTRIBUTIONS OF ESTIMATED FAILURE RISK FOR EACH LAG YEAR
(A) LAG 0 (FINAL) YEAR



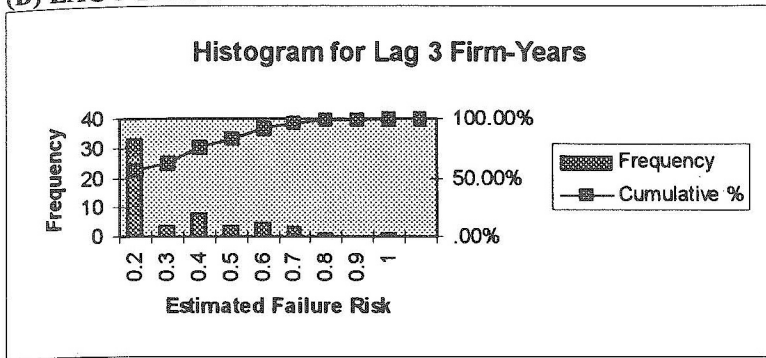
(B) LAG 1 YEAR



(C) LAG 2 YEARS



(D) LAG 3 YEARS



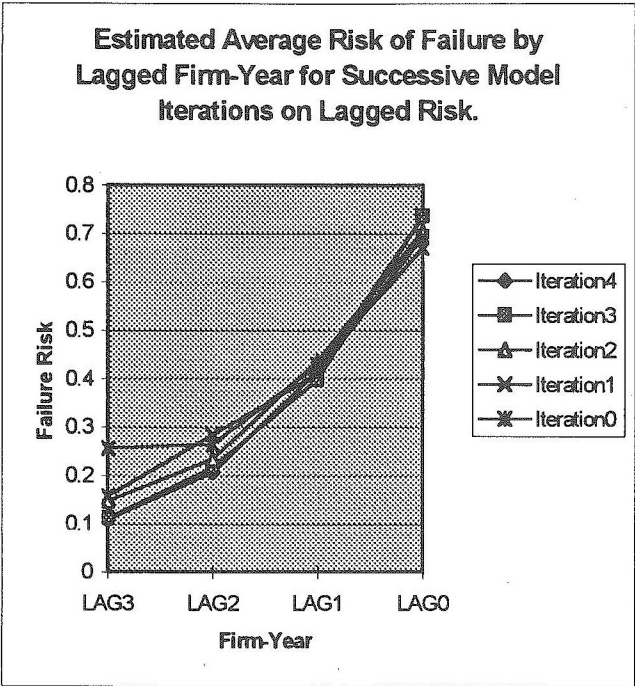
The risk is estimated at around one chance in four at three and four years prior, and increases to two chances in three at one year prior to failure—an absolute jump in risk of 41% within two years. This is a strong indication that a reorientation to process dynamics is very much overdue.

Incorporating a measure of lagged risk into the single-equation model of Equation (8) is the simplest way to add the dynamic element into the model specification, yet the improvement in model fit is good and the sequential increase in estimated failure risk from year to year is also more marked than in the model with no dynamic included. One may conclude that these increases coincide with a very rapid decline in financial stability for these firms as they

approach bankruptcy. This rapid decline is borne out by the increasing weight on the lagged risk when its value was consecutively iterated until stability was reached—indicating a distress feedback mechanism. The averages of the estimated risk for each lag period from models sequentially iterated on lagged risks are graphed in Figure 4 below.

Results from the multiple equation models within the family of models tested on the service industry data follow the finding, that at certain lag years some variables have a much more significant effect on failure risk than they do at other lag years (or they may not be statistically significant in some years). This offers considerable justification for the multi-equation modeling of failure risk using time series as well as cross-sectional data for the analysis set. In these situations, the coefficient effects in the single-equation model are averaged out over time and the power of any significance tests applied to them are consequently reduced. The result is that these effects are usually deemed statistically insignificant under a single-equation failure model specification.

Figure 4



One such variable is “cash flow from operations to total liabilities” which appears to be an immediate trigger for bankruptcy in the final year before failure. As such it is important in the final year but not at other times. Consequently this variable is not useful as an early pointer since a drop in it’s value is predictive of failure only at too short an advance period.

This may also be the reason for the controversy over cash flow variables in general as to whether they contain information value beyond that of accrual variables in bankruptcy prediction analyses. Thus, studies may reach very different conclusions with respect to this variable depending on the time of the measurement of variables as opposed to the point of time of failure.

By investigating the differences in parameter estimates and their significance to failure risk for each prior year before failure by the method of seemingly unrelated regressions, some insights into the patterns of failure over the final four years of a service industry firm's existence have been gained here. Firstly, an important result is that some variables not only remain highly significant over all four years prior to failure but also have consistent signs on the coefficients over those four years. This finding lends some weight to the validity of some single-equation failure model specifications with respect to these variables. As a consequence, these variables can be confidently used in these simple failure prediction models as their discriminatory powers are reasonably long term (at least of four years duration before failure.)

Because of this discriminatory robustness over time it was useful to examine the relative sizes of the coefficients of each of these significant variables over the four lag years. The variables that showed little difference in size from year to year were working capital to total assets, total liabilities to total assets, and interest coverage. Again, despite the comments in the point above, no stress is laid here on the strength of individual variables.

The variables that show larger differences from year to year are of even greater interest. The "labor market tightness" factor and the "expenditure (business, private and public)" factor—the latter measured both in the same year as the firm's final financial statements were submitted as well as in the previous year—all increased in their effects on failure risk as failure approached, having the most pronounced effect in the penultimate year before failure and this effect dropped only slightly in the final year prior. These results suggest that if the firm is already vulnerable to failure, low expenditure levels in the economy and a tight labor market at this time can have a devastating effect on the ultimate solvency of the firm.

Of the financial ratios, sales to net plant showed a considerably larger positive effect on failure risk at three years prior to failure. Particularly if this ratio was large, it was associated with an increased failure risk at this time. One possible reason for this effect is that the value of fixed assets was eroded at this time by selling off assets, rather than by sales increasing.

The three significant ratios to failure risk that exhibit high multi-collinearity in the data are the liquidity ratio: working capital to total assets, the leverage ratio: total liabilities to total assets, and the profitability ratio: net income to total assets. Including a second linear equation in a simultaneous equation set with working capital to total assets as a jointly dependent variable overcame the problem of an unexpected negative sign on the coefficient of total liabilities to total assets in the single-equation logit models of earlier chapters. The incorrect sign was concluded to be due to the multi-collinearity of supposedly "independent" predictors.

CONCLUSION

The proposed new modeling methodology outlined in this paper, with corresponding procedures for implementation, has the following advantages:

(a) At this stage of the development of the methodology, using only failed firms and making comparisons within failed firms in a panel design rather than between going-concerns and failed firms avoids the problem of overrepresentation of failed companies that has led to bias in past models of public company failure.

(b) Using only failed firms avoids confounding truly healthy surviving firms with those that are potential failures in the short term

(c) Each firm is essentially matched with its previous states as information from its failed year is used together with information from its surviving years.

(d) A time series formulation allows us to incorporate changes in macroeconomic conditions, and many allow us to translate vague statements such as, "A company which may have been able to survive during a boom period may not be able to survive in a slump" into more precise and useful forms.

Without exception, past models have used a single equation model that must necessarily be mis-specified, since the failures feed back into the firm itself causing a ripple effect. Nevertheless, it is a property of the methodology that it can accommodate these discrimination models within the family of models that it includes. In this context these models can be seen as partial or special case models so that their failings and/or special assumptions are made more explicit and apparent. This is not only shown to be the situation at the methodological level through the construction of a family of models, but the models examined within the methodological framework are empirically more successful than the partial, special case models.

NOTES

1. The first-stage estimates come from a "full" single equation model, where all lag years are pooled. It would not be possible to get the estimates for failure risk from these four equations analyzed separately as the Y values are constant for each; either 0 or 1. The SAS/ETS statistical package provides the procedure MODEL, which is able to fit these directly when they are written in their logistic function form.
2. The order of entry into the forward stepwise logit model was: the Labor Tightness factor, the Construction factor, the Public and Private Expenditure factor, the Cost of Capital Borrowing factor lagged one year, the Public and Private Expenditure factor lagged one year; then the ratios: Working Capital to Total Assets, Total Liabilities to Total Assets, Cash Flow from Operations to Total Current Assets, Interest Coverage after Tax (binary dummy variable), Sales to Net Plant- lowest values dummy variable, Sales to Net Plant-highest values dummy variable.
3. This number applies to the 1992 publication of "Abstracts of the U.S.A."

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APPENDIX A

The External Variables in the Model: Principal Components Analysis of the U.S. Economy 1970-1991

Using tables from *ABSTRACTS OF THE U.S.* (1992) and matching the table names with earlier years' publications going back to 1970. Amounts are in Current dollars. Variables A-BX are defined below. X=not included in Principal Components Analysis due to many missing values. In other series, single missing values are interpolated or extrapolated.

Table No.	Table Name
A DNA	years covered 1970-1991 - not used in PCA
B 449	All Governments - Debt outstanding (bil.\$)
C 491	Federal Budget Surplus or Deficit(-) (mill \$)
D	Gross Federal Debt as percent of GNP
E 494	Federal Budget Outlays Total (mill \$)
F	Net Interest Payments (mill \$)
G 501	Total Funds Loaned in U.S. Credit Markets(bil \$)
H 525	National Defense Outlays (bil \$)
I 608	Labor Force - Total employed ('000)
J	- Total Unemployed('000)
K X 623	Weekly Hours (*missing 1971-74, 1975-78)
L X 624	Total Self-employed Workers('000)(missing 1971-4,1976-9,1981-2)
M 673	GDP-all in current \$ (bil \$)
N	Personal Consumption Expenditures(bil \$)
O	Gross private Domestic Investment (bil \$)
P = ΔM 675	Average annual Percentage Change in GDP from former year
Q = ΔN	Average annual Percentage Change in Personal Consumption Expenditure
R* 683	Gross Savings (bil \$)
S*	Gross Investment (bil \$)
	(*missing 1971)
T 738	Consumer Price Indexes (base av. 1982-84)
U = ΔT 739	Percentage Change in CPI from former year
V 746	Producer Price Indexes Crude Materials (base 1982)
W	Intermediate Materials
X	Finished Goods
Y	Capital Equipment
Z*X 778	Insured Commercial Banks - Provisions for Loan Losses (bil \$)

AA*X	(*missing 1970-79)Percentage of Banks Losing Money		
AB* 789	Mortgage Debt Outstanding - Commercial (bil \$)		
	(*missing 1981,1991)		
AC 802	Money Stock and Liquid Assets	M1 Total	
AD	(bil \$)		M2 Total
AE*			M3 Total
(*missing 1971-72)			
AF* 806	Money Market Interest Rates	Commercial paper 3 mth	
AG*		Prime Rate charged by banks	
AH*		US Govt Securities 1yr Treasury	
bill			
AI*X 808	Security Prices	- Bond Prices -Dow Jones	Yearly High
AJ*X	(*missing 1971-74,1976-77,1982)		Yearly Low
BB	replace above two bond prices with Standard and Poor's Municipal		
AK* 809	Bond and Stock Yields (%)	-US Treasury constant maturities	³ -yr
AL*	(*missing 1971-72) Replaced 72 with S&P's preferred 10 stocks		
AM*			
	10-yr		
AN 862	Business Expenditure for New Plant and Equipment - All	Industries (bil	
	\$)		
AO* 864	Composite Indexes of Economic Cyclical Indicators-Leading Indicators		
AP*(1982=100)	Coincident Indicators		
AQ*	(*missing 1991)	Lagging Indicators	
AR* 866	Manufacturing and Trade	Sales	
AS*	(*missing 1971)	Inventories (NA 1990-91)	
AT* 925	Fossil Fuel prices - Crude Oil (cents per million Btu)		
	(*missing 1971,1991)		
AU 1204	Value of New Construction Put in Place - Total (mill \$)		
AV 1250	Manufacturers'	Shipments	
AW	(bil \$)	Inventories	
AX	New Orders		
AY 1315	US International Transactions -Balance on Current Acc (bil\$)*		
AZ 1407	Exchange rates (index of value relative to US \$) Germany		
BA	(1982=100) Japan		

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The following series were added. They are the rates of change (denoted Δ) of many of the above series.

BC = Δ E 494	Federal Budget Outlays Total		
BD = Δ F	Net Interest Payments		
BE = Δ I 608	Labor Force - Total employed		
BF = Δ R 683	Gross Savings		
BG = Δ S	Gross Investment		
BH = Δ Y 746	Producer Price Indexes	Capital Equipment	
BI = Δ AC 802	Money Stock and Liquid Assets	M1 Total	
BJ = Δ AD			M2 Total
BK = Δ AE			M3 Total
BL = Δ AF 806	Money Market Interest Rates	Commercial paper 3 mth	
BM = Δ AG	Prime Rate charged by banks		
BN = Δ AH	US Govt Securities 1yr Treasury bill		
BO = Δ AK 809	Bond and Stock Yields (%) - US Treasury constant year	maturities 3 -	
BP = Δ AL			5 -
	year		
BQ = Δ AM			10-
	year		
BR = Δ AN 862	Business Expenditure for New Plant and Equipment - All Industries		
BS = Δ AR 866	Manufacturing and Trade Sales		
BT = Δ AS		Inventories	
BU = Δ AU 1204	Value of New Construction Put in Place - Total		
BV = Δ AV 1250	Manufacturers' Shipments		
BW = Δ AW		Inventories	
BX = Δ AX		New Orders	

1ST PRINCIPAL COMPONENT:

NAME: LEVEL OF ACTIVITY/DEMAND IN THE ECONOMY FACTOR

This factor is a surrogate for YEAR as it is highly correlated with YEAR (an increasing function -almost monotonic.)

PC1 (54% of variation explained) loads highest ($p \leq 0.0002$) on:-

(in descending order of correlation magnitude)

(all +ve unless stated as -ve)

E 494 Federal Budget Outlays Total (mill\$)

T 738 Consumer Price Indexes

AS 866 Manufacturing and Trade Inventories

AE 802 Money Stock and Liquid Assets M3 Total

AD 802 Money Stock and Liquid Assets M2 Total

M 673 GDP -all in current \$ (bil \$) - GNP only available for early (7) years

N 673 Personal Consumption Expenditures(bil \$)

2nd PRINCIPAL COMPONENT

NAME: COST OF CAPITAL BORROWING FACTOR

PC2 (17.6% of variation accounted for) loads highest ($p \leq .0005$) on :

(in descending order of correlation magnitude)

AF 806 Money Market Interest Rates Commercial paper 3-mth

BP(Δ AL)809 Δ (Bond and Stock Yields (%)-US Treasury constant maturities 5 -yr)

AH 806 Money Market Interest Rates US Govt Securities 1yr Treasury bill

BO(Δ AK)809 Δ (Bond and Stock Yields (%)-US Treasury constant maturities 3 -yr)

BD(Δ F) 494 Δ (Net Interest Payments)

BQ(Δ AM)809 Δ (Bond and Stock Yields (%)-US Treasury constant maturities 10-yr)

AG 806 Money Market Interest Rates Prime Rate charged by banks

BM(Δ AG) 806 Δ (Money Market Interest Rates Prime Rate charged by banks)

AK 809 Bond and Stock Yields (%)-US Treasury constant maturities. 3-year

BN(Δ AH)806 Δ (Money Market Interest Rates US Govt Securities 1yr Treasury bill)

AL 809 Bond and Stock Yields (%)-US Treasury constant maturities 5-yr

3rd PRINCIPAL COMPONENT

NAME: LABOUR MARKET TIGHTNESS FACTOR

PC3 (12.4% of variation accounted for) loads highest ($p \leq 0.02$) on :-
(in descending order of correlation magnitude)

J (-ve)	608	Labor Force - Total Unemployed ('000)
BB	808	Security Prices -Standard and Poor's Municipal
BE(Δ I)	608	Δ (Labor Force - Total employed)

4th PRINCIPAL COMPONENT

NAME: CONSTRUCTION ACTIVITY FACTOR

PC4 (accounting for 5.6% of the variation) loads highest ($p < 0.03$) on:

BU(Δ AU)1204	Δ (Value of New Construction Put in Place - Total)
BE(Δ I) 608	Δ (Labor Force - Total employed)
BH(Δ Y)(-ve) 746	Δ (Producer Price Indexes Capital Equipment)

5th PRINCIPAL COMPONENT

NAME: EXPENDITURE FACTOR (PRIVATE, PUBLIC, BUSINESS)

PC5 (accounting for 2.7% of the variation) loads highest ($p < 0.04$) on:

BR Δ AN 862	Business Expenditure for New Plant and Equipment - All Industries
BC Δ E 494	Federal Budget Outlays Total
Q= Δ N 675	Average annual Percentage Change , Δ (Personal Consumption Expenditure)

A RE-EXAMINATION OF THE SIGNIFICANCE OF EMPLOYEE JOB ATTITUDES ON CUSTOMER SATISFACTION IN THE SERVICES SECTOR

Robin L. Snipes*

Past research has shown that a number of organizational and human resources practices can positively affect customer attitudes about service quality. The present study investigates the effect of employee attitudes on customer satisfaction at the individual employee level of analysis in one service industry: higher education. The use of the faculty-student setting allowed this study to be among the first to empirically link the perceptions of both groups (employees and customers) at the individual level of analysis. Results suggest that employee job satisfaction has a significant effect on service quality perceptions in this industry.

The "marketing concept" often studied in business schools today argues that customer needs must be the central focus of the firm's definition of its business purpose, and that profits are produced through creating customer satisfaction. Therefore, winning business strategies should start with an analysis of the company's actual performance compared to customer expectations of performance, especially in service industries. However, in reality, even business schools espousing such philosophies have typically focused more on their own needs and considered students only as an input to satisfying the institution's needs (Snipes, Oswald, & Hortman, 1997; Conant, Brown & Mokwa, 1985). This way of doing business is changing. With the demographic, political and economic changes in today's environment, successful colleges in the future will be the ones utilizing more of a marketing orientation, rather than a production or selling orientation. As pointed out by Shim & Morgan (1990), "due to the end of the baby boom and changing societal priorities, a marketing orientation should be considered by colleges and universities as one of the keys to their future" (p. 29).

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As noted by Wiley (1991), researchers from both the disciplines of organizational behavior and marketing are increasing their focus on the antecedents, as well as the outcomes, associated with the achievement of high levels of customer satisfaction. Past research has shown that a number of organizational and human resource practices positively affect customer attitudes about service (Hartline & Ferrell, 1996; Hallowell, Schlesinger, & Zornitsky, 1996). In these studies, it has been shown that managerial practices to improve employee attitudes regarding the company can also improve customer attitudes. However, as noted by Tornow and Wiley (1991), service organizations in their operating practices typically do not consider customers and employees within the same planning or evaluation context. This is unfortunate, because an increasing amount of research supports the notion that what happens to employees inside a firm affects what happens to customers outside a firm (Hartline & Ferrell, 1996; Ulrich, Halbrook, Stuchlik & Thorpe, 1991). Understanding employee attitudes and their impact on performance can encourage management to find methods to foster those employee attitudes that will, in turn, improve customer service.

To date, only a few empirical studies have been conducted to investigate the link between employee job attitudes and customer satisfaction. By capturing perceptions across employees and customers, this study is among the first to empirically link the perceptions of both groups *at the individual level of analysis*. Most of the studies that have been conducted involve *group-level* data rather than *individual-level* data. A drawback of aggregating or "grouping" data at the organization or department level is that the effects of individual employees may be negated. Thus, the true effects of variables may be somewhat distorted. For example, when the data are aggregated, the effect of a negative employee on his/her customers may be "canceled out" by the effect of positive employees and, thus, the "true" portion of the variance explained by employee job satisfaction cannot be accurately determined.

Therefore, the primary contribution of this study is in its design. Prior research has utilized group-level data, primarily at the organizational level of analysis, possibly because of the difficulty in matching responses across respondent groups (i.e., employees and their customers). In this study, the use of the academic setting allowed the variables to be studied at the *individual* level of analysis, such that the individual instructor ("employee") ratings could be paired with his/her respective student ("customer") ratings. This type of research design may have allowed for a more accurate analysis of the true effects of each variable.

Another goal of this study was to investigate the effects of *specific* facets of job satisfaction (e.g., satisfaction with pay, satisfaction with the work itself, etc.) in order to determine which ones exert the most influence on service quality. The use of facet scales may offer more information to managers on the true relations between job satisfaction and behavioral outcomes than global job satisfaction scales.

A last purpose of this study was to test a causal model of these relationships. The use of a structural equations model allows us to better determine the causal relationships between the variables. Structural equations modeling improves upon more traditional types of data analysis in three basic ways: (1) it allows for the estimation of multiple and interrelated dependence relationships; (2) it gives the researcher the ability to represent unobserved (latent) constructs; and (3) it increases the reliability of measures through the use of separate measurement and structural models (Hair, Anderson, Tatham, & Black, 1992).

CONCEPTUAL FRAMEWORK

Research on Employee Attitudes and Customer Satisfaction

Several studies have suggested that certain employee attitudes are positively correlated to customer attitudes in both service and manufacturing industries (Hartline & Ferrell, 1993; Reynierse & Harker, 1991; Schneider & Bowen, 1992). For example, one survey of employees at Barnett Bank found that customer satisfaction was positively correlated to employees' perceptions that the manager supported employees with new ideas on customer service, met regularly with them to discuss work performance goals, encouraged cooperation in the service of customers and took time to help new employees learn (Jones, 1991).

In an academic organization, it is possible that student satisfaction may be significantly impacted by faculty job satisfaction. Job satisfaction is probably the most studied attitudinal variable in the organizational research literature (Brown & Peterson, 1993). Job satisfaction has been perceived as an important employee attitude by managers and organizational researchers, and has been consistently linked to organizational commitment, turnover and intent to leave (Tett & Meyer, 1993). It is also a frequently studied variable in the service quality literature (see Hartline & Ferrell, 1996). In fact, in a service organization, it is possible that employee job satisfaction has its biggest impact on the organization in the area of *customer* satisfaction.

Research suggests that overall job satisfaction is the primary determinant of both service quality and perceived value (Hartline & Ferrell, 1996). Additionally, research indicates that job satisfaction is positively correlated with employee perceptions of service quality (Schlesinger & Zornitsky, 1991) and customer ratings of customer service (Reynierse & Harker, 1991). Moreover, research supports an assertion that employees can predict customer perceptions of many determinants of service quality (Reynierse & Harker, 1991), and this prediction may have a significant affect on their job satisfaction.

One variable which may moderate the relationship between job satisfaction and performance may be employee self-efficacy, which has been found to be positively correlated to job satisfaction in previous research (see Bagozzi, 1980; Brown & Peterson, 1993). The concept of self-efficacy was originally introduced as part of Bandura's (1977) social learning theory. Bandura defined perceived self-efficacy as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (p. 391). He further suggested that self-efficacy is not as much concerned with the actual skills one has, but with the "judgments of what one can do with whatever skills one possesses" (p. 391). Therefore, self-efficacy can be compared to self-esteem, but it is more task specific than self-esteem.

Self-efficacy is important because it has been shown to affect employee performance (see Lee & Bobko, 1994). Another reason self-efficacy is important is because it may affect job satisfaction in that employees that don't feel they are competent enough to perform well may experience a good deal of unhappiness and frustration at work. In fact, several studies have found significant correlation's between feelings of self-efficacy and job satisfaction (see Riggs & Knight, 1994). Self-efficacy has also been shown to be positively correlated with employee performance (Locke & Latham, 1990) and customer service quality (Hartline & Ferrell, 1993; Parasuraman, Berry, & Zeithaml, 1990). Therefore, self-efficacy is an important individual difference variable that should be included in models investigating the job satisfaction-performance relationship.

Customer Satisfaction and Service Quality

Some marketing researchers have proposed that the benefits of increased customer satisfaction come in two basic forms: the improved ability of the firm to attract new customers, and the ability of the firm to maintain repeat customers (Rust, Zahorik, & Keiningham, 1995). In fact, prior research has found that small increases in current

customer retention rates can have a dramatic effect on the profits of a company (Dawkins & Reichheld, 1990; Fornell & Wernerfelt, 1988; Reichheld & Sasser, 1990). This is because existing customers tend to purchase more than new customers (see Rose, 1990), the efficiencies in dealing with them are greater, and the selling costs are much lower (see Rust, et. al., 1995; Peters, 1988). Also, research shows that service quality (Bitner, 1990) and overall service satisfaction (Cronin & Taylor, 1992) can improve customers' intentions to stay with the firm. Customer satisfaction, then, could have a substantial financial impact on firms, especially in service industries.

In 1985, Parasuraman, Zeithaml, and Berry suggested that perceived service quality is similar to a "global judgment or attitude" (p. 42). Their conceptual definition of the service quality construct was that it is a comparison to excellence in service encounters by the customer (Taylor and Baker, 1994). Exploratory research by Parasuraman, Zeithaml and Berry (1985) revealed that the criteria used by consumers in assessing service quality fit 10 dimensions. These dimensions are tangibles, reliability, responsiveness, communication, credibility, security, competence, courtesy, understanding the customer, and access to service. Parasuraman et al. (1988) developed a scale, called SERVQUAL, to measure service quality by examining the "gap" between the customer's expectation of service quality and his/her perception of the service actually

received on each of these 10 dimensions. Through empirical testing, the authors narrowed the initial 10 dimensions of service quality to 22 items making up five basic dimensions: tangibles, reliability, responsiveness, assurance and empathy.

It is not clear, however, to what extent these determinants capture the construct of customer satisfaction. In fact, it might seem that the constructs are quite similar, and some research supports this notion (Schutz & Casey, 1983). However, the authors of SERVQUAL (Parasuraman et al., 1988) were careful to distinguish between these two constructs, and to stress that their scale was designed to measure service quality. Additionally, a review of the literature suggests that there appears to be relative consensus among marketing researchers that service quality and consumer satisfaction are separate and unique constructs, but they share a close relationship (Taylor & Baker, 1994; Cronin & Taylor, 1992). The weight of the evidence in the services literature supports the position that service quality and consumer satisfaction are best conceptualized as unique constructs that should not be treated as equivalents in models of consumer decision making. Rust and Oliver (1994, p. 2) most recently describe the dominant model of customer satisfaction in the services literature as follows:

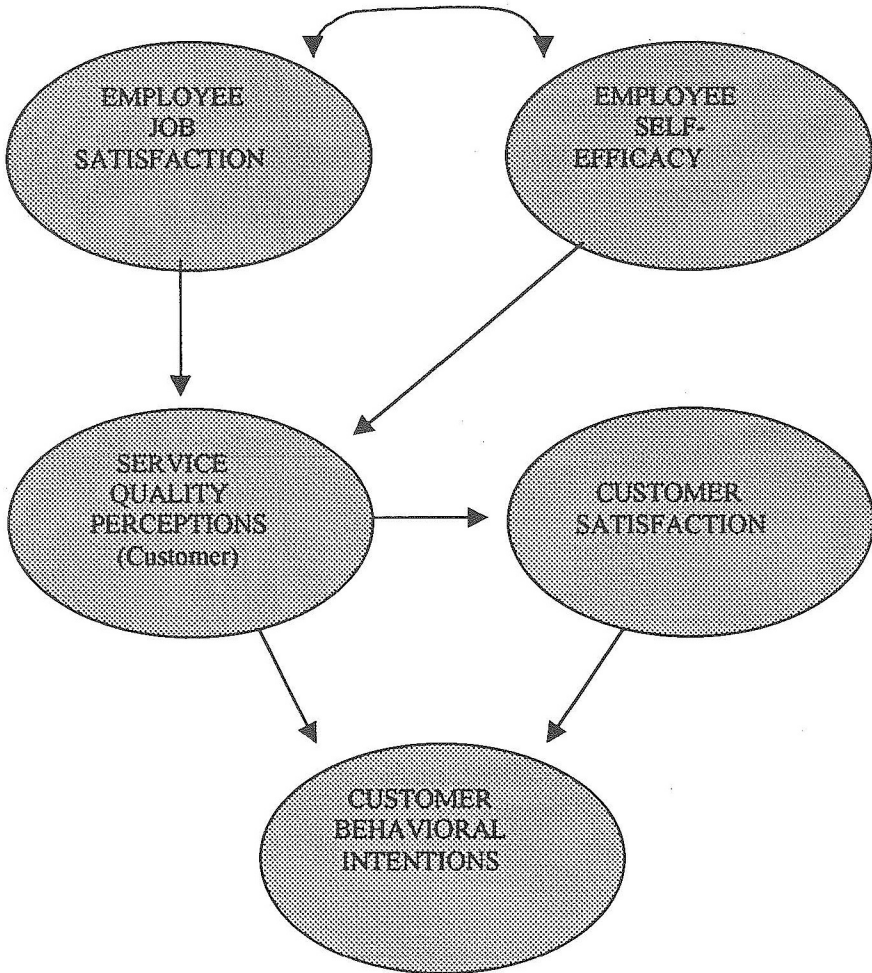
In brief, customer satisfaction is a summary cognitive and affective reaction to a service incident (or sometimes to a long-term service relationship). Satisfaction (or dissatisfaction) results from experiencing a service quality encounter and comparing that encounter with what was expected.

MODEL AND RESEARCH HYPOTHESES

Based on the foregoing literature review, the model indicated in Figure 1 is proposed and tested. As indicated in Figure 1, it is hypothesized that employee job satisfaction (which includes job satisfaction facets and global job satisfaction) and self-efficacy will be positively correlated and will both exert a positive effect on perceived service quality. It is also hypothesized that perceived service quality (i.e., student perceptions of the actual service rendered versus their expectations of the level of service they should receive) will exert a positive effect on student satisfaction, and that both student satisfaction and perceived service quality will exert a positive effect on student behavioral intentions (i.e., positive word-of-mouth and future purchase intentions).

The relationship between service quality and consumer satisfaction in the formation of consumers' purchase intentions and intentions to stay with the firm has been addressed in several recent studies (see Bitner, 1990; Cronin & Taylor, 1992; Taylor & Baker, 1994). Some research suggests that customer satisfaction directly affects behavioral intentions (Cronin & Taylor, 1992; Woodside, Frey, & Daly, 1989) and other research suggests that service quality directly affects consumer behavioral intentions (Bitner, 1990). It appears that the bulk of the research supports Rust and Oliver's (1994) conception of the service quality-customer satisfaction relationship: that quality is only one of the many potential service dimensions factored into customer satisfaction. It is highly likely and makes intuitive sense that both customer satisfaction and service quality affect consumers' behavioral intentions.

Figure 1
Hypothesized Structural Relationships



Based on the foregoing literature review, the following hypotheses are posited:

HYPOTHESIS #1: Perceptions of faculty service quality will have a positive and significant effect on overall student ("customer") satisfaction.

HYPOTHESIS #2: Perceptions of faculty service quality and student ("customer") satisfaction will each exert a positive and significant effect on behavioral intentions.

HYPOTHESIS #3: Job satisfaction will have a positive and significant effect on service quality.

HYPOTHESIS #4: Self-efficacy will have a significant, positive effect on service quality.

HYPOTHESIS #5: Job satisfaction and Self-efficacy will have a reciprocal relationship such that self-efficacy will exert a positive effect on job satisfaction, and vice versa.

RESEARCH METHOD

Sample

Student evaluations of faculty classroom behavior have been shown to be positively related both to faculty self-evaluations (Blackburn & Clark, 1975; Braskamp, Caulley & Costin, 1979; Marsh, 1987) and to ratings produced by external observers (Marsh, 1987). A review of the literature on faculty evaluations revealed that student evaluations of faculty have been correlated to research productivity (Feldman, 1987) and to other nonteaching facets of the faculty role (see Schneider, Hanges, Goldstein & Braverman, 1994). Therefore, student evaluations can be an accurate way of assessing faculty service quality. The faculty-student setting was used to provide the empirical basis for this research for several reasons, including: (1) teaching is a service profession and students, therefore, are consumers of this service; (2) using student evaluations of service quality may reduce the response rate bias typically found in customer satisfaction research; (3) this setting would allow the researcher to be better able to match responses across respondent types (i.e., employees and their customers) to obtain an individual-level of analysis; (4) these consumers may be able to give more accurate responses than other consumers who may feel their response will affect the employee's employment outcomes (as per research in the performance appraisal area); and (5) because of the higher level of interaction between students and faculty, students may be better able to assess employee (faculty) service quality than consumers in other industries.

Instructors from six post-secondary academic institutions located in three states were chosen for the sample. Surveys were sent to all full-time faculty in each of the six colleges inviting them to participate in the study. Customer satisfaction data was collected from their students. Several control variables were included in the study to control for differences across classes (i.e., freshmen vs. senior level classes) and across schools (see the "Control Variables" section below). Additionally, teaching-oriented colleges were chosen to allow the researcher to accurately assess the relationship between job satisfaction and customer satisfaction. In this study, the customer (or student) satisfaction scales are concerned only with the teaching quality, and do not assess research or administrative quality. Faculty in teaching-oriented colleges, such as junior colleges or technical schools, spend the majority of their time in the classroom. Therefore, it was felt that an accurate relationship between employee attitudes and customer satisfaction could be better assessed in this type of college.

Although convenience sampling was used to determine the sample, the sample is felt to be a representative one given its size ($n=351$) and diversity (see Table 2). All full-time faculty members from six colleges were invited to participate in the study. The colleges were located in the southeastern region of the United States. The following is a brief description of each college:

- School #1: A small, two-year community college
- School #2: A medium-size five-year liberal arts college
- School #3: A small, five-year regional college
- School #4: A medium-size vocational-technical school
- School #5: A small, five-year regional college
- School #6: A small, five-year regional college

Control Variables

To insure that the effects of individual or school differences would not contaminate the data, several control variables were included in the analysis. The control variables were based on a review of the literature on teaching evaluations and included *employee tenure*, *employee work experience*, *employee workload* (i.e., teaching hours per week and the number of students taught each quarter), *employee gender*, and *employee age*, *perceived class complexity*, *student GPA*, *student class level*, *student gender*, *student age*, and *student perceptions of grading fairness*. Including these variables achieves two specific purposes: (1) eliminates some systematic error outside the control of the researcher that can bias the results, and (2) accounts for differences in the responses due to unique characteristics of the respondents.

Instrument

Measuring Job Facet Satisfaction. Job satisfaction measures of all levels of specificity have been widely used and found useful in both theoretical and practical research. One approach to obtaining general measures of job satisfaction is to ask directly about overall feelings about the job, which are called *global scales*. Global scales ask the respondent to combine his or her reactions to various aspects of the job in a single, integrated response.

Rather than using measures of overall job satisfaction, such as the sum of satisfaction with several facets of the job or the sum of responses to items concerning overall satisfaction, one could focus on the relationship between separate facet satisfaction scores to performance. In fact, some research has shown that performance implications may differ depending upon the type of satisfaction under study (Schwab & Cummings, 1970). To predict job performance, it would make more sense to use more specific measures of attitudes, such as satisfaction with job facets that seem to be relevant to the particular situation (Fisher, 1980).

The Job Satisfaction Survey (JSS), developed by Spector (1985), was developed specifically for human service, public, and nonprofit sector organizations. It was developed to cover the major aspects of job satisfaction in service organizations, with the subscales (facets) being clearly distinct in their content. For each item, the respondent is asked to rate their amount of agreement or disagreement on a 7-point scale, with 1 being "disagree very much" and 7 being "agree very much." This scale adds more dimensions to the five used on the popular JDI. Past research has shown the internal consistency reliability of this scale to be fairly high for each subscale, with a coefficient alpha for the total scale of .91 (Spector, 1985).

Dependent Measures

Perceived Service Quality. The scale used in this study was the SERVQUAL scale, as modified by Hartline and Ferrell (1996). One of the most popular measures of service quality is SERVQUAL, originally developed by Parasuraman, Zeithaml and Berry (1988). SERVQUAL was originally conceived as a generic measure that could be applied to any service. It was designed to assess perceived service quality by subtracting subjects' ratings of expected level of service from their ratings of the actual level of service received with respect to each of a number of specific items representing the five dimensions of service (i.e., tangibles, reliability, responsiveness, assurance and empathy). In the original SERVQUAL instrument, the average of the difference scores making up a dimension serve as the measure of that facet, while the average score across all items serves as the overall measurement of service quality.

Several problems have been identified with the original version of SERVQUAL, including (1) the required customization of the scale to the industry being studied, (2) the problems associated with the calculation of difference scores, and (3) the number of dimensions measured by SERVQUAL. Carman (1990) found that the five SERVQUAL dimensions are not completely generic, and suggests that items on seven or eight of the original ten SERVQUAL dimensions be "retained until factor analysis shows them not to be unique" (p. 50). Based on a review of the relevant literature on teaching effectiveness surveys, it was felt that two of the original 10 dimensions, competency and communication, should be added back due to their importance in evaluating instructional service quality. In their original work, Parasuraman, Zeithaml and Berry (1985) described the "communication" dimension as "listening to customers and keeping them informed in language they can understand", and the competency dimension as "possession of the required skills and knowledge to perform the service" (p. 47). Due to the indisputable importance of these dimensions to the teaching profession, they were added back to the instrument as suggested by Carman (1990). These additions increased the total number of items from 22 to 26.

Because of the aforementioned deficiencies in calculating "difference" scores, an alternative scale was used in this study. It is basically the SERVQUAL scale, but combines consumer "expectations" and "perceptions" into one measure by asking customers whether certain aspects of service quality exceed or fall short of expectation. For example, in this study the student is asked to compare his/her perception of the class on each of the attributes against the performance level he/she believes an academic institution should deliver (i.e., expectations of performance). This scale is the same scale used in several service quality studies (e.g., Hartline & Ferrell, 1996; Babakus & Boller, 1992) and is recommended by several service quality researchers (Carman, 1990; Cronin & Taylor, 1992).

As in previous research (Hartline & Ferrell, 1993; Bolton & Drew, 1991), a separate item was added to assess overall service quality. Customers (students) will be asked to rate each of these items on a scale ranging from 1 ("much worse than I expected") to 7 ("much better than I expected"). Thus, higher scores reflect higher perceived service quality.

Customer Satisfaction. Oliver (1981) probably best explained the construct of customer satisfaction as the "summary psychological state resulting when the emotion surrounding disconfirmed expectations is coupled with the consumer's prior feelings about the consumption experience" (p. 27). This definition presents customer satisfaction as an overall feeling or emotion derived, at least partially, from a consumer's evaluation of service quality. The customer satisfaction scale used in this study matches Oliver's conceptualization of the construct (see Appendix). It is a three-item scale similar to the one used in a study by Taylor and Baker (1994), who obtained a high internal consistency reliability ($\alpha = .94$).

Behavioral Intentions. The behavioral intentions scale used in this study includes an item for future “purchase” intentions (“I would take another class from this instructor if I could”) and two items for word-of-mouth “advertising” (“I will recommend this class to my friends”). This type of scale is similar to the ones used by Taylor and Baker (1994) and Bitner (1990). Table 1 shows a summary of the scales used in this study.

Table 1

SUMMARY OF STUDY VARIABLE CHARACTERISTICS
(N=351)^a

CONSTRUCT MEASURE	# OF ITEMS	MEAN	S.D.	ALPHA
Employee Job Satisfaction				
Satisfaction with Contingent Rewards	10	4.22	1.29	.90
Satisfaction with Co-workers	6	5.82	1.18	.87
Satisfaction with Customers	5	5.59	.93	.78
Satisfaction with Benefits	3	4.98	1.50	.85
Satisfaction with the Work Itself	6	5.89	.89	.74
Satisfaction with Pay	4	4.26	1.40	.76
Satisfaction with Operating Procedures	2	3.71	1.49	.70
Global Job Satisfaction	17	5.97	.92	.95
Employee Self-Efficacy	7	6.33	.81	.84
Perceived Service Quality^b				
Empathy	12	5.17	.65	.97
Competence and Reliability	10	5.31	.59	.95
Tangibles of the Work Environment	4	4.77	.49	.79
Overall Quality	1	5.47	.76	--
Customer Satisfaction	3	5.48	1.49	.93
Customer Behavioral Intentions				
Future Purchase Intentions	1	5.24	.73	--
Positive Word-Of-Mouth Intentions	2	5.62	4.92	.83

^aTotal number of faculty respondents = 351.

^bTotal number of student respondents = 8,667 (represents an average of 25 responses per instructor)

RESULTS

Sample Descriptive Statistics

The surveys were collected within the last three weeks of the academic quarter from each school. All faculty members participating in the study were located in one of six post-secondary academic institutions located in the southeast. Raw descriptive statistics shows the diversity of the sample respondents. Although convenience sampling was used to determine the sample, it was felt that the sample was a representative one given its size and diversity.

Faculty Responses

A total of 571 faculty surveys were distributed and 366 were returned for an overall response rate of 65%. No student matches were found for 15 faculty surveys and, consequently, they were discarded. This left a sample size of 351, which was 16 more than the 335 required for this study. Of the remaining 351 respondents, 61% were male and 39% were female. Eighty-five percent (85%) of the respondents were married. The respondents' average age was 49 years, and average tenure with the organization was approximately 11 years. The respondents spent an average of 14 hours each week in class teaching and eight hours each week with students outside the classroom. Table 2 shows faculty sample characteristics.

Table 2

FACULTY SAMPLE CHARACTERISTICS

Males (%)	61%
Females (%)	39%
Married (%)	85%
Single (%)	15%
Average Age	49
Average Tenure with the Organization	11 years
Average Years of Work Experience in Field	20 years
Average Hours Each Week Spent in Class Teaching	14 hours
Average Office Hours Each Week (with Students)	8 hours
Average Number of Students Taught Per Quarter	45 students

Student Responses

Approximately 15,000 student surveys were distributed and 8,871 were returned for an overall response rate of 59%. No faculty matches were found for 204 student responses and, therefore, they were discarded. This left a sample size of 8,667. Therefore, for each faculty response there was an average of approximately 25 student responses (8,667 student responses to 351 faculty responses). Prior studies, conducted at the group level, have utilized as few as nine customer responses per unit (see Hartline & Ferrell, 1993). Therefore, this amount was felt sufficient to provide an accurate assessment of the instructor's service quality. Additionally, since the average number of students taught each quarter was 45, the 25 student responses per instructor represents a student response rate of more than 50%.

Control Variable Effects

The influence of the 11 control variables was controlled by statistically removing their effects from the variance/covariance matrix (see Newcomb & Bentler, 1988). Due to the large size of the model, the control variable influences were "partialled out" rather than including them in the model. The process of partialing out control variables involves removing their effects from the variance/covariance matrix so that only the contribution of the study variables is included in the model. A partial variance/covariance matrix is used as the input for model estimation. Thus, the structural model depicts the marginal contribution of the study variables *after* the effects of the control variables have been removed.

Analysis of the Structural Model

Structural equation modeling was used to analyze the hypothesized model. The software chosen to analyze the structural equation model proposed in this research was EQS (see Bentler, 1992). The maximum likelihood method of model estimation was used in this study. A two-step structural equations modeling approach was used to test the hypotheses to assess the validity of the measurement model first, and then the hypothesized structural model. First, to test the measurement of the constructs, a confirmatory factor analysis was conducted. In this model, all constructs and stand-alone variables were allowed to covary so that a problem in model fit can be pinpointed to the measurement model. The second step involved generating a structural model that tests the research hypotheses. The goodness-of-fit of the structural model was then compared to the fit of the final confirmatory model.

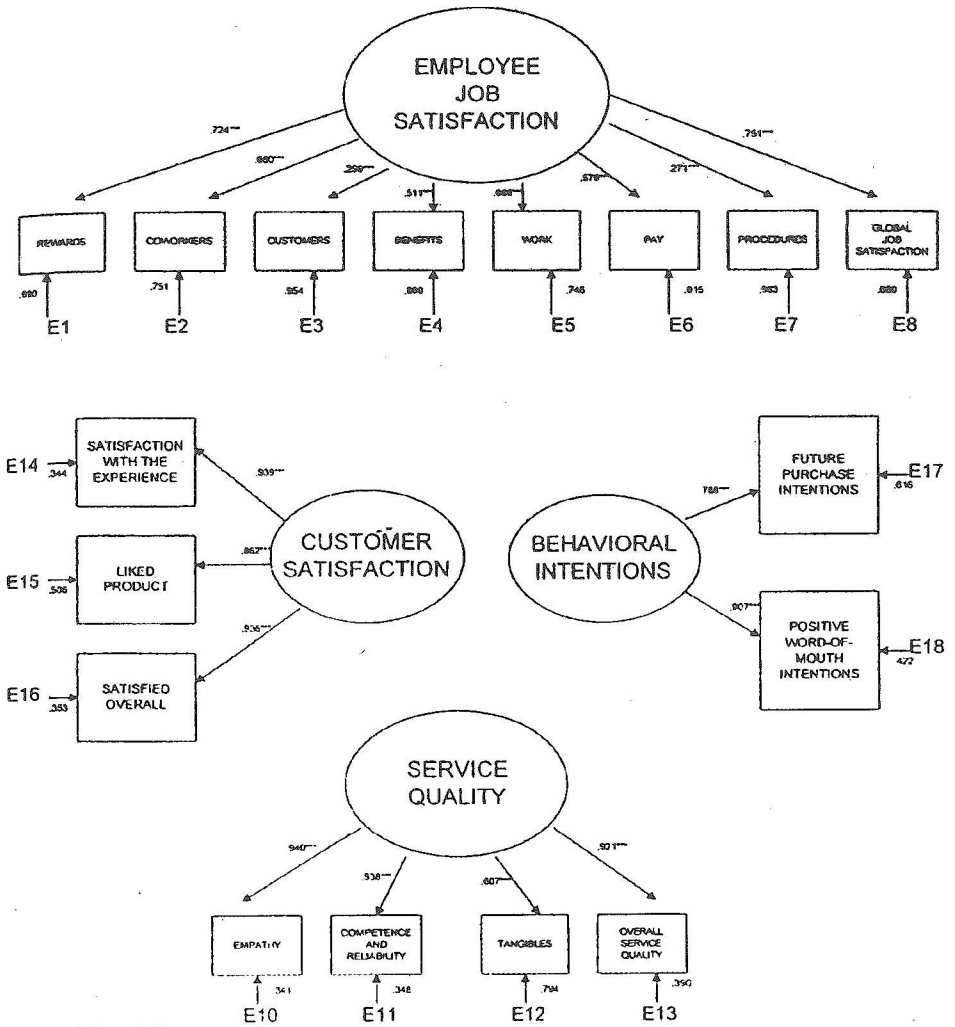
Measurement Model Analysis

Using the maximum likelihood method of estimation, an initial confirmatory factor analysis (CFA) was run that (a) fixed factor variances at one, (b) allowed all latent constructs to correlate freely, and (c) freed all hypothesized factor loadings. As stated by Byrne (1994), "the focal point in analyzing structural equation models is the extent to which the hypothesized model "fits" or adequately describes the sample data" (p. 53).

The initial confirmatory factor ("CFA") model produced an average absolute standardized residuals of .0541, and the plot of the distribution of standardized residuals looked to be fairly normal (slightly skewed to the left). All of the indicators loaded significantly on the factors they were intended to represent, providing evidence of convergent validity. The NFI (Normed Fit Index) and CFI (Comparative Fit Index) indices were fairly large (.86 and .88, respectively), suggesting that modifications to the model should yield an acceptable fit. Typically, the modifications suggested by researchers include correlating error terms, which may be correlated due to method effects such as common method variance (see Bentler & Chou, 1987). A CFI of .88 suggests there is some degree of misfit in the model. Ideally, one would want the CFI to be greater than .90.

By examining selected Lagrange multiplier modification indices, correlations among eight pairs of measured-variable residuals were added to the model. This practice is suggested by Bentler (1992) to improve the confirmatory factor ("CFA") model fit. Some of these correlated residuals reflect method or response effects between variables measured in similar formats (such as common method variance). These modifications resulted in a model that adequately reflected the data (CFI = .92). Additionally, this final CFA model was a significant improvement over the initial CFA model. As pointed out by Byrne (1994), "although the Normed Fit Index ("NFI") is reported in the EQS output, the Comparative Fit Index ("CFI") should be the index of choice" (p. 55). A CFI value of greater than .90 indicates an acceptable fit to the data (Bentler, 1992; Byrne, 1994). As in the initial CFA, all hypothesized factor loadings in this final CFA were highly significant ($p < .001$), confirming the hypothesized factor structure. Standardized factor loadings and residual variances of the observed variables in this final CFA model are graphically depicted in Figure 2.

Figure 2
FINAL CONFIRMATORY FACTOR (CFA) MODEL

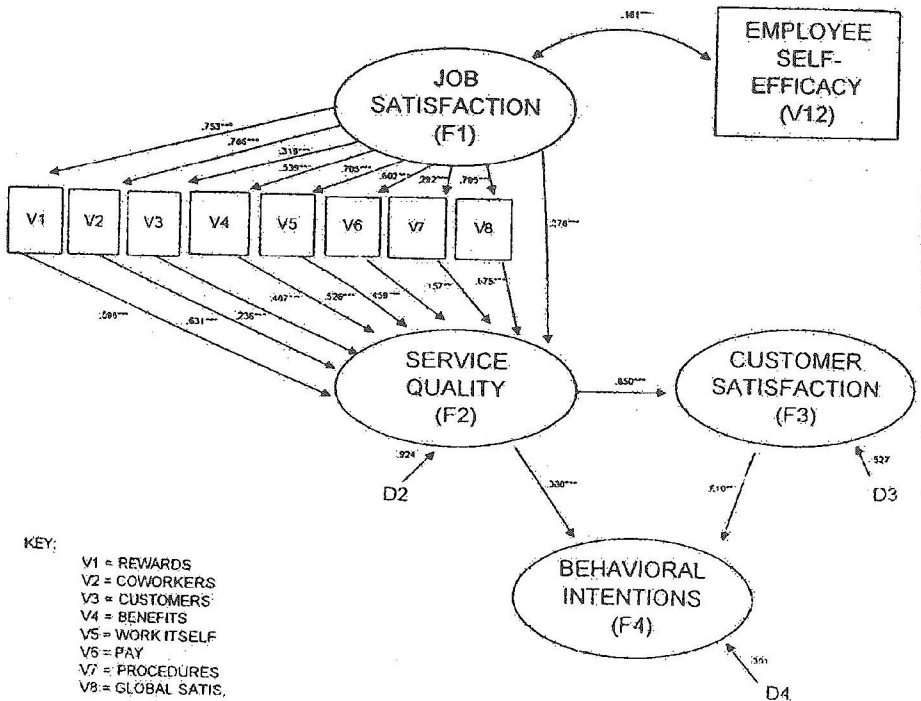


*** $p < .001$

Structural Model Analysis

The final stage of the analyses was the creation of a structural (or path) model, which included the hypothesized regression effects representing influences of one variable or factor upon another. As can be seen in Table 6, the final structural model fit the data fairly well (CFI = .91). Associations among the factors are displayed graphically in Figure 3.

Figure 3
FINAL STRUCTURAL MODEL



* p < .05
** p < .01
*** p < .001

Table 3 shows the change in model fit in the structural model from the final CFA model. As shown in this table, there is not a significant difference between the structural model and the final confirmatory factor model (chi-square difference = .82, 3 df). This is an indication that the data adequately “fit” the hypothesized model and adds support to the hypotheses. Since the CFA model allows all constructs to covary freely, a comparison of the hypothesized model to the final confirmatory (CFA) model is one indication of adequate model fit. Therefore, a lack of significant difference between the CFA and the hypothesized model indicates that the data supports the hypothesized relationships.

Table 3
SUMMARY OF MODEL FIT STATISTICS

Model	Chi-Square	df	P-Value	NNFI	CFI
Initial CFA	662.86	126	.001	.85	.88
Final CFA	495.56	118	.001	.89	.92
Structural Model	496.38	115	.001	.89	.91

Chi-Square Difference:

Initial CFA to Final CFA	167.30 (8 df)***
Final CFA to Structural Model	.82 (3 df)

* p<.05
** p<.01
*** p<.001

The results of the final structural model support the first three hypotheses: (1) the path coefficient for the service quality-customer satisfaction path is significant and positive (+.850); (2) the path coefficients for the service quality-customer behavioral intentions and customer satisfaction-customer behavioral intentions paths are significant and positive (+.380 and +.610, respectively); and (3) the path coefficient for overall job satisfaction is significant and positive (+.376).

The specific effects of job satisfaction were tested to determine which facets contribute significantly to perceived service quality. All job satisfaction facets were significant in this model, with the “satisfaction with coworkers” (path coefficient = .631) and the “satisfaction with contingent rewards” (path coefficient = .598) paths contributing most to service quality.

The path relating self-efficacy to service quality was not found to be significant. However, the path relating self-efficacy to job satisfaction was found to be significant and, therefore, it is possible that self-efficacy has an *indirect* effect on service quality through its effect on job satisfaction.

The paths relating service quality to customer satisfaction (path coefficient = .850), and customer satisfaction to behavioral intentions (path = .610) were all significant at the $p=.001$ level, which offers support to Hypotheses #1 and #2. Additionally, the model explains 14.6% of the variance in service quality ($D2 = .924$), 72.2% of the variance in customer satisfaction ($D3 = .527$), and 90.9% of the variance in customer behavioral intentions ($D4 = .301$).

DISCUSSION

This study improved on previous studies relating job satisfaction to service quality in four main ways: (1) it assessed the variable relationships at the *individual*, rather than the group, level of analysis; (2) it added to the present body of knowledge by including certain individual difference variables in the model to control for their effects so that the true effects of the variables could be assessed; (3) it tested the hypotheses in a structural equations model which improves upon previous methodology by allowing for the estimation of multiple and interrelated dependence relationships and by increasing the reliability of measures through the use of separate measurement and structural models; and (4) rather than just using a global job satisfaction measure, this study investigated the effects of individual facets of job satisfaction on service quality to determine if certain facets better predict service quality than others.

Company experience and previous research studies have reported that employee satisfaction is the single best predictor of service quality at the *group* level of analysis (see Hartline & Ferrell, 1993). In one case example, Xerox Corporation discovered that work teams that score high levels of customer satisfaction also have high job satisfaction. In fact, in the late 1980s, Xerox named employee satisfaction as a business objective and noticed dramatic improvements in business effectiveness. As one company manager pointed out, "the more we focused on that linkage, the more it became clear that we could ultimately leverage our business results by engaging our employees in measures to improve their satisfaction" (see Watson, 1994, p. 4).

This study provides additional information regarding the effects of job satisfaction at the individual level of analysis. At this level of analysis, the data suggest that employee job satisfaction significantly affects service quality perceptions in higher education. Previous studies conducted in other types of service firms have investigated these relationships only at the group level of analysis. At the group level of analysis, these studies have also found a significant relationship, but the effect size has been smaller (see Hartline & Ferrell, 1993). In fact, the data presented in this study explained almost 15% of the variance in service quality—a significant amount considering the impact of service quality on organizational performance. For example, one previous study presented data which suggests that "an annual one-point increase in customer satisfaction has a net present value of \$7.48 million over five years for a typical firm in Sweden" (see Anderson, Fornell & Lehmann, 1994, p. 63). This same study also suggested that "if the same coefficients apply to a sample of U.S. firms, the cumulative incremental returns from a continuous one-point increase in customer satisfaction over a five-year span would be \$94 million" (see Anderson, Fornell & Lehmann, 1994, p. 63). Therefore, considering that service quality and customer satisfaction are highly related, even small increases in service quality could have a substantial impact on a firm's long-term financial performance.

Another contribution of this study is the addition of several employee "difference" variables. Several variables were included as control variables for employee differences such as work experience, organizational tenure, gender, and age. Previous research has shown that individual differences could affect the job satisfaction-service quality relationship. This model, however, takes these differences into consideration by controlling their effects so that the true relationship between the studied variables could be accurately assessed.

The effect of another individual difference variable, self-efficacy, was added to the model to better understand its effect on job satisfaction and service quality. Although some previous research has found a significant correlation between self-efficacy perceptions and service quality (see Hartline & Ferrell, 1993), no significant relationship between these two variables was found in this study. However, the sample used in this study only consisted of professionals in the academic industry, and it is possible that a different sample consisting of other service employees would produce different results.

The high mean score on the self-efficacy measure for this sample (6.33 in a 7.0 scale) adds support to this explanation. Additionally, it may be that the variance in self-efficacy perceptions in this sample is much less than in other types of samples (i.e., blue collar or hourly paid employees). Using different types of samples, other studies have found different results regarding self-efficacy's effect on performance quality. In their study on service quality in the hotel industry, Hartline and Ferrell (1993) found that self-efficacy perceptions significantly affected overall customer service ratings. The sample used in their study consisted of both hotel managers and hourly paid employees. Additionally, McDonald and Siegall (1993), in their study involving service technicians, found that technicians with high self-efficacy were more satisfied with their jobs and had higher quality and quantity of work production.

The results of this study further suggest that service quality is an antecedent of consumer satisfaction, and that consumer satisfaction exerts a stronger influence on purchase intentions than does service quality. This supports the work conducted by Cronin and Taylor (1992), who pointed out that managers need to emphasize total customer satisfaction programs more than strategies centering solely on service quality. By interviewing 660 consumers in four service industries, they found that perceptions of service quality affected overall customer satisfaction, but that customer satisfaction had a significantly larger effect on future behavioral intentions. It may be that it is more the convenience or availability of products that affects future purchase intentions than service quality. Nevertheless, this study shows that service quality is an important determinant of customer behavioral intentions and should be included in an organization's strategic plans.

CONCLUSION

The model presented in this study explains 14.6% of the variance in instructional service quality, 72.2% of the variance in student ("customer") satisfaction, and 90.9% of the variance in student behavioral intentions. This study presents further proof that job satisfaction may have a larger impact on productivity than previously thought. Previous studies relating job satisfaction to productivity have generally produced weak correlations (Moorman, 1993; Petty, McGee & Cavender). This study supports recent research by Hartline and Ferrell (1996) which suggests that job satisfaction may have its biggest financial impact on the organization in the area of customer satisfaction. In fact, the data presented in this study explained almost 15% of the variance in service quality—a significant amount considering the impact of service quality on organizational performance and the company's bottom-line.

Results from this study indicate that overall job satisfaction, as well as satisfaction with individual job facets, are positively related to service quality. Consequently, programs aimed at monitoring and improving these specific dimensions should be examined. Service firms must be careful to avoid management practices that may discourage personnel's internal desire to give good service (Moorman, 1993). In an academic setting, data concerning the facets of instructor attitudes and behavior that are related to student perceptions are important for several reasons, but mainly because these are the attitudes and behaviors that should be supported as part of the creation and maintenance of a good service climate. In a business setting, the results of this study suggest that managerial practices to improve employee job satisfaction, such as flex-time, realistic job previews ("RJPs"), child care assistance, improved communications, and competitive pay rates may all have an impact on service quality. Managers should also find out what is on the minds of employees so that they can identify problem areas and correct them as quickly as possible. Additionally, management can reinforce employees' positive perceptions about their jobs by establishing the feeling that the company cares for them and is genuinely interested in their opinions about business operations (Moorman, 1993).

Limitations and Directions for Future Research

This research looked at only one service industry: higher education. Although academics is similar to other service industries in many ways, it is unclear whether or not the results of this study can be generalized across all industries. As with any other study utilizing one industry, this study should be replicated to provide validation across all industries. For example, several service quality researchers have found that one scale used in this study, SERVQUAL, is not completely generic across service industries and, therefore, must be somewhat tailored to each specific industry (see Carman, 1990). It is also possible the effects of some of the constructs, such as employee self-efficacy, could differ somewhat across industries and across job types.

This study utilized cross-sectional data. A replication of this study utilizing longitudinal data may provide a different view. Examining the effects of changes in job satisfaction over time may lead to other significant findings. In light of the changes occurring in the workplace today, such as organizational downsizing and employee empowerment programs, a longitudinal study of this type might be particularly useful to practicing managers. Additionally, longitudinal data would allow for the tracking of changes in service quality occurring as a result of changes in employee job satisfaction. Due to the number of changes going on in the workplace today, it would be of interest to investigate the effects of these changes, such as the effects of changes in organizational structure and reduced budgets.

The data used in this study was the result of surveys, albeit from two different groups of respondents. Some researchers have argued that common method variance could falsely inflate the relationships found in this type of study (see Campbell & Fiske, 1959). As defined by Spector (1987), method variance is "an artifact of measurement that biases results when relations are explored among the constructs measured by the same method" (p. 438). However, at least one study concerning the use of surveys in measuring constructs has found that method variance is not a significant biasing problem if the instruments studied are properly developed (see Spector, 1987). The measures used in this study have all been previously used, tested and validated by several researchers. Additionally, the use of structural equations modeling to analyze the data increased the reliability of the measures. Therefore, the amount of bias due to common method variance was minimized. However, future studies should employ the inclusion of other objective variables, such as absenteeism and production output, to confirm the results of this study.

Past research has shown that even minor increases in service quality can have a significant impact on the company's bottom-line. However, though the variance explained by the present model is significant, the model's explanatory power is limited to its included constructs. Obviously, many other constructs could affect faculty service quality. For example, other studies have found that employee job fit, horizontal communication, role conflict and role ambiguity also have an effect on employee service quality (Hartline & Ferrell, 1996; Parasuraman, Zeithaml, & Berry, 1990). Therefore, future studies should investigate other employee and management factors that may also impact service quality. Data concerning the facets of employee attitudes and behavior that are related to customer perceptions are important to managers mainly because these are the attitudes and behaviors that should be supported as part of the creation and maintenance of a good service climate.

These and other limitations notwithstanding, the results provide support for the significant relationship between job satisfaction, service quality, and customer satisfaction. Not only does job satisfaction have a significant financial impact on the organization, studies have shown that it also has a significant impact on employee life satisfaction. This makes an emphasis on job satisfaction the socially right thing for a company to do.

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A MANAGEMENT SYSTEM FOR CREATING ENTREPRENEURS

George McMaster*

In 1984, a private health care company, We Care Health Services, was co-founded by a nurse and the author to deliver home health care in Canada, where traditionally this service was provided by the government. In a three-year period, innovative business systems were developed for effectively delivering quality care. This included, among others: a marketing system, management system, computer system and training programs. In order to deliver private health care throughout Canada, the franchise business methodology was chosen where nurses would be required to act as chief executive officers of their own corporations. This required the identification of, or creation of nursing entrepreneurs. Through extensive research, we determined that the typical personality profile of a nurse was one classed as a "Care Taker Profile" which is necessary for effective care but it becomes more challenging for this type of person to operate and innovate their own business. This profile is diametrically opposite to the typical entrepreneurial profile in a Canadian corporation. In this paper, we will describe methods for identifying nurses with an entrepreneurial bent, how to identify and enhance those entrepreneurial abilities that may be missing, and how to select and surround themselves with the type of people that will enhance their chances of business success. The results of this management methodology have been proven to be effective. In 8 years, 65 home health care businesses have successfully emerged, operated by 60 nurses, and the home health care company has become the largest in Canada.

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THE CANADIAN HEALTH CARE ENVIRONMENT

We first describe the challenging environment that the nurse finds themselves in today. The rationale for selecting and developing a nurse entrepreneur will then be seen as a necessary adjunct to this description. Recent developments in the Canadian health care

system have prompted many organizations to rethink the way they operate. The economic crisis facing governments is threatening the security of a health care system which is considered sacred by most Canadians.

The Canadian health care environment is profoundly impacted by the current deficits of both the federal and provincial governments. Both have accumulated considerable long term debt and the consequence of this financial situation has necessitated cut backs in government funded programs in health and education as well as pending reform of Unemployment Insurance and welfare. Although the provision and delivery of health services are a provincial responsibility, the federal government has consistently reduced transfer payments to the provinces. At current levels, more than 40% of provincial government budgets is spent on health services. This action, coupled with the reduction in federal transfer payments has forced scrutiny of all health related expenditures at the provincial level as the provinces struggle to meet the public's demand for services.

The Canadian workplace is also changing and so are the needs of employers and their employees. This we believe, causes a demand for new management systems and models and new ways for analyzing them. While provincial governments are shifting more health care responsibility to individuals and their employers, the 90s have also brought unprecedented stressors on workers and thus to management. Trends suggest:

- an aging population with an emerging labor force dominated by less mobile "baby boomers"
- roughly 65% of all new entrants to the work force are female; 40% of all families have dual incomes
- a growing number of single parent families
- a growing number of Canadians working longer hours
- crippling absenteeism rates due to family pressures and stress related conditions (the rate for family-related causes doubled between 1977 and 1987)
- families often have to care for aging parents in addition to children

These stressors are compounded by the fact that the recent recession has limited opportunities for growth and mobility of the workforce. Companies are operating with fewer and fewer resources in a highly competitive global marketplace. As federal and provincial governments struggle with skyrocketing budget deficits and out of control health care cost, employers are burdened with a proportionately higher allocation of health costs through taxes, workers' compensation rates, disability and health benefit premiums. Thus additional ways to analyze a business to ensure a higher success rate are needed.

The health and life insurance industry is also undergoing significant change, with many Canadian insurance icons disintegrating in an uncertain economy. Scarce resources in all sectors have prompted increased claims for supplemental health care, either because services are no longer available or waiting lists deter reasonable access.

These trends, combined with financial pressure on business, mean that the role of all stakeholders will be redefined. Private insurers, business, and individuals will ultimately be accountable for and fund proportionately higher shares of health care costs. As a result, private home health care companies such as We Care Health Services have emerged to meet the exploding demand for private health care.

We Care's business strategy is to use the vehicle of franchising, where a motivated franchisee is given a proven business system. From a business effectiveness point of view, this is an excellent strategy for the nurse entrepreneur, since the average first five year survival rate for a franchise business is 85%, however for individual persons starting a business, the average is only 15%.

Experientially, we have determined that the best franchisee is a nurse, who has the medical skills and the determination, and when these skills are combined with the We Care business systems that are learned at We Care franchise University, they become skilled business people. However, we use a screening process to obtain a profile to select those nurses who are awarded a franchise in the We Care System. In this paper we will discuss the profile that is optimal, those that are acceptable, and personality profiles that we have found to not lead to good business people in the health care industry. This selection process thus minimizes the risk associated with starting a new business. The motivation for nurses to choose a business is certainly there, since in the changing landscape of health care, no one has a secure position and owning and operating a business provides a higher degree of security and correspondingly, a greater reward.

Additionally, in today's knowledge society, crucial issues for managers are innovation and entrepreneurship. Hence, this paper provides useful advice for managers in addition to advice to individuals starting up a business. It is important to observe that the traditional factors of production, no longer assure a particular competitive advantage. Management has become the decisive factor in productivity. Hence explorations such as the one conducted in this paper will become increasingly important to business survival and prosperity.

CHARACTERIZING THE ENTREPRENEUR

The word entrepreneur is often given as a name for the ideal business person. When the French economist J.B. Say coined the word entrepreneur over 200 years ago, he meant someone who upsets and disorganizes. Later Joseph Schumpeter, the only modern economist to take entrepreneurship seriously, described the process as "creative destruction". To get at the new and better, you have to throw out the old, outworn, obsolete, no longer productive, as well as the mistakes, failure, and misdirection of effort of the past (Drucker, 1992). This certainly requires a special individual, or a corporation with a carefully selected management team.

To put this idea in a medical frame work, think of the old medical saying "as long as the patient eliminates, there is a chance. But once the bowels and the bladder stop, death does not take long". If organizations cannot get rid of their waste products, they poison themselves. They must organize abandonment, a most difficult thing to do, because most organizations, most governments and the people they govern, develop a strong emotional attachment to the services, employees, system and/or products that they create. This is certainly true in the health care system.

In the context of this paper, we describe the entrepreneur as someone who can adapt to the rapidly changing health care environment as described in the introduction, and can innovate but can still work within a system defined by the franchiser, in order to provide the best possible care to the public. This is important in health care since entrepreneurship, invention and innovation can profoundly alter the economy in a very short time (Drucker, 1992) and we believe that this ability is essential.

In our business environment, we need to find and develop successful business entrepreneurs. At We Care Health Services (Gappa, 1987), we have identified the following characteristics that profile a successful entrepreneur.

1. *Good Health.* Successful entrepreneurs are physically resilient and free of illness. They are able to work for extended periods of time. In the process of building their business, entrepreneurs seem to deny themselves the luxury of illness and will themselves well.
2. *A Basic Need to Control and Direct.* Entrepreneurs do not function well in traditional structured organizations. They do not want anyone in authority over them. They believe that they can do the job better than anyone. They need maximum responsibility and accountability. It is a need for freedom to initiate the action that they see as necessary. It is not a need for power, especially not a need for power over people. They enjoy creating and executing strategies. They thrive on the process of achieving. Goals achieved are superceded by greater goals. They see the future in their life as within their control and they strive to exert their influence over future events.

3. *Self-confidence.* Entrepreneurs are ebulliently self-confident in what they believe possible when they are in control. They tackle problems immediately and directly. As long as they are in control they are persistent in their pursuit of objectives. They are at their best in the face of adversity. Conversely, with loss of control, their involvement and constructive participation diminishes.
4. *Never-ending Sense of Urgency.* Entrepreneurs seem to have a never-ending sense of urgency to do something. Inactivity makes them impatient, tense, and uneasy. When in control, and especially when building their businesses, they seem to thrive on activity and achievement.
5. *Comprehensive Awareness.* Successful entrepreneurs have a general overview of the entire situation when they plan, make decisions, and work in specific areas. They have a constant awareness of the effect of a single event upon the whole undertaking. They have distant vision and simultaneously, an awareness of important specific immediate detail. They are continuously aware of the possibilities and alternatives.
6. *Realistic.* Entrepreneurs accept things as they are and deal with them that way. They may or may not be idealistic, but they are seldom unrealistic. They want to know the status of things at all times. They want to measure and be measured. News is neither good nor bad as long as it is timely and factual. They seek firsthand verification of data, often bypassing organizational structure. They deal with people the way they deal with functions and things. They say what they mean and assume everyone else does too. They are good to their word. Honesty and integrity flow from this characteristic.
7. *Superior Conceptual Ability.* Entrepreneurs possess that peculiar raw intellectual ability to identify relationships among functions and things quickly in the midst of complex and confused situations. They identify the problem and begin working on the solution faster than other people around them. They are not troubled by what appears to be ambiguity and uncertainty because they perceive order. They are accepted as leaders because they are usually the first to identify the problem to be overcome. This conceptual ability applies primarily to functions and things; it does not often appear when interpersonal problems need resolution.

8. *Low Need for Status.* Successful entrepreneurs find satisfaction in symbols of success that are external to themselves. They like the business they have built to be praised but are often embarrassed by praise directed toward them as individuals. Their status needs are satisfied by achievements rather than clothes, office decor, or the automobiles they drive. Their egos do not preclude their seeking facts, data, and guidance. They don't hesitate to say, "I don't know," especially in areas outside their own expertise where they are not expected to know.
9. *Objective Approach to Interpersonal Relationships.* Entrepreneurs are more concerned with peoples accomplishments than with their feelings. They generally avoid becoming interpersonally involved. They keep themselves at a distance psychologically. They don't hesitate to sever relationships to help them progress toward established goals. During the period of building the business when resources are scarce, they seldom devote time or assets to satisfying people's feelings beyond what is essential to achieving operational effectiveness and efficiency.
10. *Sufficient Emotional Stability.* Entrepreneurs have considerable self-control and are able to handle the anxieties and pressures of the business and other problems in life. In stress situations having to do with functions and things, entrepreneurs are cool and effective. They are challenged rather than discouraged by setbacks or failure, but this does not extend to problems involving people's feelings. Entrepreneurs tend to handle these problems by suggesting an action plan. This is seldom perceived as addressing the "feeling" problem.
11. *Attraction to Challenges. Not Risks.* Entrepreneurs are neither high nor low risk takers. They prefer situations in which they can influence the outcome. They are highly motivated by a challenge in which they perceive the odds to be interesting, but not overwhelming. They seldom act until they have assessed the risk. In one sense, they may appear to take great risk. They play for high stakes. In entrepreneurland, all personal assets are at stake until the business becomes a very substantial enterprise.

METHODOLOGY

In finding franchisees for home health care, it was determined through applied research that nurses and in particular, some nurses, made ideal entrepreneurs for operating a We Care franchise. One goal of the research was to determine the characteristics of these nurses so that their risk of failure would be minimized.

After much evaluation, one of the tools that proved to be most effective was the DISC System (Marston, 1989). It is uncanny, that the independently determined CEO profile or/and their explanation of the characteristics of a CEO, closely models our description at We Care Health Services of an entrepreneur.

The DISC Personality Profile is derived from the works of Dr. William Moulton Marston (1989). In 1928 he published a book, "The Emotions of Normal People," in which he described the theory in use today. He viewed people as behaving along two axes with their actions tending to be active or passive depending upon the individual's perception of the environment as either antagonistic or favorable.

By placing these axes at right angles, four quadrants were formed with each circumscribing a behavioral pattern.

1. DOMINANCE produces positive activity in an antagonistic environment.
2. INFLUENCE produces positive activity in a favorable environment.
3. STEADINESS produces passivity in a favorable environment.
4. COMPLIANCE produces passivity in an antagonistic environment.

Dr. Marston believed that people tend to learn a self-concept which is basically in accord with one of the four factors. It is possible, therefore, using Marston's theory and a forced choice adjective checklist device (DISC Personality Profile, Appendix B), to apply the powers of scientific observation to behaviour and to be Objective and Descriptive rather than Subjective and Judgmental. The 96 forced choice adjective questionnaire and an ancillary position analysis questionnaire, enable us to identify "Patterns of Behaviour" in such a way as to make practical application of the Marston theory. A mini-sample questionnaire is included in Appendix B to illustrate the methodology of obtaining a DISC profile.

An important underlying premise to this paper is that there are no "good" or "bad" profiles, no "right" or "wrong" answers to the profile instrument. Research has shown that there are appropriate profiles for specific roles, and that in order for an organization to function effectively, it requires a balance of different behaviour patterns.

Before setting out to attract and interview the nurses who display the ability to operate their own business, a careful assessment of the role and responsibilities of a chief executive officer/entrepreneur was examined. This process must be completed by at least four individuals with relevant business experience in a "round-table" discussion format. An instrument comprising 24 job related, questions is used to focus the discussion.

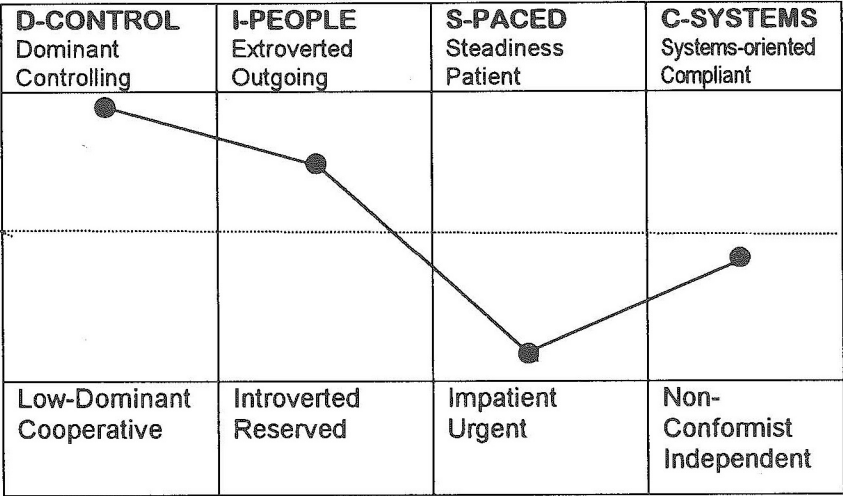
As much information about the role as can be gathered should be available. This could include the following: A job description; an advertisement for the role; details of specific functions to be performed; key result areas or critical success factors which will be measured to analyze effectiveness in the future; and specific competencies relating to nursing and care giving in general.

Fundamental questions require answers, such as: What are the specifics of acceptable or excellent performance for the role?; What functions will the CEO perform?; How large and diverse is the team responsible to the CEO role?; Is the role pro-active or re-active?; In what kind of cultural/behavioral environment does the work take place?; What are the most critical characteristics of the role which are non-negotiable?; What is the management style of the Franchiser to whom the CEO reports?

The resulting position profile compiled by the group is only a theoretical benchmark — simply a guiding picture of the perceptions of the group regarding the CEO role. These perceptions must be validated by comparing them to the profiles of successful CEOs' occupying the identical or similar position. These profiles will represent an actual benchmark of current performance in the job.

In 1995, a study was conducted on 248 top Canadian CEOs. Ninety percent (90%) of participants shared the same behavioral emphasis: High Dominance, High Influence with Low Steadiness and Low Compliance. To illustrate, consider the profile of a typical CEO (See Figure 1—CEO profile). This profile shape represents the actual benchmark of current CEO behaviour. As stated in our introduction, it has been our experience that the typical personality profile of a nurse is different.

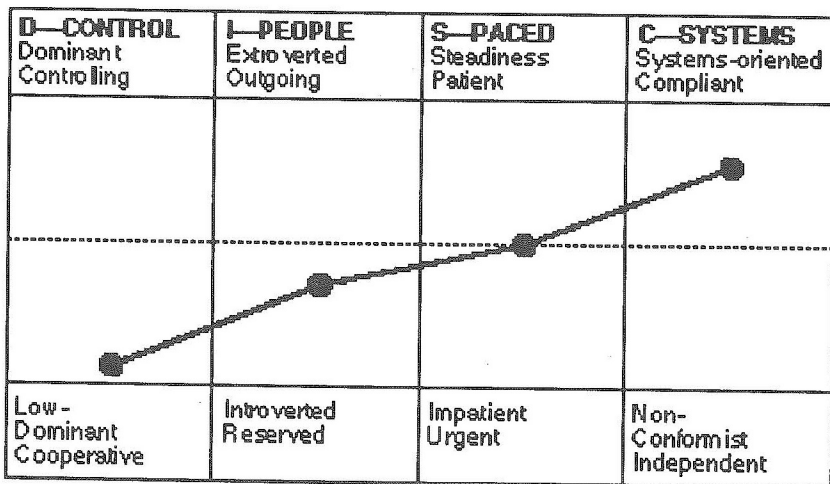
FIGURE 1



This profile make sense since a CEO must be dominant (high D), also a “people person” (not a high ‘I’ but still likes people), have a sense of urgency (the company has to get something accomplished, especially in today’s challenging and highly competitive environment), and to be an independent thinker, but not totally independent, as the flare-up in the line indicates—he/she must work with others while maintaining a healthy degree of independence. To contrast, examine a typical nurse and software programmers profile shown in Figure 2.

In a survey of 60 nurses applying for a We Care franchise, 90% of them were high S or high C (their highest personality trait was an S or a C), as shown in Figure 2, which represents a typical “Care taker” profile. It is for this reason that our method of identification and coaching has had to rigorously encompass an integrated recruiting and management system that takes these differences into consideration. Note that the graph is divided into two parts by the middle or center line. If a factor, either D, I, S, or C, is above or below the center, it is referred to as either HIGH or LOW. HIGH factors are called “work strengths,” and low factors are called intensifiers or efficiency factors. Each individual has a unique blend of high and low DISC factors. The profile in Figure 2, causes a lot of challenges for this person who deals with directors. The directors and managers tend to be the bottom-line dominant type that say “let’s do it”, but the nurses with the “S” and “C” personality styles say “let me have the detail.” The CEO is frustrated with the nurse because they want all that detail; the CEO feels that they should “get on with it”, but the nurse feels frustrated because the CEO goes off, in their opinion, “half cocked” without having all of the requisite information.

FIGURE 2



The question then is: What is the ideal profile?

Let us examine a **We Care CEO Position Description**: The role of CEO requires that tangible and measurable results must be obtained despite opposition or resistance to their accomplishment. The position requires decisive and pro-active performance, geared to ensuring that all critical goals are achieved on time and according to thorough planning. There will be pressure to meet tight and rapidly changing deadlines in an environment laced with a wide variety of problems and interruptions. The ideal CEO will react quickly, be competitive, results focused, have a demanding yet flexible attitude, be an original thinker (innovative) and a quick decision maker.

The CEO will be active, mobile, open and alert. By definition, the CEO will be opportunistic and self-starting with the persistence and firm confidence to practically solve problems. The CEO should have good knowledge and understanding of themselves. This will promote an open-minded strategy that embraces collaborative input without sacrificing the individual independence required to make a business successful. We demonstrate clearly in this paper how that is possible.

The next step is to understand the nature of the health care organization structure, the reporting relationships, and each role within the team. To produce an effective behavioral analysis of a team it is essential to have a "real" team and to see that team in its work situation. The behavioral characteristics of the CEO will have a strong influence upon the team culture.

1. **Position Fit**: an essential pre-requisite to analyzing the effectiveness of the team is to have carried out a comparison of each persons fit to the profile of the position. Position fit implies looking at all aspects of the incumbent's fit with the role; an analysis of each team members current personality profile; a comprehensively prepared position analysis; and the comparison.
2. The personality profile of the team should then be set out in a diagram (see Appendix A and Figure 3) showing the reporting relationships. Generally speaking, clarity will be enhanced if only two levels are analyzed at a time.

An analysis of the team is then conducted as follows: identify team work strengths; assess team compatibility; identify potential power struggles; identify potential team conflicts; assess team training and development needs.

3. Having identified any problems, shortfalls or potential weaknesses it is now necessary to review the possible courses of action to improve working strengths and/or reduce potential team conflicts. There are four main options:

- Change the position profiles—thereby altering the balance of work within the team.
 - Develop people—If possible, by training and by management.
 - Live with the status quo—It may be too costly or difficult to effect change in the short term.
 - Redeploy people—within the team or the company.
4. For both parts of this review, the indication from the DISC profile as regards the possible success of training and development should be noted. Namely, the LOW factor nearest to the centre line is likely to be worth developing, but that the LOWEST factor on the graph will not be susceptible to development. The easiest factors to enhance and further develop are those above the centre line i.e. the Work Strengths.
 5. Assuming that suitable programs are identified to satisfy the training and development needs, and assuming that the programs are successful in developing the desired characteristics, then one can compare and comment on the improvement or reduction of the problem and make the necessary management decisions.

As an example, let us consider a real life corporate application of the methodology. The company background is as follows:

The company provides home health care services within the city limits in which it operates. It is part of the National We Care Health Services Operation comprised of 68 Franchises and has achieved the distinction of being the “Top Performing Franchise” in the We Care System.

The company hierarchy structure is shown in Appendix A and the DISC profiles are overlaid on the position.

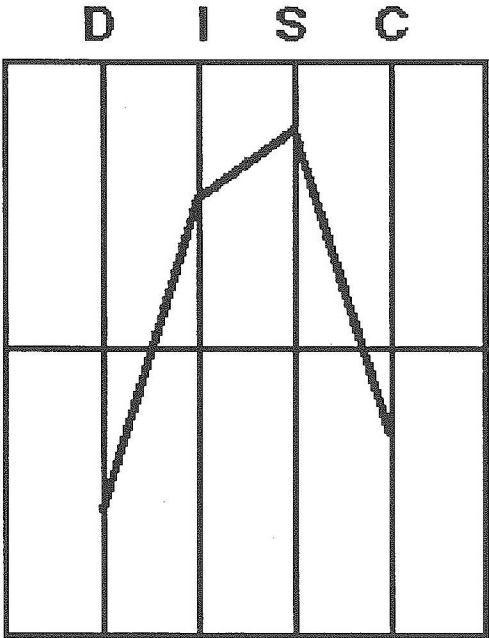
Let us examine Appendix A. Through effective screening by the franchiser, We Care Health Services, the president (and CEO) and nurse franchise owner, has the typical CEO profile. Her profile explanation closely matches the description of an entrepreneur. This contributes to much of her success and is certainly a factor in the corporate recruiting scheme. We attempt to find as many nurses that are as close as possible to this profile.

Notice the predominance of caregivers in the other positions on the chart where the majority are high S's and high C's which is consistent with the statistics gathered on our population of nursing applications.

Let us examine the profile for the V.P. finance. This is a typical accounting profile where a high attention to detail and caution is required. As a potential franchise operator, we note that we would not grant this person a franchise. Notice that this profile is opposite to the directors profile. This person is so “cautious in nature” that they seldom enter the arena to play the great game of business. They are constantly concerned about what may or may not happen and have difficulty taking action in a timely manner. This is an ideal profile, however, to ensure that all client details are taken care of and that all clients receive the best possible care.

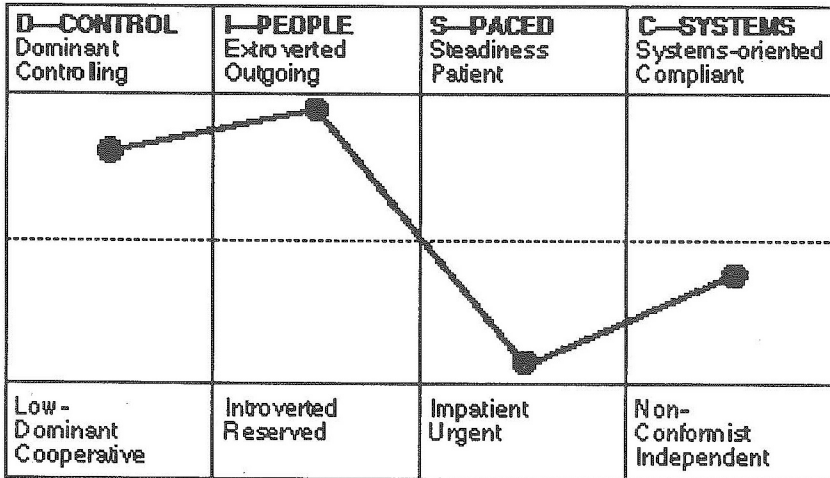
We have now identified the ideal candidate and the candidate that would not be chosen. Let us for the moment, extract further management data that will assist us in making our franchise director successful. Using all of the profiles in the office, we can create a composite corporate profile. This profile characterizes the office as an identity in itself and Figure 3 is the result.

FIGURE 3



This profile is another variation on the caretaker profile. What this means then, is that the business propensity is to maintain the status quo. Ideally, every business wants to grow. The entrepreneur or director profile is a perfect DISC profile for growth, however without the constant presence and drive of the director, growth will be challenging for this franchise. To effect this goal, some of the positions in the management structure can be adjusted. Notice the profile for the V.P. of marketing in Appendix A. This again is a care taker or status quo profile and not a growth profile. The ideal profile for a marketer follows.

FIGURE 4



Notice that the dominance factor is above the centre line indicating that they have to be strong but not too dominant (D factor), very much a people person (I factor), with a sense of urgency (S factor) and a certain degree of independence (C factor).

If a person with this profile is placed in the marketing position, then the overall corporate profile will shift more to the entrepreneur profile. Additionally, the director will have someone in the office who can act as an engine for growth when they are not there (the profile is closer to the entrepreneur profile).

The question then remains, what of the nurse that does not have the ideal profile? It has been our experience that a high S profile, such as the V.P. of marketing, can make an excellent entrepreneur in the franchise system. The first thing that we do is make this director aware of their profile, and the areas that they can adjust to be more effective. We

believe that this is, in itself, 50% of the solution. The second step is to choose staff to join this director that will complement their profile to ensure that the franchise has an entrepreneurial bent. The business systems that are given to the franchisee such as management and recruiting all motivate the entrepreneurial result. These adjustments and fine tuning lead to very successful franchise offices. We have also found that the directors profile, after several years in business, begins to shift, and more closely models the CEO profile, although certain shifts, as those mentioned earlier, are very unlikely.

CONCLUSION

This paper has demonstrated an exciting tool that is relevant for success in business management in a rapidly changing environment such as health care. In order for companies to survive and prosper, they must practice entrepreneurship and innovation. This paper strongly suggests a management style and a personnel composition that will lead to optimizing success. It has contributed to making a franchise capable of innovation. This methodology has been applied for over seven years and has lead to one of the most successful business results in Canadian health care.

There is a dark side to focusing on an entrepreneur mentality in running a company or in shaping the composite management profile to resemble the entrepreneurial profile. The entrepreneur who starts their own business, generally does so because they are a difficult employee. They do not take kindly to suggestions or orders from other people and want most of all, to run their own shop. Their idiosyncrasies do not hurt anybody so long as the business is small, but once the business gets larger, requiring the support and active cooperation of more people, they are at risk if they do not change their approach. It is correctly said, that the biggest burden a growing company faces is having a full-blooded entrepreneur as its owner. These issues are addressed when we discuss awarding a franchise to a prospective applicant.

This fact was identified in the early development years of We Care Health Services Inc. by applying the tool that has been specified here. As can be seen, the entrepreneur nurse at the helm of the company is very different from the rest of the company personnel, that basically have a caretaker profile, which is maintain the status quo, and provides excellent client care. Thus, the entrepreneur would say, "Why don't they like me and why aren't they like me?" "Why don't they see a need to grow the corporation?" This could be a stressful situation for them. When the owner sees that their profile is diametrically opposed to the rest of the company, then this awareness means that half the challenge is already over come. Coaching with the franchisee can then proceed, using this data, to create a more effective management environment.

Occasionally, the entrepreneur's preoccupation with control affects their ability to take direction or give it appropriately and has serious implications for how they get along with others. They find it very difficult to work with others in structured situations and are unable to submit to authority. Again, coaching is needed here.

People who are overly concerned about being in control also have little tolerance for employees who think for themselves. They are most reluctant to delegate authority. Because true accountability is lacking, the entrepreneur builds a mediocre management group, endangering the future growth of the enterprise. In organizations, this desire for control can lead to extreme behaviour, for instance, an owner-manager needing to be informed about even the most minute operation of the company. Excessive concern with detail that may be appropriate in the start-up phase of a company, will increasingly become a burden to the organization as it stifles the information flow, hampers decision making, and inhibits the attraction and retention of capable managers. Again all of these issues can be discussed effectively using the DISC model, and the composite corporate DISC model of Figure 3 and Appendix A.

The entrepreneurs bias toward action, which makes them act rather thoughtlessly, sometimes can have dire consequences for the organization. The company pays a price in deteriorating morale, low employee satisfaction and declining productivity for the entrepreneur's lack of attention to peoples' feelings.

Again, there issues can be discussed fully using the DISC model and the enhanced "Corporate DISC hierarchy" chart as explained in Figure 3. We can focus on behaviour and understanding by the affected parties and our experience with applying this tool in many situations has led to astonishing results with less personality stress throughout the management structure.

We conclude with a micro example of the power of the model of Appendix A. The author, in the corporation, has the CEO profile. Their publishing person has the profile of the V.P. of operations, what we call a "high C" since the "C" characteristic is the highest. The CEO, before a meeting, would see the publisher's two page written list of items to cover and think in a frustrated way, "I'm going to be here forever!" The publisher would think of the CEO, "He'll come up with a few way-off-the-shelf ideas" and we'll never complete the next marketing newspaper issue.

Once they were aware of each others behaviour mode, they both saw each other's roles as being essential to the effective accomplishing of the goal. A newspaper won't be successful if there is no attention to detail, and it also won't be successful if bold new ideas are not used. The recognized balance is necessary and productive.

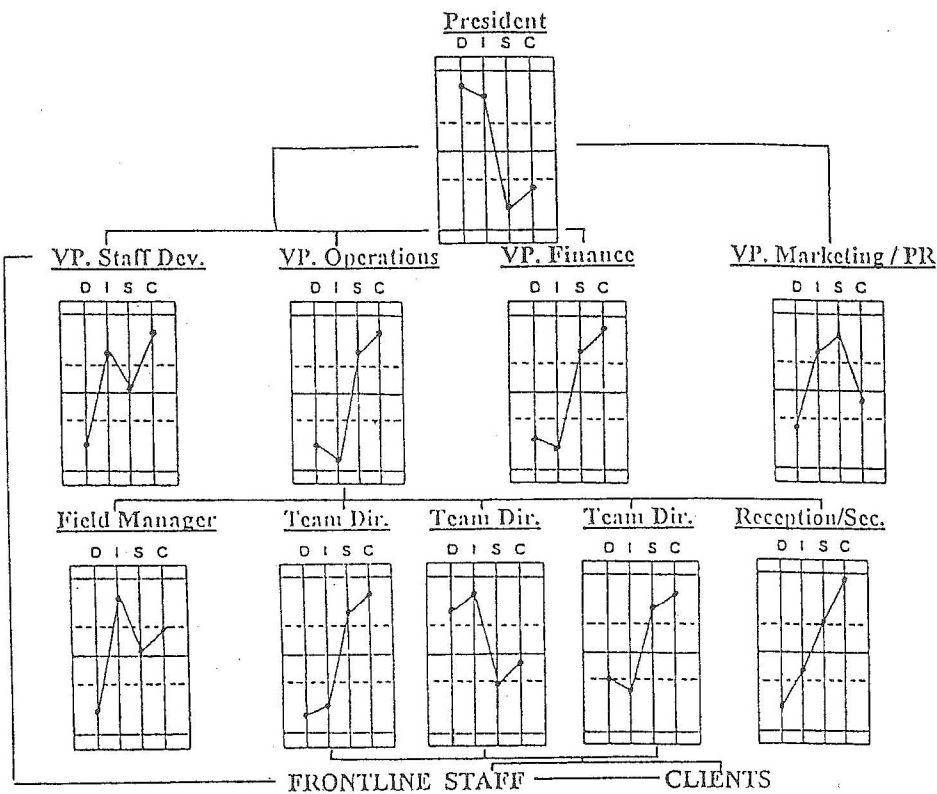
Finally, we briefly mention some of the coaching concepts that we focus on in this environment. We train the entrepreneur to move from a controlling style to a delegation style. From the initial start-up of the franchise, rather than focus the franchise around the entrepreneur, we organize it around the mission statement. We encourage the entrepreneur, who thinks of themselves as the expert, to train others to be an expert. The tendency of the entrepreneur to do everything themselves (Gerber,1995) is counteracted by developing an effective management team that is iconized in Appendix A and can be used as a communication tool. The entrepreneur, who naturally prefers a hands-on approach, is given a proprietary management system that focuses on accomplishments and behaviour. One tendency of the entrepreneur is to keep all of the information and power to themselves and this characteristic is countered by communicating the vision

throughout the organization (Barker,1993) and by having the franchise head office continually reinforce the collective franchise system's vision during visits to franchise sites. The entrepreneur prefers to make all the important decision themselves and our management system encourages a participative management style. This is built in, not only to the management system, but a model of this style is actually demonstrated during the hiring period (McMaster, 1992). Finally, the tendency of the entrepreneur to hire but drive away superior performers is modified to hire and retain superior performers by utilizing a reward and recognition system, and a compensation method that focuses on retaining high performers.

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Appendix A



APPENDIX B

	1	2
<input type="checkbox"/> Stubborn	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Convincing	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Relaxed	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Soft-spoken	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Satisfied	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Emotional	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Restless	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Fussy	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Accurate	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Self-controlled	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Confident	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Forceful	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Attractive	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Determined	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Careful	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Generous	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Demanding	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Correct	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Willing	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Outgoing	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Charming	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Precise	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Even-tempered	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Daring	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Aggressive	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Good-natured	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Agreeable	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Talkative	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Optimistic	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Considerate	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Competitive	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Diplomatic	<input type="checkbox"/>	<input type="checkbox"/>
3. TOTALS	D	I S C

Behavioural Tendency Inventory

In column 1, rank the four items in each group by placing a 1 beside the item that is most like you, a 2 beside the item that is second most like, a 3 beside the item that is third most like you, and a 4 beside the item that is least like you. Once complete, transfer the number on each line into the white box in column 2 for that line. Then, sum each column in section 2. Place your totals for each column into the boxes in section 3.

Now, transfer the totals for D, I, S, and C to the boxes at the top of the chart immediately below. In each column, circle the number that represents each of your D, I, S and C scores. Join the numbers together to give yourself a profile line.

TOTALS		D	I	S	C
HIGH	8	8	8	8	
	9	9	9	9	
	10	10	10	10	
	11	11	11	11	
	12	12	12	12	
	13	13	13	13	
	14	14	14	14	
	15	15	15	15	
	16	16	16	16	
	17	17	17	17	
MIDDLE	18	18	18	18	
	19	19	19	19	
	20	20	20	20	
	21	21	21	21	
	22	22	22	22	
LOW	23	23	23	23	
	24	24	24	24	
	25	25	25	25	
	26	26	26	26	
	27	27	27	27	
	28	28	28	28	
	29	29	29	29	
	30	30	30	30	
	31	31	31	31	
	32	32	32	32	

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NEURAL NET BASED BUSINESS FORECASTING: AN APPLICATION TO THE MUSIC INDUSTRY

Owen P. Hall, Jr.

One of the major problems facing the music industry today concerns returned product. Predicting product return rates and quantities has been a challenge. The total industry wide estimate for product return exceeds \$1 billion annually. A significant portion of this waste can be traced to relatively poor product forecasting. Recent developments in artificial intelligence (AI) techniques suggest that there is an opportunity to improve the predictive ability of business forecasts. The primary purposes of this study are twofold: 1) to introduce the use of neural nets as a simple and user friendly forecasting system and 2) to develop a prototype model for estimating product return and sales. The preliminary results show that a neural network can accurately predict product return over a wide range of sales and initial return volumes. The reported R-squares exceed 95%. The new generation in AI technologies holds considerable promise for improving forecasting in this dynamic business.

One of the major problems facing the music industry today concerns returned product. Typically, record distributors, as opposed to retailers, must take the brunt of the risk associated with new releases. Such programs under which this risk is shifted to the distributor will remain in place. The distributor, therefore, must find a way to manage this risk. Whether through advanced distribution systems, revamping of returns policy, or reducing the costs associated with returned product, distributors must take action. The music industry is making a shift toward advanced distribution systems that allow quick response product replenishment (Jeffrey, 1995). Under this type of system, product manufacturers are responsible for automatically replenishing inventory for their retail accounts, where they base their decisions on fast-moving computerized sales trend data. As a result of these trends and policies the amount of product that will ultimately be returned will diminish.

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Recently, Universal Music and Video Distribution set in motion a "groundbreaking new policy of supplying accounts a credit for unsold goods without requiring the physical return of the product.", (Christman, 1998). Universal is making all singles configurations, except for the CD-5, non-returnable. Accounts will now get a credit on such items from invoiced orders for the first 15 weeks of availability. Universal will charge accounts 18 cents for each unit processed for credit. This system is advantageous for Universal because it allows the company to avoid dealing with actual returned singles product.

Another way music distributors can deal with the onerous task of returns management is to construct a system under which the costs of returns handling are minimized. Such a system would reduce the amount of product that is refurbished and placed in inventory and increase the amount of product that is scrapped upon receipt. Record companies tend to be very conservative about scrapping product, not wanting to scrap something that may be in demand later. But what if later demand could be accurately forecasted? Record distributors could then scrap upon receipt that product which is not projected to sell, thus reducing the costs associated with refurbishing and storage. By what method could record distributors determine future demand for its releases?

Operations management decision support systems (DSS) encompass computer programs designed to help improve the decision-making process. Typically, the problem-solving strategy differs between systems which necessitates different methodologies. Artificial neural nets (ANNs), Bayesian nets, decision trees, statistical based models, pattern recognition, rule-based and hybrid systems are some examples of methodologies (Slater, 1993). These models are used in conjunction with historical data to identify and evaluate decision options and to predict future performance. Specific benefits associated with computer based DSSs, as related to product forecasting applications, include:

- Improving the accuracy of sales forecasting.
- Enhancing the reliability of product return decision-making.
- Designing optimal inventory and replacement policies.
- Strengthening the use of modern management systems throughout the organization.

Artificial neural nets (ANNs) have found widespread acceptance throughout business and government (Perry, 1994). In the arena of forecasting, ANNs have emerged as a significant forecasting tool (Poli, 1995; Annsuj, 1996). More specifically, ANNs are being used extensively in improving market targeting at all levels (King, 1992; Venugopal, 1994). ANNs are a branch of artificial intelligence that address the problem of forecasting by simulating the biological neural network found in the human brain (Hampe 1996). This study evaluated the effectiveness of an ANN for generating accurate product sales and return forecasts.

DISCUSSION

Problem Statement

The problem of unnecessary product refurbishment can be addressed by using ANNs to analyze a database of unit sales and returns information. The pilot database consists of approximately 150 CD selections released in 1996 from a major distributor. For each product selection, 12 months of sales and returns data has been collected. The primary focus of the analysis was to develop forecasts for:

- Annual sales based on data from the first few months of product release.
- Annual product returns levels based on data from the first few months of release.

The development of accurate annual sales and product return forecasts would significantly improve cost management, including the design of criteria under which product selections can be designated as "scrap upon receipt". Table 1 provides a summary of the input factors considered for this study.

Table 1 Summary of Input Factors

Input Factor	Variable Type	Min Value	Max Value	Mean
1 st Month Sales	Continuous	44,258	2,214,393	175,834
Popular Music	Dummy	0	1	0.50
Country Music	Dummy	0	1	0.15
Ratio 3 rd to 2 nd Sales	Continuous	0.01	1.97	0.50
otal Returns After 3 mo.	Continuous	16	21,987	2,497
otal Returns After 6 mo.	Continuous	510	73,698	14,228

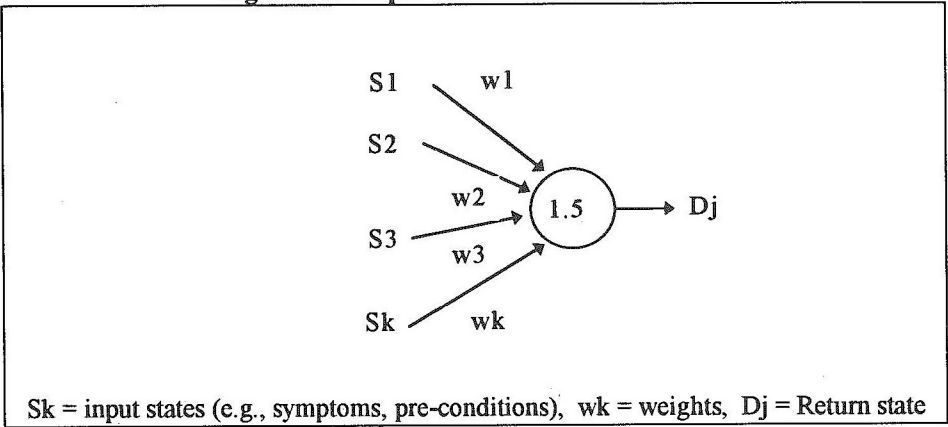
For example, this data show that the average of 1st month sales was 175,834 units, which amounted to approximately two-thirds of the total unit sales for the year. This large proportion suggests the potential that highly accurate annual forecasts can be developed. Interestingly, sales declined about 50% from the second to third month. Furthermore, about 50% of the product database was popular music and 15% was country music.

NEURAL NETS

First proposed in 1947, ANNs use nonlinear equations to mimic the connections between sets of data. ANNs have been touted as the ideal model for non-linear applications (Ajlumi, 1995). Among other things, ANNs have the advantage of not requiring a prior assumptions about possible relations as is the case with standard regression analysis (Foster, 1997). The architecture of an ANN consists, at a minimum, of two layers: an input neuron or neuron layer and an output neuron. There may also be one or more intermediate or “hidden” layers of neurons. It is these hidden layers of neurons and the complexity of the interconnections that increase the computational power of ANN.

Neural networks can employ a feed-back (back propagation) or a feed-forward architecture. Several subsets of these main types are available, including: probabilistic neural network, general regression network, self organizing maps, and neural networks employing genetic algorithms. In the most common schema, each neuron in one layer is connected to each neuron in the layer above it as shown in Figure 1.

Figure 1 Example Predictive Neural Net



In this example, the prediction of product return (Dj) is derived as a function of input states and a set of weights. The values for the input states may come from the activation of other neurons or specific environmental factors, e.g., age. The example numerical value inside the node represents the threshold value for firing or activating the neuron. In

this case, if the sum of the weights exceeds 1.5 then the neuron is "fired" which suggests a certain level of product return. The values for the weights are determined through an iterative process wherein the goal is to minimize the system error. Typically, a portion of the data base is used to train the neural net and the remaining data is used for predictive or forecasting purposes. In general, the input values can be either discrete, e.g., 0=not

popular music, 1=popular music, or continuous, e.g., 1st month sales.

Compared to many other network-type DSSs, e.g., Bayesian net, an ANN approach has a distinct advantage in terms of defining the structural relationship since a complex influence diagram is not required. Furthermore, the size of the required database can be significantly smaller for an ANN especially if a large number of discrete factors are involved. ANNs also hold a similar advantage over traditional regression techniques (linear and non-linear systems) in their relative ease of use. This is particularly the case for non-linear regression designs where model specifications are required. The ease of use is an important consideration when introducing analytical forecasting into the management process. However, neural nets are basically a black box and offer little if any insight into possible causal relationships which is of considerable interest in forecasting (Rodriguez, 1994).

RESULTS

The database was analyzed using NeuralShell Easy Predictor, by the Ward Group. This neural system is one of several that is currently available in the market (Machrone, 1995, Etteridge, 1994). A standard stepwise multiple regression analysis also was conducted on the data set as a basis for comparison with the neural net analysis. A more complex non-linear regression model could have been used which could have matched the performance of the neural net. However, this would have tended to negate one of the primary purposes of the paper -- namely the capacity of providing the manager with a simple and user friendly forecasting system. The testing database consisted of 133 observations. A "hold-out" group of ten observations was set aside for comparative analysis between the two analytical approaches. The two dependent variables examined were 1) annual sales (units) and 2) annual product return (units). Table 2 presents the statistically significant results of the multiple regression analysis at the 0.05 level where the dependent variable is annual sales.

Table 2 Multiple Regression Analysis of Annual Sales

Variable	Beta
1 st month sales	0.919
Popular music	-0.70
Constant	-

Not surprisingly 1st month sales is the dominant variable in the model. Interestingly, popular music products tend to yield lower sales results compared with non-popular music products. Table 3 shows the statistically significant results of the regression analysis at the 0.05 level where annual product return is the dependent variable. Again, 1st months sales is statistically significant, however, the dominant variable, as measured by the standardized betas, is six months product return. This is not surprising since six month product returns constitute nearly 38% of total returns while three month returns account for less than 7% of total annual returns. This result suggests that, unlike the sales forecasts, more monthly observations are need to make an accurate forecast of annual product return.

Table 3 Multiple Regression Analysis of Annual Product Return

Variable	Beta
1 st month sales	0.207
Ratio 3 rd to 2 nd sales	0.091
6 th mo. Returns	0.747
Constant	-

The NeuralShell Easy Predictor model was run using the same database. The reported R^2 for the regression analysis are adjusted for sample size. Table 4 shows a comparison of model performance between the two methods for the sales forecast application. The neural net yielded a larger R^2 for both the “in-sample” or model case and the “hold-out” or forecast case. Again, the “hold-out” case consisted of ten observations that were randomly sampled from the original database.

Table 4 Annual Sales Forecast Comparison

Model	Model R^2	Forecast R^2
Neural Net	0.88	0.97
Regression	0.84	0.94

Similar results were also obtained for the product return analysis data as reported in Table 5. The neural net mode was based on the three-month product return while the regression model used the six-month return. Interestingly, the ANN was less efficient

with variable values that were significantly outside the general trend of the data. This was particularly the case for the variable involving the ratio of 3rd month sales to 2nd month sales.

Table 5 Annual Product Return Forecast Comparison.

Model	Model R ²	Forecast R ²
Neural Net	0.89	0.98
Regression	0.76	0.86

CONCLUSION

The purpose of this paper was to examine the feasibility of using neural nets to help shape product return policies and improve cost management. The preliminary results are encouraging. The neural net "out performed" the standard regression model in both applications. The fact that the net was able to accurately predict product return levels based on only the first three months of data is extremely encouraging. Furthermore, the neural net is not constrained by the assumptions associated with regression analysis and is considerably easier to use. Ease of use is a very important factor if analytical forecasting methods are going to be effectively integrated into the management process. One downside, of course, is that the ANN appears to the user as a black box. Another concern is that ANNs are built primarily for developing point forecasts while traditional regression models can generate both point and interval estimates.

The analysis also identified several possible areas for further improving the performance of the net. These include:

- Developing several models based on segmenting the data into more homogeneous groups, e.g., in the present model annual product sales ranged from over 2.5 million units to less than 45,000 units.
- Developing models for estimating quarterly sales and returns over a two-year period.
- Designing a screening model for identifying "out of range" data sets.
- Conceptualizing an approach for allowing managers to evaluate a wide range of database ratios.
- Assessing the relative effectiveness of an ANN classifier model versus a traditional regression model.
- Formulating a training system for introducing neural nets into the management process.

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DATABASE QUALITY DIMENSIONS

John Hoxmier*

To ensure a quality database application, should the emphasis during model development be on the application of quality assurance metrics (designing it right)? It's hard to argue against this point, but there is a significant amount of research and anecdotal evidence that suggests that a large number of organizational database applications fail or are unusable. A quality process does not necessarily lead to a usable database product. Databases are a critical element of virtually all conventional and ebusiness applications. A database should be evaluated in production based on certain quantitative and information-preserving transformation measures, such as data quality, data integrity, normalization, and performance. However, there are also many examples of database applications that are in most ways 'well-formed' with high data quality but lack semantic or cognitive fidelity (the right design). Additionally, determining and implementing the proper set of database behaviors can be an elusive task. Whether the database meets the expectations of its end-users is only one aspect of overall database quality. This paper expands on the growing body of literature in the area of data quality by proposing additions to a hierarchy of database quality dimensions that includes model and behavioral factors in addition to the process and data factors.

Most information systems depend on a database to record and retrieve application data and preserve organizational memory. The ultimate objective of database analysis, design, and implementation is to establish an electronic repository that is a physical and behavioral model of the manageable aspects of a user's information domain. Database design is a complex, complicated art. Many factors must be considered during the process including, but not limited to, historical and future information requirements, the diversity of the data consumer community, organizational requirements, security, cost, ownership, performance, interface issues, and data integrity. These factors contribute to the success of a database application in both quantitative and qualitative ways and determine the

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overall quality of the database application. *Process* and *data* quality is quantitative management factors that are fairly well documented and understood, albeit underutilized. However, *data model* and *behavioral* considerations include important qualitative factors that contribute to overall database quality. A database is more than the instances of the data it manages. Data quality, while important, is just one element of assessing overall database quality.

This paper expands on the growing body of literature in the area of data quality by proposing additions to a hierarchy of database quality dimensions that includes model and behavioral factors in addition to the process and data factors. The term "database quality" in this context expands on the ISO definition of quality, i.e. *conformance to requirements and fitness for use* (1993). This definition is not adequate for the purposes of assessing database quality. While the requirement definition phase of the system development life cycle is critical to the success of an application, doing a good job of defining requirements is not sufficient in the implementation of a successful database application. A database must also be judged by how closely it represents the world of the data consumer (the model) and its ability to respond to both routine and unanticipated requests within the domain it is expected to manage (the behavior). The framework presented herein expands on work previously proposed (Hoxmeier, 1997; Hoxmeier and Monarchi, 1996) and incorporates data quality dimensions put forth by several prominent data quality researchers (Ballou and Pazar, 1995; Storey and Wang, 1994; Strong, et al., 1997; Wand and Wang, 1996; Wang et al., 1993; Wang, et al., 1995).

The Problem/Solution Cycle

The database design process is largely driven by the requirements and needs of the consumer, who establishes the boundaries and properties of the problem domain and the requirements of the information. As organizations seek to preserve organizational memory and manage richer forms of information over broader networks, this task has become increasingly more difficult.

Figure 1. Problem to Solution Cycle

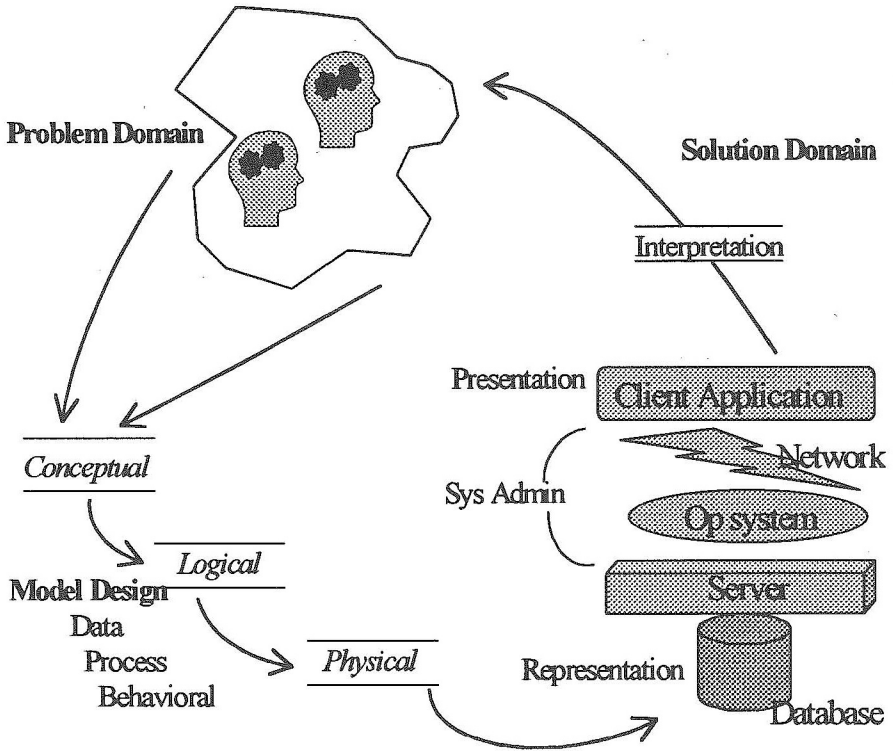


Figure 1 illustrates a typical scenario in the problem to solution cycle. It is not difficult to see why so many database applications are ultimately unsuitable to the consumer. Designers attempt to conceptualize the problem domain into a suitable physical implementation. The proposed solution is subject to many constraints including the physical representation, system administration, application presentation, and information interpretation. These constraints or solution layers all contribute to the perceived quality of the solution by the information consumer. Figure 1 also shows the critical elements in the problem to solution cycle that are the bases for the discussion on database quality dimensions:

- The cycle *process* must be managed toward a successful outcome.
- The *model* itself must represent a usually diverse and fuzzy problem domain.
- The quality of the *data* in the database must be of sufficient grade.
- The application must *behave* in a way the consumer understands.

The last step depicted in the illustration, interpretation, is probably outside of the direct control of the design and development team. However, the consumer's ability to interpret the information is also critical to the success of a database application and, therefore, to the perceived quality of the database.

To ensure a quality database application, should the emphasis during model development be on the application of quality assurance metrics (designing it right)? It's hard to argue against this point, but there are a significant number of studies and anecdotal evidence that suggests that a large number of database applications fail or are unusable (Standish Group, 1997; Wand and Wang, 1996). A quality process does not necessarily lead to a usable database product (Hoxmeier, 1995; Redman, 1995). A database should be evaluated in production based on certain quantitative and information-preserving transformation measures, such as data quality, data integrity, normalization, and performance. However, there are also many examples of database applications that are in most ways 'well-formed' with high data quality but lack semantic or cognitive fidelity (the right design). Additionally, determining and implementing the proper set of database behaviors can be an elusive task. Depending on the risk factors affecting the application, there may be certain aspects of the quality assessment that deserve heavier weights. Contrary to the popular notion of product quality, whether the database meets the expectations of its end-users is only one aspect of overall database quality.

Significant Prior Research

Quality metrics have been used for years in the design, development, and marketing for consumer goods and services. Quality engineering methods, such as Total Quality Management (TQM) and Quality Function Deployment (QFD) are commonly used by many product design and manufacturing disciplines, and are rapidly entering the service disciplines. In the area of information quality, however, the use of these techniques is virtually non-existent. Recently, researchers have begun to evaluate and study the characteristics of information as they would any other product or service (Wang et al., 1995).

Researchers and practitioners alike have tried to establish a set of factors, attributes, rules or guidelines in order to evaluate system quality. Zmud concluded that a set of four dimensions divided into 25 factors represented the dimensions of information quality (Zmud, 1978). The dimensions included data quality, relevancy, format quality, and meaning quality. Referring to information systems, James Martin stated that the collection of data has little value unless the data are used to understand the world and prescribe action to improve it (Martin, 1976).

Cap Gemini Pandata, a Dutch company, uses a framework that decomposes the entire information quality notion into four dimensions, 21 aspects, and 40 attributes (Delen and Rijsenbrij, 1992). Cap Gemini has adopted this framework on the company procedures covering software package auditing. AT&T is researching data quality and have identified four primary factors including accuracy, currentness, completeness and consistency (Fox, et al., 1994). Another group, the Southern California Online Users Group (SCOUG), defined characteristics of a quality library online database (Tenopir, 1990). The purpose of the set of characteristics was to allow professional searchers to rate each library online database system.

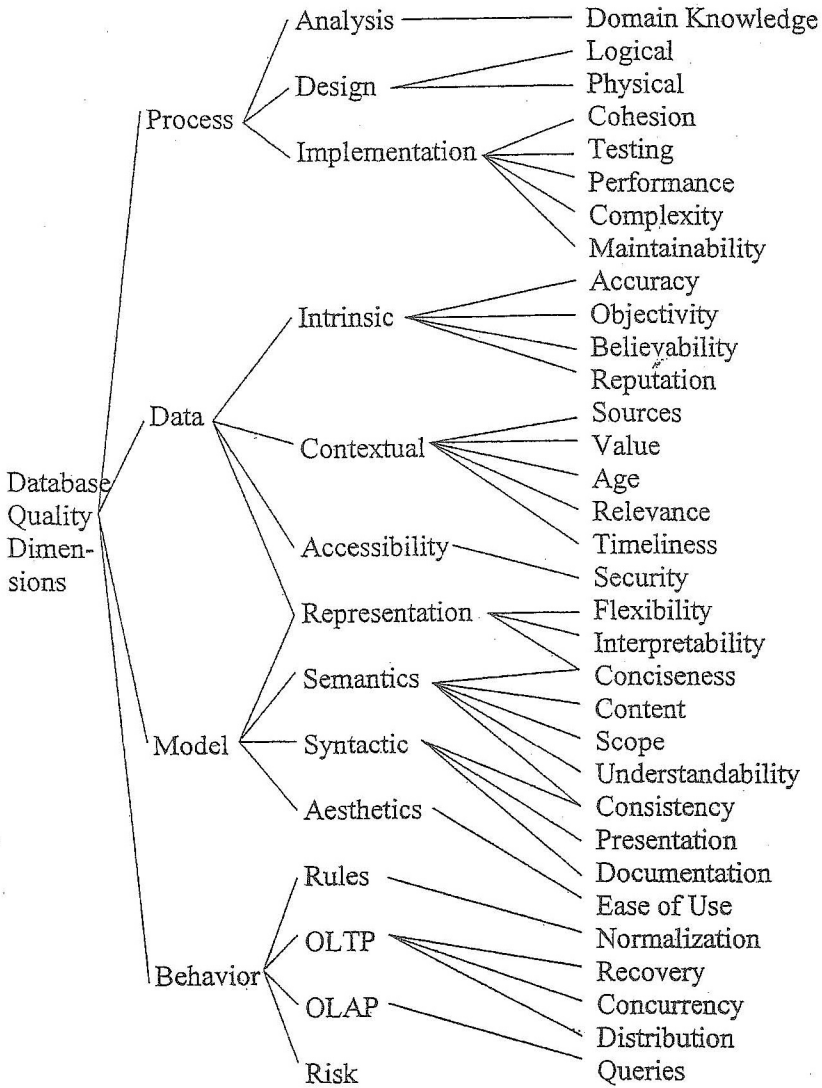
Marketing research has identified approaches used to assess product quality attributes that are important to consumers (Churchill, 1991; Menon, 1997). Wang et al. applied this concept toward a data consumer (1996). They performed a comprehensive survey that identified 4 high-level categories of data quality after evaluating 118 variables). The Wang factors include intrinsic data quality, contextual data quality, representation data quality, and accessibility data quality. A recent study applied the model to a series of field studies that focused on the concerns of the data consumer (Strong et al., 1997). These field studies confirmed the dimensions of data quality set forth in the Wang study.

There appear to be many similarities in the factors identified in these studies based on the perspective of the evaluators. Both developers and data consumers are concerned with data quality metrics like accuracy, timeliness, and consistency. Most of the research, while focused on data or information quality, indicates that there are a diverse set of factors influencing data quality. Any individual variable however, such as accuracy, is difficult to quantify. Nonetheless, researchers have developed a fairly consistent view of data quality. There is little available in the literature on the evaluation of overall database quality including other considerations such as semantic fidelity, behavioral, and value factors.

The Proposed Framework

It is proposed that through the hierarchical framework presented below, one can evaluate overall database quality by assessing four primary dimensions: process, data, model, and behavior. Portions of the hierarchy draw heavily from previous studies on data and information quality, and documented process quality standards. A dimension is a set of database quality attributes or components that most data consumers react to in a fairly consistent way (Wang, et al., 1996). The use of a set of dimensions to represent a quality typology is consistent with previous quality research (Dvir and Evans, 1996; Wang, et al., 1996; Strong, et al., 1997). The framework presents the four dimensions in a dimension-attribute-property hierarchy.

Figure 2. Database Quality Dimensions



Process Quality

Much attention has been given over the years to process quality improvement. *ISO-9000-3*, *Total Quality Management (TQM)*, and *Quality Function Deployment (QFD)* are approaches that are concerned primarily with the incorporation of quality management within the process of systems development (Costin, 1994; Dvir and Evans, 1996; Schmauch, 1994). *Quality control* is a process of ensuring that the database conforms to predefined standards and guidelines using statistical quality measures (Dyer, 1992). It compares variations of identified activities with the results of predetermined standards and assesses the variation between the two. When deviations from the problem domain are found, they are resolved and the process is modified as needed. This is an effective, yet reactive form of quality management. *Quality assurance* attempts to maintain the quality standards in a proactive way. In addition to using quality control measures, quality assurance goals go further by surveying the customer to determine their level of satisfaction with the product. Conceivably, potential problems can be detected early in the process.

The philosophy of ISO-9000-3 is to build quality into a software system on a continuous basis, from conception through implementation. ISO-9000-3 as a process quality standard does not offer any particular metrics to be utilized during the process. In addition, as a general software standard, ISO-9000-3 does not deal specifically with database issues.

A specific property addition to the framework within the dimension of process implementation quality is performance. All too often, specific performance requirements are either ignored during the design process or evaluated after implementation. While performance, per se, is more of an implementation issue, it should be considered as an aspect of overall database quality, even in the conceptual phase. Both relational and object databases can contain rather serious problems in terms of data redundancy, relationships, integrity, and structure. The objective is to design a normalized, high-fidelity database while minimizing complexity. When evaluating performance there are times when de-normalization may represent an optimal solution. However, anytime a general-purpose database is optimized for a given situation, other requirements inevitably arise that negate the advantage. The measures used to assess the trade-off may include query and update performance, storage, and the avoidance of data anomalies. Similar to the contrast between data and semantic quality, a database that is otherwise well designed but does not perform well is useless.

Database Data Quality

Data integrity is one of the keys to developing a quality database. Without accurate data, users will lose confidence in the database or make uninformed decisions (Redman, 1995). While data integrity can become a problem over time, there are relatively straightforward ways to enforce constraints and domains and to ascertain when problems exist (Moriarty, 1996). The identification, interpretation, and application of business rules, however, present a more difficult challenge for the developer. Rules and policies must be communicated and translated and much of the meaning and intent can be lost in this process. Because data quality has been a focus of previous research (for an excellent discussion, see Strong et al., 1997) and these studies have been used as a basis for the data dimension presented here, the individual attributes will not be discussed. However, a couple of additional properties are worth noting.

A frequently overlooked metric in the evaluation of data integrity is the age of the data, database, and model. Data or model age is different than the timeliness property. Timeliness refers to the delay between availability and accessibility. Age refers to the time that has passed since the data was entered into the database or when the data model was developed. The data should only be as old as the problem domain and information sources will allow and maintained only as long as the situation requires. This can be a few seconds or several years. At some point, the data needs to be refreshed in order to maintain its currency. Over time, the age of the model may degrade in its ability to depict the problem domain. The model must be updated so that as the problem domain changes, the model of the database changes as well.

Additionally, the assessment of data quality must include value considerations. Time and financial constraints are real concerns. As IT departments are expected to do more with less and as cycle times continue to decrease for database applications, developers must make decisions about the extent to which they are going to implement and evaluate quality considerations. Shorter cycle times present a good argument for modularity and reusability, so quality factors must be addressed on a micro basis.

Data Model Quality

As has been presented, data quality is usually associated with the quality of the data values. However, even data that meets all other quality criteria is of little use if it is based on a deficient data model (Levitin and Redman, 1995). Data model quality is the third of the four high level dimensions presented above. Information and an application that represent a high proportionate match between the problem and solution domains should be the goal of a database with high semantic quality. Representation, semantics, syntax, and aesthetics are all attributes of model quality (Hoxmeier and Monarchi, 1996; Levitin and Redman, 1995; Lindland et al., 1994).

The database design process is largely driven by the requirements and needs of the data consumer, who establishes the boundaries and properties of the problem domain and the requirements of the task. The first step in the process, information discovery, is one of the most difficult, important, and labor intensive stages of database development (Chignell and Parsaye, 1993; Sankar and Marshall, 1993). It is in this stage where the semantic requirements are identified, prioritized, and visualized. Requirements can rarely be defined in a serial fashion. Generally, there is significant uncertainty over what these requirements are, and they only become clearer after considerable analysis, discussions with users, and experimentation with prototypes. This means previous work may be revisited. Additionally, while many studies point to the importance of user involvement in the discovery and design phase, many information consumers are uncertain about their requirements or have insufficient database knowledge to provide much insight.

Concentric design is an approach that is appropriate in database design. This cyclical process emulates the philosophy of continuous quality improvement used in Total Quality Management (Braithwaite, 1994; Dvir and Evans, 1994). The costs associated with developing quality into the application from design to implementation are much lower than the costs of correcting problems that occur later due to poor design. However, the learning curve within the domain for the designer may be steep and the demand for the application may force rapid delivery. So, how do designers arrive at high semantic quality in a very short period of time?

Qualitative techniques address the ambiguous and subjective dimensions of conceptual database design. The interaction between people and information is one where human preference and constraints have a huge impact on the effectiveness of database design. The use of techniques such as affinity and pareto diagrams, semantic object models, group decision support systems, nominal group, and interrelationship digraphs help to improve the process of problem and solution domain definition. Well studied quantitative techniques, such as entity-relationship diagrams, object models, data flow diagrams, and performance benchmarks, on the other hand, allow the results of the qualitative techniques to be described in a visual format and measured in a meaningful way. Other object attributes that explicitly express quality can be included in the model as well. Storey and Wang present an innovative extension to the traditional ER approach for incorporating quality requirements (database quality data and product quality data) into conceptual database design (1994). The underlying premise of the approach is that quality requirements should be distinct from other database properties.

These techniques can be used to assist the developer extract a strong semantic model. However, it is difficult to design a database with high semantic value without significant domain knowledge and experience (Navathe, 1997). These may be the two most important considerations in databases of high semantic quality. In addition, conceptual database design remains more of an art than a science. It takes a high amount of creativity and vision to design a solution that is robust, usable, and can stand the test of time.

Database Behavior Quality

Many databases are perceived to be of low quality simply because they are difficult to use. In a recent survey in the UK, managers and professionals from various disciplines were asked to evaluate the quality of information they were using (Rolph and Bartram, 1994). Using eight factors, "accuracy" rated the highest, "usable format" the lowest. Developers tend to focus on aspects of data quality at the expense of behavioral quality. Granted, the behaviors associated with a general-purpose database used for decision and analytical support are varied and complex.

What constitutes a database of high behavioral quality? Are the criteria different than those used for software applications in general? Clearly the behaviors for a database that is used to support transaction processing (OLTP) are different than those of a database used to support analytical processing (OLAP). Software development, in general, is very procedure- or function-driven. The objective is to build a system that works (and do it quickly). Database development, on the other hand, should be more focused on the content, context, behavior, semantics, and persistence of the data. Rapid application development and prototyping techniques contribute to arriving at a close match between the problem and solution domains. There may be no substitute for experience and proficiency with the software and tools used in the entire development process. It is one thing to discuss how a database should behave and even document these behaviors completely. Implementation and modification of these behaviors is an altogether different issue. The process of behavior implementation consists of the design and construction of a solution following the identification of the problem domain and the data model.

Because of the difficulties associated with the definition of a fixed set of current requirements and the determination of future utilization, the database problem domain is typically a moving target. The size and scope are constantly changing. In addition, insufficient identification of appropriate database 'behaviors', poor communication, and inexperience in the problem domain leads to inferior solutions. As a result, the solution domain rarely approaches an optimal solution. The database developer must attempt to develop a database model that closely matches the perceptions of the consumer, and deliver a design that can be implemented, maintained, and modified in a cost-effective way. A partial solution is more likely. The consumer will then dictate whether there is 1) enough of a solution to use, 2) the solution is of sufficient quality and, 3) whether they trust the database. Additionally, databases to be used in online analytical processing, data warehousing, or data mining applications present difficult challenges. The information consumer in these areas generally does not know what may be asked of the database. The database must behave in a fashion to respond to the most difficult requirement of all; that which the consumer has not yet thought of.

And finally, an additional important contributor to database quality that is difficult to categorize is that of information risk. Risk is addressed in the project management literature but not even discussed in the information quality literature. Risk may determine the grade of acceptable information quality. Consumers of on-line critical care database information that monitors hospital patients require a very high grade of information quality because the risk is very high. A database that tracks responses to a customer satisfaction survey, on the other hand, may be of lower grade because the overall information risk is low.

CONCLUSION AND RESEARCH DIRECTIONS

How does one ensure a final database product that is of high quality? Database quality must be measured in terms of a combination of dimensions including process and behavior quality, data quality, and model fidelity. The framework presented above offers a typology for assessing these dimensions. The purpose of this paper was to expand on the existing research on data and process quality in an attempt to provide a more comprehensive view of database quality. The area is of great concern as information becomes a critical organizational asset and preserving organizational memory remains a high priority (Saviano, 1997). Further research is required to validate the framework; to identify additional quality dimensions and develop metrics to quantify the properties; and to develop and deploy techniques to improve the fidelity of the data model.

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