A MULTI-OBJECTIVE APPROACH TO CEO SELECTION

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ABSTRACT

A critical decision that a board of directors must make involves Chief Executive Officer (CEO) selection. In order for an organization to be successful, board of directors must identify CEO candidates that offer a good fit with the needs of the organization. Unfortunately, few analytic techniques have been suggested to aid directors in making complex CEO selection decisions. This paper presents a modeling approach that combines the concepts of strategic management, the operations research technique of goal programming, with PC technology to provide board of directors with an effective method for evaluating CEO candidates and making selection decisions. The paper extends existing literature on CEO selection by applying a computer-based model to CEO selection in a way that has not been done before. The informational efficacy of the modeling approach is demonstrated using data from a Fortune 500 experimental CEO selection case study. The results of the application reveal the unique contribution this paper's modeling approach can make to CEO selection.

Keywords: Goal programming, Chief executive officer selection, Human resource decision support

1. INTRODUCTION

Executive succession is a topic of intense interest and critically important one to any organization. Reports of key corporate successions appear routinely in the popular press and academic research continues to increase as well. Indeed, surveying a succession of articles [see Chen and Wan (1999); Kesner and Sebora (1994)], which have appeared in management and strategy journals, reveals a 250% increase in the number of pieces from the 1970s through the 1990s.

One reason executive succession is so important is because in many ways organizations are a reflection of their top managers and the decisions they make [see Anil and Yermack (1999); Chaganti and Sambharya (1987); Hambrick and Mason (1984); Miller et al. (1982)]. Dalton and Kesner (1985) showed that within the scope of the organization the CEO is the agent who is ultimately responsible and accountable for action on a reaction to an organization's strategy, design, performance and environment. Vancil (1987) points out that the title "CEO" has come to signify the individual who has ultimate legal authority and responsibility in today's corporate hierarchy. The CEOs role has been described by Wastphal and Zajac (1995) as the most powerful of the

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Recd. July 2002, Rev. Sept. 2003, Feb. 2004, Acc. Feb. 2004

power centers in a corporation, controlling and directing the efforts of the organization toward its goals.

However, over time firms are required to replace their CEOs. Consequently, what a firm becomes can be significantly influenced by how and to whom this power and authority are passed. Kesner and Sebora (1994) described how succession affects all types of constituents at virtually every level of the organization. This makes CEO succession both historically "and today" a defining event for virtually every organization [see Chaganti and Sambharya (1987); Ferguson (2000); Jauch et al. (1980); Zald (1969)].

In many ways the selection decision of a CEO can be considered to be a strategic decision, which Schwenk (1984) suggests occurs "relatively infrequently and involves ambiguous data and possible disagreement about which data are relevant." Vancil (1987) felt any boards most important duty was CEO selection, and as such, can be one of the most important strategic decisions they make. Gunderman and Weaver (2000) and Kaplan (2000) found that typically a matching or choice decision process is undertaken by either the incumbent CEO or the board in order to identify the candidate with the attributes that match best with the needs of the firm. The methodology currently used to support such a decision is characterized by individual or group decision making augmented by tabular calculations of candidate attributes [see Kesner and Sebora (1994); Sebora and Onken (1995)].

Although some effort had been made to investigate successor characteristics during the 1960s, the 1970s brought about a greater concentration in this area. Leadership style was perhaps the most common characteristic to be studied. Helmich and Brown (1972), for example, found that pre-succession performance influenced the criteria used to evaluate and choose successors. This conclusion suggested that successors with different leadership styles were selected to respond to different conditions.

Helmich's studies raised the issue of finding the candidate with the best "fit" with the organization. Picking up this theme, Hall (1976) and Pfeffer and Salancik (1977) demonstrated that there was a relationship between specific characteristics of CEOs and the organizations they led. Hall (1976), for example, found that the level and type of education and the functional career paths CEOs pursued were associated with certain types of organizations. Thus, succession was most effective when it matched the needs of the organization with the background of the new leader.

Beginning in the 1980s, researchers began to reinforce the importance of "fit" by suggesting that executive transition was more effective if the characteristics of the successor matched the characteristics of the firm and its environment. Although primarily conceptual in nature, a number of studies implied that succession was more effective if new managers were matched to the strategic needs of their organizations [for examples see, Gupta (1984); Hambrick and Mason (1984); Leontiades (1982); Szilagyi and Schweiger (1984); Wisseman, et al. (1980)]. In addition to these conceptual works, there is also some empirical evidence to support this "fit" concept. For example, Gupta and Govindarajan (1984) and Govindarajan (1989) in studies of 121 and 58 managers respectively found that "matches" were associated with superior performance. Although theoretically compelling and consistent with the other theories of personnel selection and development, many of the studies on matching the CEO to organizational needs have stopped short of informing decision-makers about how to execute the matching process.

Most of the more recent research tends to empirically focus on issues of fit that should be factored into the CEO selection process. Westphal and Zajac (1995) and Zajac and Westphal (1996) cautioned how board selections could be influenced by political factors that in turn would have a negative impact on selection decisions unless there is a fairly objective approach used in the decision making process. Other research, like that of Gunderman and Weaver (2000) warn of legal issues that will negatively impact the firm if a decision process for the CEO does not consider in great detail many of the decision making criteria that are supposed to be used in the actual selection process. The point of these studies show that humans trying to weigh dozens of criteria in a complex decision making process can be inappropriately influenced by political and other factors to make a less than desirable selection decision.

The purpose of this paper is to present the development of a model for CEO selection that combines the concept of business strategy, strategic fit, the operations research technique of goal programming, and personal computer (PC) technology to provide any board of directors with a more inclusively objective and effective framework on which to support CEO selection decisions. To demonstrate the unique features of the proposed modeling approach, this paper uses data from a CEO selection problem for a Fortune 500 firm as a case study.

2. METHODOLOGY: A STRATEGIC GOAL PROGRAMMING MODEL FOR CEO SELECTION

A primary purpose of strategic management involves a process of attempting to match or fit the organization with its changing environment in the most advantageous way possible. This includes adapting the organization itself (via internal changes such as the hiring of a new CEO) to fit the external environment. The Strategic Goal Programming (hereafter referred to as Strategic GP) modeling approach for CEO selection shown in Figure 1 is based on several conceptual classic strategic management models [see Andrews (1965); Digman (1986); Glueck (1980); Thompson and Strickland (1980); Steiner (1979)]. The eight steps to the Strategic GP modeling approach, which includes the development of the Strategic GP model and its use, are described below:

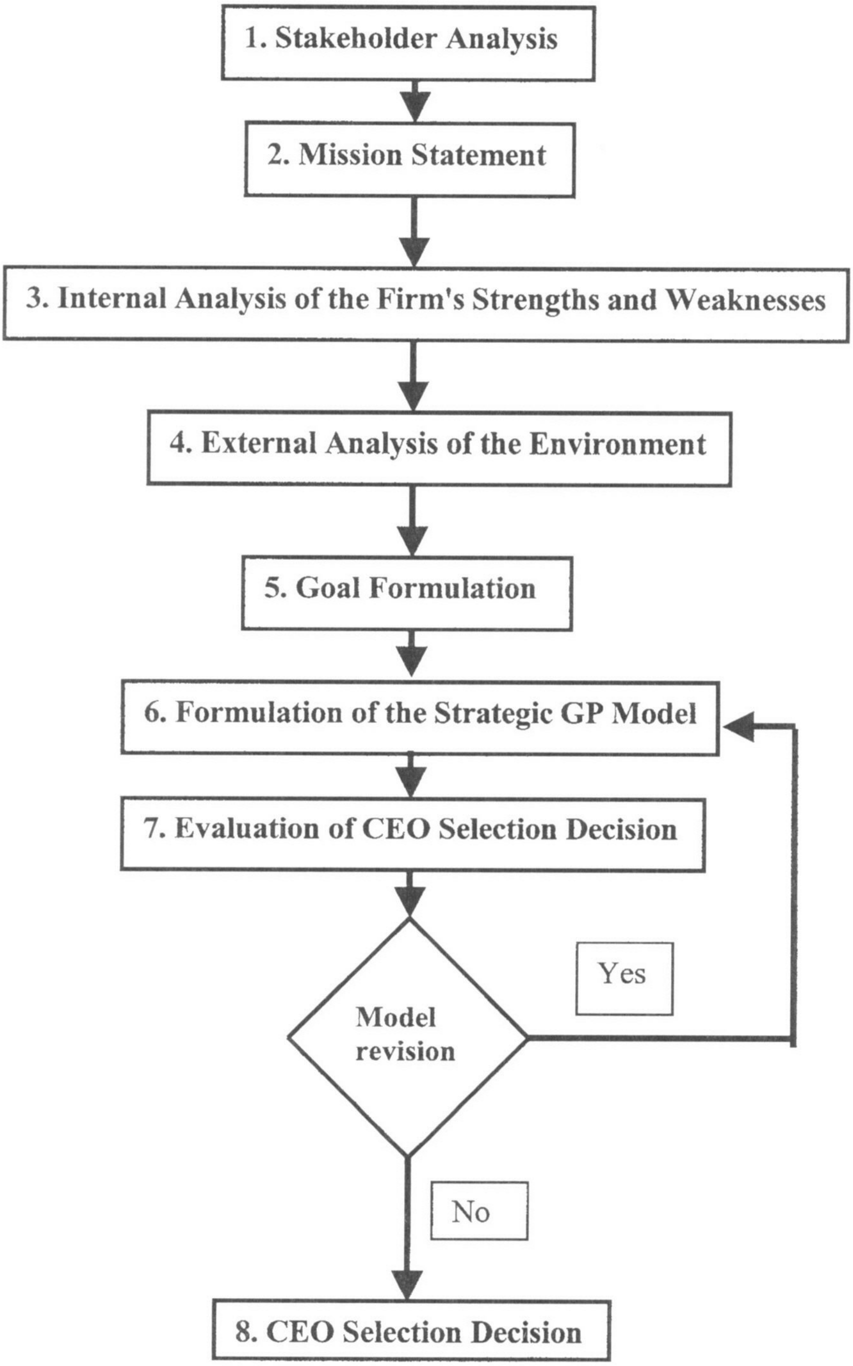
Step 1. Stakeholder Analysis: The first step of the Strategic GP modeling approach involves the analysis of stakeholder values. Stakeholders are individuals or groups with a positive "stake" in how well the organization performs. Stakeholders are also the main source of resources for the organization and their values must be considered during any decision making process. For this reason stakeholder values serve as the basis for goal formulation in many strategic management models [see Digman (1986); Glueck (1980); Zajac and Westphal (1996)] and serves as a starting point for the Strategic GP modeling approach.

Step 2. Mission Statement: The second step of the modeling approach involves the analysis of the firm's mission statement. An organization's mission statement defines why the organization exists and guides what it should be doing. A firm's mission statement represents the values of the organization's stakeholders. The mission statement (like stakeholder values) also serves as a basis for goal formulation [see Digman (1986); Glueck (1980); Thompson and Strickland (1980)].

Step 3. Internal Analysis of the Firm's Strengths and Weaknesses: In the third step an analysis of the firm's internal resources is undertaken in order to determine the organization's major strengths and weaknesses. These strengths and weaknesses can stem from the firm's structure, culture, and functional area resources. A firm's strengths and weaknesses could revolve around factors such as [see Bradley and Wilkie (1974); Digman (1986); Glueck (1980); Miles (1980); Thompson (1967)]:

1. A culture that may or may not promote a high service level and employee loyalty.
2. An organizational structure that may or may not promote flexibility and innovation.
3. Financial resources that may or may not give the firm the ability to obtain new equity and provides a steady cashflow.
4. Human resources that may or may not include quality managers and may or may not provide the firm with low labor costs, low absenteeism, and low worker turnover.
5. Technical resources that may or may not promote high service level and employee efficiencies.
6. Physical resources that may or may not allow for flexible facility and equipment requirements and/or economies of scale.

Figure 1: Steps in the Strategic GP modeling approach for CEO selection



7. Organizational resources that may or may not include an effective management information system, good coordination of functional departments throughout the organization, effective marketing, and/or a good public image.

Step 4. External Analysis of the Environment: In the fourth step an analysis of the firm's external environment is undertaken in order to determine the major threats and opportunities facing the organization. For analytical purposes the objective features of the environment can be identified at two levels: (1) The general environment, consisting of technological factors, political factors, economic factors, physical factors [Miles (1980)], and social factors [Bradley and Wilkie (1974)]; (2) The task environment which for most organizations includes potential customers, suppliers, competitors, and regulatory groups [Thompson (1967)].

The completion of these first four steps in the modeling approach are typical steps in the strategic planning process. For a review of conceptual and procedural basics for these steps see Andrews (1965); Digman (1986); Glueck (1980).

Step 5. Goal Formulation: Information from Steps 1 through 4 are used to set a board's goals regarding the attributes that they desire in a CEO. During this step a firm would only examine those attributes that are projected to be most important to the CEO's eventual success. The selection is based on specific hypothesized needs that have come out of the prior four steps in the modeling approach. As shown on Table 1, a review of the literature reveals that at least 25 important CEO attributes are commonly considered in the selection problem. These are viewed as "targeted attributes" or goals that will be achieved if the right CEO candidate is eventually selected. (Further explanation of the development of the goals is given in Step 6.)

Step 6. Formulation of the Strategic GP model: The sixth step of the modeling approach involves the formulation of the Strategic GP model that will be used to select CEO candidates. To model this decision consider the following notation:

x_j are zero-one decision variables, such that if $x_j = 1$ select candidate j from $j = 1,2, ..., n$ candidates, or $x_j = 0$ then do not select candidate j,

d_i^-, d_i^+ are underachievements and overachievements of targeted attribute selection goals i, $i = 1,2, ..., m$,

P_K of k, $k = 1,2, ..., K$ ordinal rankings of targeted attribute goals, where $P_1 >>> P_2 >>> P_K$,

α number or set of multiple CEO candidates to select at one time,

a_{ij} matrix of attribute contribution weightings for the ith targeted attribute selection goal when the jth candidate is selected, and

β_i of i, i=1,2, ... , m targeted attribute selection goals.

The Strategic GP model can then be expressed as a zero-one goal programming model:

$$\text{minimize} \quad \sum_{i\in 1}^{m} P_k(d_i^-, d_i^+)\ (k = 1, 2, \ldots, K) \tag{1}$$

$$\text{subject to:} \quad \sum_{j=1}^{n} x_j = \alpha \tag{2}$$

$$\sum_{j=1}^{n} a_{ij}x_j + d_i^- - d_i^+ = \beta_i, \quad i = 1, 2, \ldots, m \tag{3}$$

$$\text{and} \quad x_j = 0 \text{ or } 1, j = 1, 2, \ldots, n;\ d_i^-, d_i^+ \geq 0,\ i = 1, 2, \ldots, m. \tag{4}$$

The objective function (1) seeks to minimize the deviation variables in (3). In doing so, it seeks

Table 1: CEO selection attributes and measuring methodology found in the literature

1) Administration Skill	Scoring/rating, ranking	Chen and Wan (1999), Gupta (1984), Digman (1986), Wareham (2000), Mace (1986), Miller and Toulouse (1986)
2) Communication Skill	Scoring/rating, ranking	Chen and Wan (1999), Leontiades (1982), Gupta (1984), Wareham (2000), Mace (1986)
3) Personality Type	Scoring/rating, ranking	Chen and Wan (1999), Digman (1986), Mace (1986), Miller and Toulouse (1986)
4) Conceptual Skill	Scoring/rating, ranking	Pfeffer and Salancik (1977), Wareham (2000), Mace (1986)
5) Ethical	Scoring/rating, ranking	Chen and Wan (1999), Pfeffer and Salancik (1977), Leontiades (1982), Gupta (1984), Digman (1986), Mace (1986)
6) Knowledge of Finance	Scoring/rating, ranking	Chen and Wan (1999), Helmich and Brown (1972), Leontiades (1982), Mace (1986)
7) Innovative	Scoring/rating, ranking	Chen and Wan (1999), Helmich and Brown (1972), Miller and Toulouse (1986)
8) Intelligent	Scoring/rating, ranking	Helmich and Brown (1972), Pfeffer and Salancik (1977)
9) Interpersonal Skills	Scoring/rating, ranking	Chen and Wan (1999), Pfeffer and Salancik (1977), Mace (1986)
10) Leadership	Scoring/rating, ranking	Chen and Wan (1999), Leontiades (1982), Digman (1986), Wareham (2000), Mace (1986)
11) Manufacturing Knowledge	Scoring/rating, ranking	Chen and Wan (1999), Pfeffer and Salancik (1977), Digman (1986)
12) Marketing Knowledge	Scoring/rating, ranking	Chen and Wan (1999), Helmich and Brown (1972), Leontiades (1982), Gupta (1984)
13) Motivation Skill	Scoring/rating, ranking	Helmich and Brown (1972), Pfeffer and Salancik (1977), Wareham (2000), Mace (1986)
14) Negotiation Skill	Scoring/rating, ranking	Chen and Wan (1999), Helmich and Brown (1972), Gupta (1984), Wareham (2000)
15) Team Player	Scoring/rating, ranking	Chen and Wan (1999), Leontiades (1982), Gupta (1984), Mace (1986)
16) Planning Skill	Scoring/rating, ranking	Chen and Wan (1999), Pfeffer and Salancik (1977), Gupta (1984), Mace (1986)
17) Vision	Scoring/rating, ranking	Helmich and Brown (1972), Leontiades (1982), Wareham (2000), Mace (1986)
18) Work Experience Diversity	Scoring/rating, ranking, years	Chen and Wan (1999), Pfeffer and Salancik (1977), Wareham (2000)
19) Firm Experience	Scoring/rating, ranking, years	Chen and Wan (1999), Helmich and Brown (1972), Pfeffer and Salancik (1977), Digman (1986), Wareham (2000)
20) General Management Experience	Scoring/rating, ranking, years	Chen and Wan (1999), Pfeffer and Salancik (1977), Leontiades (1982), Digman (1986), Wareham (2000), Mace (1986)
21) Industry Experience	Scoring/rating, ranking, Years	Chen and Wan (1999), Anil and Yermack (1999), Helmich and Brown (1972), Digman (1986), Wareham (2000)
22) International Experience	Scoring/rating, ranking, years	Chen and Wan (1999), Helmich and Brown (1972), Digman (1986), Mace (1986)
23) Government Experience	Scoring/rating, ranking, years	Chen and Wan (1999), Helmich and Brown (1972), Mace (1986)
24) Turnaround Experience	Scoring/rating, ranking, years	Chen and Wan (1999), Helmich and Brown (1972), Leontiades (1982)
25) Successfulness	Scoring/rating, ranking, financial	Chen and Wan (1999), Anil and Yermack (1999), Helmich and Brown (1972), Pfeffer and Salancik (1977), Digman (1986), Mace (1986)

the ideal strategic fit between the m desired CEO targeted attribute goals β_i and the assessed contribution a_{ij} of each of the n CEO candidates or x_j that they might bring to the organization if selected. Which of the m deviation variables that should be brought into (3) depends on the particular β_i objective being sought. If β_i is a desired maximum value, then only d_i^- is placed in the objective function for those goal constraints to minimize their deviation. Alternatively, if β_i is a desired minimum value, then only d_i^+ is placed in the objective function. If β_i is simply a targeted value that the modeler seeks to achieve as closely as possible (exactly if possible) in the CEO selection, then both d_i^+ and d_i^- are placed in the objective function.

In (2) the decision-maker can choose to set the model to select the single best candidate (α = 1) or a set of two or more candidates (α = 2, 3....) at one time, though the model is more efficient if the selection is one at-a-time. In (4) the model formally states the zero-one requirement of the decision variables x_j and the usual non-negativity requirements on all deviation variables.

This formulation builds on the analysis of previous steps of the Strategic GP modeling approach [for overview of process see Hill and Jones (1992, pp. 67–197)]. The attribute criteria are selected based on the strategic needs of the organization [for an example of the quantification of personality attributes see Hamilton and Zanna (1972)]. Once selected these attributes become the model's goals in selecting the best criteria satisfying CEO [for examples of what may be important to select see Miller and Toulouse (1986)]. What each CEO candidate is perceived as bringing to the organization if chosen must be rated or scored for each of the attributes or criteria, and these represent the a_{ij} in (3) of the Strategic GP model. The rating or score used can vary on those attributes listed in Table 1 or any desired attributes used as selection criteria from very objective (e.g., counted years of experience) to very subjective (e.g., a rating on negotiation skills). The choice of the attributes and the measures used to reflect them are up to the particular board of directors. A rating or scoring scale similar to one suggested by Hax and Majluf (1983) or any Likert-based scale (e.g., where a interval range of scores, from a score of 1 for a candidate which might represent a very unfavorable rating, to a score of 10 for a very favorable rating) can be used to assign mathematical contribution or weighting that each candidate is assessed at possibly contributing to the organization if selected [(see Likert (1967)]. Other types of objective and subjective information are routinely collected and used in current CEO selection processes [see Cannella et al. (1991); Hamilton and Zanna (1972); Kesner and Sebora (1994); Mace (1986); Miller and Toulouse (1986)]. Since the prior methods of selection included tabular methods of judgmentally assessing mathematical contribution of candidates, the data requirements for the proposed Strategic GP model does not require any unique data collection effort over the current methods described in the literature.

Since the a_{ij} are selected by groups or at least several board members, these assessments must be combined into a single value reflecting the judgment of the group for that particular CEO candidate. This can be accomplished by simply summing the total scores of the group for that candidate's specific criterion. We assume here that the averaged value converts and reflects a continuous scale over the entire possible interval of the original scaled item. While other measures of central tendency can be used, a standard deviation about this value is a necessary condition for the use of these parameters in the Strategic GP model. We will later show how the variability in any averaged parameter can be examined in light of their potential solution sensitivity.

An alternative and possibly less biased approach would be to compute a mean value of the scores and then normalize it for individual assessment variation by dividing the mean by its standard deviation. Simply stated:

$$a_{ij} = \text{Total score, or (Mean score of all evaluators)/(Standard dev. of mean score)} \qquad (5)$$

The targeted β_i attribute goals in (3) can be set by a group decision on what is desired or can be easily selected by looking at the best criteria satisfying a_{ij} for all candidates, for that particular ith criterion. That is, decision makers can review the a_{ij} for a particular targeted β_i attribute and select the single best parameter from all the candidates for that particular targeted β_i. This would then be repeated for each β_i. The "maximax" type decision logic here is that the most desired candidate's a_{ij} can be selected for each of the β_i attribute goals. Another approach is to take an average value of the β_i for each criterion and seek a desired maximum or minimum value from the average. An approach by Chen and Wan (1999) suggests the β_i values can be determined by arbitrarily selecting a minimally acceptable value representing the lowest possible threshold for a particular criterion and then set the model's objective function in (1) to minimize negative deviation. Still another approach can be to establish a range of acceptable values for β_i by building two constraints, one with the highest value and one with the lowest value for the β_i. In this situation the ranged values can be accomplished easily by use of interval GP methodology (see Harrold et al. 1978; Schniederjans 1995, pp. 57–58).

It was observed by Sebora and Onken (1995) in the current tabular methods that the decision-makers who are responsible for selecting the CEO usually must define the relative importance of the selection attributes or criteria. This same priority ranking is incorporated into the Strategic GP model via a P_k priority parameter. For example, if the firm is currently in severe financial trouble and manufactures a product that is sold internationally, the firm might rank "turnaround experience" as its highest CEO attribute priority (at P_1), then "international experience" (at P_2), then "manufacturing experience" (at P_3), and so on until all the important CEO attribute goals have been included in the model. If normalized for variations in decision-maker judgments, these attributes can be placed into groups with the same ranking. For example, years of experience in finance might be grouped with years of experience in planning since both are measured in years.

While P_k are presented here as preemptive priorities (i.e., ordinally ranked preferences, where P_1 is fully achieved before P_2 is considered, and so on), they could also be modified into mathematical weights, w_k as in (6) below:

$$\text{minimize} \quad \sum_{i \in 1}^{m} w_k(d_i^-, d_i^+) \ (k = 1, 2, \ldots, K) \tag{6}$$

where w_k would represent the proportionality of importance a board places on each goal to be more accurately considered in a final solution. For a review of weighted GP models see Schniederjans (1995, pp. 5–8).

Steps 7 and 8. Evaluation and CEO Selection: Once the model is formulated use of inexpensive PC technology allows decision-makers to generate CEO selection solutions even when a substantial number of CEO candidates and attributes are modeled into the problem. There are a number of newer software applications that exist that can generate zero-one GP model solutions in seconds of CPU time, such as the current version of the PC-based LINDO (2003) system. The informational output of the Strategic GP model can be quite extensive and goes far beyond any simple tabular solution. The model identifies the best criteria satisfying and strategically fitting CEO candidate. The model's solution can also be extended by using "GP sensitivity analysis" to provide useful information on the variability in CEO attributes or criteria parameters used in a given solution. [For methodology procedures and references see Ignizio (1982, pp. 430–470); Lee (1973); Romero (1991); Schniederjans (1995, pp. 61–62); Schniederjans et al. (1991), and Steuer (1986)]. For example, GP sensitivity analysis information can identify parameters where minor variability can render an existing solution invalid. By calling attention to critically important scored parameter values, management's time is more efficiently focused on evaluating the validity of critically important parameters and avoiding the investment of time on non-critical parameters.

3. APPLICATION

To illustrate how the Strategic GP modeling approach works, an experimental case study of a Fortune 500 firm is examined. In Sebora and Onken (1995) a Fortune 500 case study was devised to explore the selection bias found in the traditional group decision making process of

Table 2: Partial listing of CEO selection attributes, scores, and priorities for Fortune 500 application

CEO attributes	Measuring method	Candidate mean scores and std. deviations[a]						P_k priority[b]
		x_1	x_2	x_3	x_4	x_5	x_6	
1) Administration Skill	Mean Score	7.18	6.55	7.54	7.20	6.70	6.45	P_1
	Std. Dev.	1.25	1.44	1.45	1.62	1.49	1.57	
2) Communication Skill	Mean Score	6.00	7.27	7.77	8.30	7.50	5.73	P_1
	Std. Dev.	1.34	1.27	1.17	0.42	1.78	1.27	
:	:	:	:	:	:	:	:	:
17) Vision	Mean Score	7.82	7.82	7.31	6.80	7.80	7.55	P_1
	Std. Dev.	1.40	1.08	1.25	1.55	1.32	1.21	
18) Work Experience Diversity	Mean Score	8.09	7.90	7.15	6.80	6.40	7.18	P_2
	Std. Dev.	0.94	1.14	1.86	1.61	1.26	0.47	
:	:	:	:	:	:	:	:	:
24) Turnaround Experience	Mean Score	8.27	6.18	7.15	6.10	6.90	6.00	P_2
	Std. Dev.	0.90	1.17	1.21	1.45	1.45	1.00	
25) Successfulness	Mean Score	7.91	8.27	8.77	8.50	7.80	7.91	P_3
	Std. Dev.	0.94	0.91	0.44	0.71	1.40	1.14	

[a]Original data scored on a 1 to 10 scale from Sebora and Onken (1995).
[b]Priorities based original data from Sebora and Onken scale of 1 to 5.

CEO selection. In their study Sebora and Onken devised a case study from an actual Fortune 500 firm CEO selection. The experiment was necessary to avoid the typical bias that comes from actual board members who may or may not know unique information about CEO candidates and who share such information during a selection session. In the Sebora and Onken experiment two groups of decision-makers (i.e., 37 executives and 116 MBA graduate students) were asked to devise a preference ordering of candidates for selection from an actual group of six finalist (i.e., the x_j in the model) being considered for the CEO position of the Fortune 500 firm. Specifically, the candidate "solution preference ordering" would allow an organization to make a job offer to the first preferred CEO candidate, with a second preferred candidate designated (just in case the first candidate was no longer available), and so on until all six candidates were preference ordered.

The scoring of the 25 selection criteria for the subject group of 37 executives is presented in brief in Table 2. (The subject group of MBA students performed a similar task and their results will be shown later but only the executive group computations will be presented here for purposes of brevity.) The P_k priorities were determined by the executives who where asked to mathematically weight on a 1 (most important) down to 5 (least important) scale the importance of each of the 25 attributes or criteria (note the ordering of attributes is the same as in Table 1). The mathematical weighting was then averaged and the mean values ranged from 1 to 3.5. The mathematically weighted attributes with a weighting of 1 to 1.9 were assigned to the P_1 priority, those with a weighting of 2 to 2.9 were assigned to the P_2 priority, and those with a weighting of 3 to 3.5 were assigned to the P_3 priority. This established the priority ranking that was used by them in a ranking context (not a mathematical weighting context) in the evaluation of the CEO in the Sebora and Onken study. The same priorities were used in the Strategic GP model to rank the goal constraints.

The a_{ij} parameters were scored using a 1 (i.e., CEO candidate offers little to satisfies this criterion) to 10 (i.e., CEO candidate offers much to satisfy this criterion). These scores and their standard deviations are presented in Table 2. By taking the standard deviations for each of the mean scores in Table 2 and dividing them into their respective means as in (5), the resulting Strategic GP model parameters are generated as listed in Table 3. The targeted β_i attribute goals in Table 3

Table 3: Partial listing of CEO selection attributes model parameters for Fortune 500 application

CEO attributes	Candidate a_{ij} parameters[a]						Targeted β_i attribute goals[b]
	x_1	x_2	x_3	x_4	x_5	x_6	
1) Administration Skill	5.74	4.55	5.20	4.44	4.50	4.11	4.20
2) Communication Skill	4.48	5.72	6.64	19.76	4.21	4.51	4.50
:	:	:	:	:	:	:	:
17) Vision	5.59	7.24	5.80	4.39	5.91	6.24	6.69
18) Work Experience Diversity	8.60	6.93	3.84	4.22	5.08	15.28	4.88
:	:	:	:	:	:	:	:
24) Turnaround Experience	9.19	5.28	5.91	4.21	4.76	6.00	4.35
25) Successfulness	8.43	9.09	19.93	11.97	5.57	6.94	5.81

[a]Based on (5).
[b]Based on (5) where subjects were allowed to set minimum acceptable scores, which were averaged and normalized.

were developed by the executives who were asked to score the individual attributes in the same manner that the a_{ij} parameters were scored, but to do so with a minimum acceptable score as a basis for each targeted attribute goal. The standard deviations for these values were again computed and used in (5) to generate the β_i attribute goals.

Based on the parameters in Table 3 the Strategic GP model for the executive subject group can be stated as:

$$\text{Minimize} \quad P_1\,(d_1^- + \ldots + d_{17}^-) + P_2\,(d_{18}^- + \ldots + d_{24}^-) + P_3\,(d_{25}^-) \tag{7}$$

$$\text{subject to:} \quad x_1 + x_2 + x_3 + x_4 + x_5 + x_6 = 1 \tag{8}$$

$$5.74\,x_1 + 4.55\,x_2 + 4.20\,x_3 + 4.44\,x_4 + 4.50\,x_5 + 4.11\,x_6 + d_1^- - d_1^+ = 4.20 \tag{9}$$

$$4.48\,x_1 + 5.72\,x_2 + 6.64\,x_3 + 19.76\,x_4 + 4.21\,x_5 + 4.51\,x_6 + d_2^- - d_2^+ = 4.50 \tag{10}$$

$$\vdots$$

$$5.59\,x_1 + 7.24\,x_2 + 5.80\,x_3 + 4.39\,x_4 + 5.91\,x_5 + 6.24\,x_6 + d_{17}^- - d_{17}^+ = 4.69 \tag{11}$$

$$8.60\,x_1 + 6.93\,x_2 + 3.84\,x_3 + 4.22\,x_4 + 5.08\,x_5 + 15.28\,x_6 + d_{18}^- - d_{18}^+ = 4.88 \tag{12}$$

$$\vdots$$

$$9.19\,x_1 + 5.28\,x_2 + 5.91\,x_3 + 4.21\,x_4 + 4.76\,x_5 + 6.00\,x_6 + d_{24}^- - d_{24}^+ = 4.35 \tag{13}$$

$$8.43\,x_1 + 9.09\,x_2 + 19.93\,x_3 + 11.97\,x_4 + 5.57\,x_5 + 6.94\,x_6 + d_{25}^- - d_{25}^+ = 5.81 \tag{14}$$

$$\text{and } x_j = 0 \text{ or } 1;\ d_i, d_i \geq 0 \text{ for all } i, j. \tag{15}$$

In the Sebora and Onken (1995) study traditional tabular methods (i.e., simple summation of scores) were used in part as a basis to generate the candidate "solution ordering preference" in the selection of CEO candidates. The groups were also allowed to derive their final ordering on their best subjective judgment during group discussion, seeking to mimic board decision making. It was felt that this personal "judgmental latitude" should be allowed to create a more realistic decision process mirroring the actual board decision process. It was expected, though, that the tabular methods would reflect the judgmental input in the scores and mathematical weighting by the board in their final preference ordering. The resulting ordering for both the subject groups (executives and MBA students) turned out to be the same as shown in Table 4. While the scoring and mathematical weighting differed slightly between the two groups of subjects, their final resulting preference ordering turned out to be exactly the same.

Table 4: CEO selection preference orderings for Fortune 500 application

CEO preference ordering of candidates	Resulting executive ordering[a]	Resulting MBA student ordering[a]	Initial Strategic GP model ordering[b]	Revised Strategic GP model ordering[c]
First choice	x_2	x_2	x_4	x_2
Second choice	x_5	x_5	x_3	x_5
Third choice	x_1	x_1	x_2	x_1
Fourth choice	x_4	x_4	x_1	x_4
Fifth choice	x_6	x_6	x_5	x_6
Sixth choice	x_3	x_3	x_6	x_3

[a]Based on tabular and judgmental methods in Sebora and Onken (1995).
[b]Based on same criteria, ranking, and scoring as executive and MBA student ordering problem.
[c]Based on revision of priorities to simulate both subject groups actual ranking preference of attributes.

As a means to demonstrate the reliability of the Strategic GP model both the executive generated and the MBA student generated scoring and priorities were used in models to duplicate the results of the two subject groups. The Strategic GP model was rerun for both subject groups five times using Bitran's (1979) zero-one algorithm written in BASIC for use on a Compaq Presario PC. Each time the model was run, the best single candidate was selected, and that candidate's parameters were set aside, and the next best candidate was selected on the next run. CPU run time was less that one second on each run. This process was repeated until the ordering of the first choice, second choice, and so on until the remaining sixth place candidate was determined. It should be noted that this feature of selecting the candidates one-at-a-time can be very valuable in saving time and money in recruiting CEOs since it gives an best criteria satisfying ordering of secondary candidates in situations where the best choice candidates are no longer available.

In the ten runs of the Strategic GP models, the ordering of both groups (i.e., executive and MBA students) resulted in the same "initial" solution in Table 4. To our surprise the preference ordering was substantially different than both of the subject groups. Indeed, the first two choices were totally different. What had caused the difference? It turned out that in retracing the algorithm steps of the Strategic GP model solutions that the "judgmental latitude" allowed the executives and MBA students permitted their personal bias to enter in their decision process. Specifically, both groups ignored their own scoring and prioritization of criteria on the candidates. As Hamilton and Zanna (1972), Richey et al. (1975) and Sebora and Onken (1995) have shown, this type of bias results can come from group decision making and judgmental methods even when supported by tabular scoring in a decision process like CEO selection. The fact that the Strategic GP model objectively generated the best criteria satisfying answer in this case problem, when both groups of subjects willfully violated their own objective scoring, can be viewed as a plus for the GP model in two ways: (1) the model did not permit bias in the decision process once the parameters where established, and (2) the modeled solution could be replicated as a means of proving consistency and fairness in the CEO selection decision process. This second item is particularly important in light of recent legal issues pointed out by Gunderman and Weaver (2000) in the CEO selection and why consistency in decision methods are essential today. In addition, by being able to retrace the actual decision making steps of the Strategic GP model (via its simplex algorithmic methodology), we were able to estimate the divergence points taken by the subject group decision-makers. By re-ordering the priorities in the Strategic GP model to take into consideration the actual desire to avoid select attributes, the model generated the exact same ordering as the two subject groups. This consistency in the solution shown in Table 4 supports the hypothesis that the Strategic GP model reliably produces the same results effectively in PC microseconds as opposed to days by the groups of decision-makers.

Beyond just reliability of obtaining a selection choice ordering of CEO candidates, the Strategic GP model can be extended with GP sensitivity analysis procedures to aid in examining the validity of any give solution. For example, using Ignizio's (1982, pp.430-470) GP sensitivity analysis methodology, the allowable boundaries of the targeted β_i values can be computed. These GP sensitivity analysis values define where an existing solution might be changed (or be invalid) if the β_i parameter is changed or might be in error. Since the β_i's are computed from mean values, they undoubtedly possess some error. While the normalization procedure in (5) does impact the β_i coefficients to adjust their size for the computed variation of individual scoring (i.e., reflected by the standard deviation of the mean), there is still always some error in such measures. The sensitivity analysis boundaries give the specific range under which an existing solution remains true or valid. Board members making the CEO decision can look at these ranges and decide if the measures that they themselves have computed can vary enough to make an existing solution questionable or even invalid.

This analysis can be taken one step further using an approach by Schniederjans et al. (1991) where the probabilities of violating the sensitivity analysis boundaries can be determined. Their procedure assumes a normal distribution for the β_i parameters and using the a_{ij} as a mean and its related standard deviation the overlapping zones (i.e., area representing the probability of a valid solution) of the assumed normal distribution and the sensitivity analysis boundary can be computed. (For a detailed explanation of this procedure see Schniederjans et al. (1991). It should be noted that the assumed normal distribution might require adjustments in the statistics for sample size and could necessitate the need for a different distribution being applied.) For example, the actual mean score for Administration Skill was 5.04 and the standard deviation was 1.20 (resulting in β_1 of 4.20 as stated in Table 3). By placing the standard deviation value of ±1.20 times 3 from the 4.20 β_1 value you have 99.97% of the area under the assumed normal distribution ranging from 0.6 to 7.8. The sensitivity analysis boundary of $\beta_1 \leq 4.55$ from Table 5 represents about 61.41% of the area or a probability of 0.6141 that the β_1 parameter will stay in the sensitivity analysis boundary range, thus not violating the existing solution. Of course this also means that there is a probability of 0.3859 (i.e., 1 − 0.6141) that the parameter may be violated rendering the existing solution invalid. The remaining probabilities for each β_i are presented in Table 5. Note that for the two attributes of "communication skill" and "work experience diversity" neither constraint was binding, as such they are not likely to violate the existing solution. All of the data in Table 5 provide excellent risk factor information on which board members can judge the likelihood the existing solution might be valid or invalid and will alter an existing solution.

4. TOWARD IMPLEMENTATION

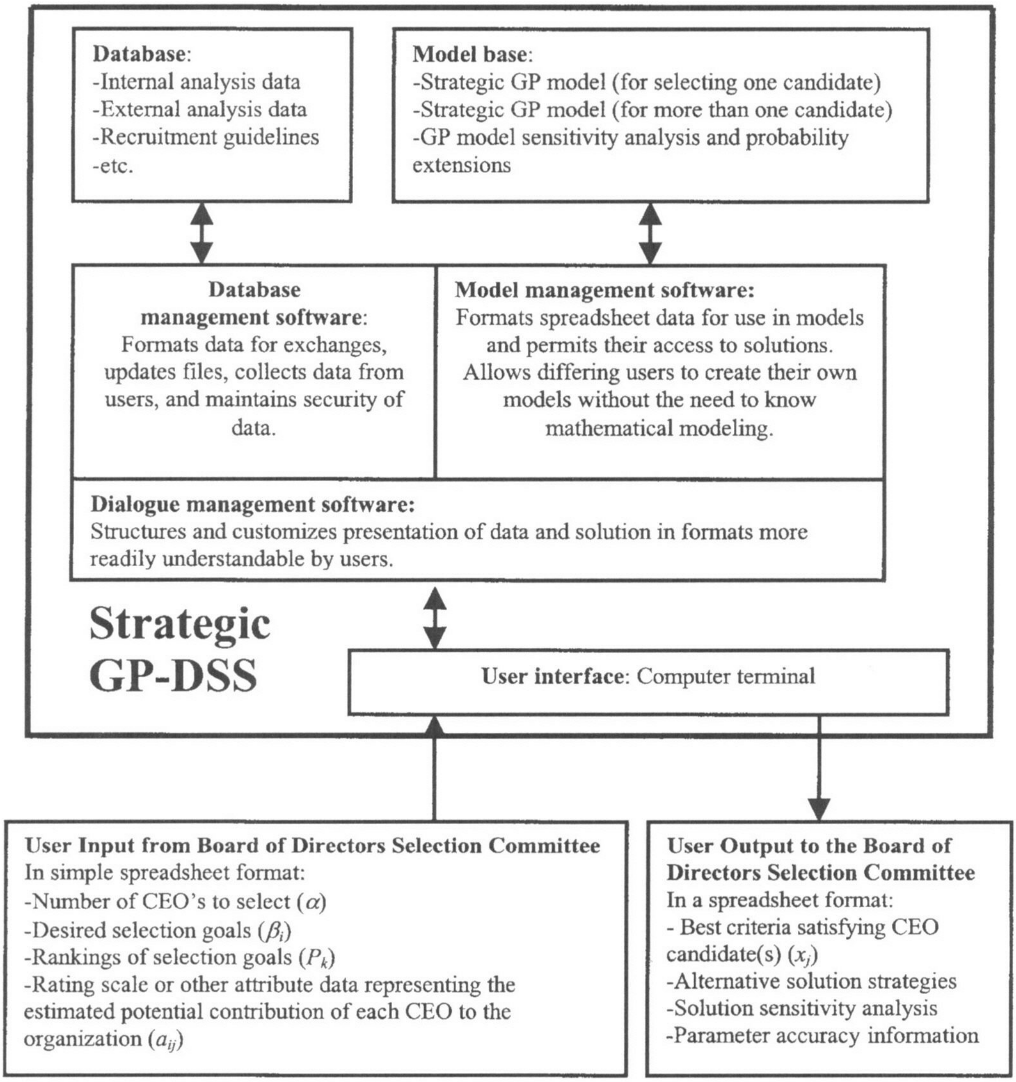
The feasibility of the Strategic GP modeling system proposed in this paper rests on its use as a decision making aid. Its application could help organizations better screen multiple criteria and solve for an best criteria satisfying CEO choice (as opposed to the manual potential for human error and bias) might make the Strategic GP modeling system easily worth far more than the developmental and implementation costs of using the model. Indeed, to broaden the proposed system its use might also be applicable to selecting any top executive officer (e.g., vice presidents) where multiple criteria is analyzed in a similar manner to the CEO decision. To help make the Strategic GP model readily available and useful to boards of directors or selection committees in general, it would have to be, as most models are today, incorporated into a decision support system (DSS) similar to that outlined in Figure 2.

Such a system would not require the user to have any modeling knowledge but would allow a friendly environment for all constituent or stakeholder users. Specifically, no additional effort would be required for use by users beyond that currently performed in typing up or preparing data for consideration to selection committee members. The same board of directors effort cur-

Table 5: Sensitivity analysis of select attributes for Fortune 500 application

Attributes of administrative skill for first choice x_2 CEO candidate	Allowable change in the targeted β_i attribute goals before existing solutions will no longer be valid	Sensitivity analysis boundary interpretation	Probability existing solution will not violate the sensitivity analysis boundary
Administrative skill	$\beta_1 \leq 4.55$	If the current value of 4.20 goes no greater-than or equal-to 4.55 the existing solution is still valid. Beyond 4.55 it is invalid.	0.6141
Communication skill	Non-binding, no interval	Any change in current value of 4.50 is possible and the existing solution is still valid.	1.0000
Vision	$5.91 \geq \beta_{17} \leq 7.02$	If the current value of 6.69 is set less-than or equal-to 7.02 or greater-than or equal-to 5.91 the existing solution is valid. Beyond those boundaries the solution is invalid.	1.0000
Work experience diversity	Non-binding, no interval	Any change in current value of 4.88 is possible and the existing solution is still valid.	1.0000
Turnaround experience	$\beta_{24} \leq 4.76$	If the current value of 4.35 goes no greater-than or equal-to 4.76 the existing solution is still valid. Beyond 4.76 it is invalid.	0.7632
Successfulness	$\beta_{25} \leq 10.95$	If the current value of 5.81 goes no greater-than or equal-to 10.95 the existing solution is still valid. Beyond 10.95 it is invalid.	1.0000

Figure 2: Components of a Strategic GP decision support system for CEO selection



rently used in the manual method to weight and rank the criteria manually would be required, but the benefits of using the Strategic GP-DSS to them would include:

1. A best criteria satisfying listing of the candidate(s) for their organization,
2. Helps to avoid possible decision bias caused by group dynamics during decision-making process,
3. A savings of time (and its equivalence in costs) in finding the best candidates,
4. Would save additional time in situations where first choice candidate decides not to accept offer and a new selection effort would required (the model could be quickly rerun to select the next best choice with the need for additional board time),
5. Would permit more applicants and more criteria to be considered since the computer would be processing their data, saving the board of directors or selection committee time, and
6. An ability to check the impact of their goals (via sensitivity analysis) in one solution, and quickly revise them to see the simulated impact on a differing set of goals.

The use of the Strategic GP model also provides a variety of additional benefits and features, which could include:

1. The model can be used in finding a set of best criteria satisfying candidates. In addition to identifying the single best candidate the model can be used to identify a set of top candidates. This can be accomplished by systematically setting $\alpha = 1$ to select the best candidate, removing that selected candidate from the pool of remaining candidates, and repeating the process until the desired set number of top candidates have been selected. Note that is possible where α is set at a number greater than 1, the resulting set will be the best satisfying collection selected as a group, but not necessarily the individually selected best set of CEO candidates.
2. The model can also be used to identify the key criteria used in the final selection of a CEO. Unlike manual selection methods, the GP methodology and sensitivity analysis can be used to reveal both the specific prioritized goal(s) and the individual parameter(s) that determined the best satisfying solution. This would permit decision makers an opportunity to revise a goal to insure its relevance in the decision-making process and the accuracy of the parameter. This helps to focus effort on just those model criteria that might change an existing solution and thus save needless effort on non-critical model criteria, which represents the bulk of the model.
4. The model can be used as a tradeoff analysis simulator. Once a candidate has been selected, board members who favored another candidate could use the sensitivity analysis tradeoff information to compare, criterion-by-criterion, what the model chosen candidate offers the board verses what another candidate might offer. This might be helpful in situations where the board would be willing to consider revising the selection criteria or revising priorities in an effort to permit compromise in solutions.
5. The model can be used as a pre-screening method in combination with traditional selection methods. For boards that require interviews and other traditional selection approaches on which final selection decision are to be made, the GP model can save time by being used just as a pre-screening methodology to reduce the list of possible interviewee's.

5. DISCUSSION AND RESULTS

CEO selection is an infrequent and critically important decision requiring considerable time and careful analysis. This type of decision is an ideal candidate for using an operations research technique like goal programming augmented by computerization. Building on currently used tabular methodologies this paper has presented a PC-based modeling approach for CEO selection that provides boards of directors with an effective quantitative process on which to choose CEO candidates. Development of such a model is important since the CEO plays a vital role in the organization's success. It is also important since the primary reason boards of directors were created and recognized by law is to ensure continuity in the management of organizations and to fix a locus of responsibility for the control of independent organizations (Zald 1969).

Based on the experimental case study data, the Strategic GP model presented in this paper was shown to support both the reliable (more so than the bias subject groups in the Fortune 500 case study) and the valid as a tool in CEO selection decisions. The model was shown to be able to be used to not only make the best criteria satisfying selection decision but to achieve a preference ordering of candidates that could be used to guide the recruiting efforts when first choice candidates become unavailable. The use of GP sensitivity analysis was also shown to be useful methodology in helping to analyze a given solution.

Although the modeling approach presented in this paper provides a powerful decision support tool for CEO selection, there are limitations that should be considered. As Romero (1991) explains, there are many ways that a GP model can generate less than desirable results. GP, like all multi-objective programming methodologies requires a number of modeling assumptions to hold true in order for the model to generate a valid solution. These limitations chiefly include the model assumptions of [see Lee (1972), pp. 32–34)]: (1) "proportionality" (e.g., the selection of the x_j CEO will contribute exactly its respective a_{ij} to achieving the respective β_i) otherwise a nonlinear GP solution procedure might be more applicable; (2) "additivity" (e.g., the addition of the a_{ij} are independent of the values of the decision variables); and (3) "deterministic" (e.g., all the parameters in the model are known to be constant or certain over a specific period of time). While the risk of violating the assumptions of proportionality and additivity are basically voided by the nature of the selection process (i.e., zero-one type of problem, usually where only one candidate is being selected at a time), there is never complete certainty on model parameters, particularly in situations where subjective estimation and forecast values are included in the analysis. In defense of the Strategic GP model, there is no difference in the data currently being used in traditional tabular or manual methods and that used in the GP model. So, there is no greater degree of risk of error due to inaccuracy of data. To the contrary, the GP sensitivity analysis allows for an opportunity to find key parameters in the decision process and determine how sensitive they might be to inaccuracy. This feature makes the Strategic GP model approach a less risky means of dealing with potentially flawed data.

Another limitation is that fact that the model is dependent on the judgmentally derived parameters. The resulting solution will only be valid if the parameters used to judge the candidates are relevant and accurate. Since the same parameters are currently used in the tabular methods we can assume that the Strategic GP modeling approach can not do worse in selecting a CEO than existing methodology, but will help to avoid some of the observed biases in the selection process. Yet it is possible those changes in the valuation of criteria and priorities can take place in the dynamics of a CEO selection board meeting, and that these dynamics may have value in the actual decision process. If such dynamics are important enough to alter a selection decision, they should be recorded and incorporated into the Strategic GP model. Thus the GP model again helps to insure discipline, that selection criteria is fairly applied to all candidates.

Another limitation concerns the interpretation of the sensitivity analysis values. In the sensitivity analysis presented in this paper, only one parameter is allowed to be changed and the interpretation remain true. If more than one parameter is changed at one time, the impact of such changes can render the sensitivity analysis boundaries invalid. Fortunately, decision-makers can determine the impact of parameter changes very efficiently by using the Strategic GP model as a deterministic simulation tool. That is, a change in the solution can be observed by making multiple parameter changes in the model and simply rerunning the model to see the simulated impact of all the changes in the new solution. When compared with the current tabular or spreadsheet methods for simulating a change, the efficiency of the Strategic GP model becomes very apparent.

An additional limitation might be the natural resistance board members have to relying on a complicated modeling process that they do not fully understand. This resistance to change is common in the implementation of new complex technology or methodology. The proposed Strategic GP methodology does have the advantage of offering the results of using sensitivity analysis to defend a particular choice, once the model has rendered that choice. Unlike most manual scoring or rating methods currently used, the Strategic GP model allows users to check the answers against possible alternative choices. The computer model also allows, if need be, changing parameters and quickly rerunning the model to simulate a potential change in CEO selection choices from criteria changes. It is felt, that such additional analysis will help users to become less unsure of the modeling approach suggested in this paper.

One limitation that cannot be addressed in this paper is the fact that some CEO candidates have political "pull" or insider experience that can bias the final decision in their favor. There are also board members who can manipulate other board members or play hidden "games" to have their candidates chosen. Fortunately, the use of the proposed GP model in this study will help to provide a consistent evaluation of the mathematical criteria the model is given, helping to eliminate the unwritten human bias during the selection process that currently occurs when human behavior might slant the selection decision away from agreed to criteria. The GP model will help to insure consistent and disciplined evaluation of all criteria via the GP algorithm, as it is directed to by the board that directs the model's construction. The GP model, though, can be rigged to be bias in the selection process by weighting the model parameters to favor a particular candidate. The fact that such bias manipulations are required to be placed in writing in the model and could be used in evidence of discrimination may, from a legal standpoint, help to inhibit their occurrence in the CEO selection process.

This paper has presented one of the first illustrations of how an advanced multi-objective programming methodology can be used to aid in solving a CEO selection problem. Based on reviewer comments, we recommend that the logical extension of this paper's research is a comparative application of our Strategic GP model with other multi-criteria decision making methodologies, such as those suggested by Steuer (1986) and others.

Another possible extension of this research is the incorporation of hierarchical data. While not observed in the field studies on CEO selection conducted for this paper, there may be a need to reflect hierarchical criteria in the data used in the decision model. One multi-criteria approach that is recommended is the use of the "analytic hierarchy process" or AHP by Saaty (1980), which can be included in the Strategic GP model using a similar modeling formulation as suggested in Schniederjans and Garvin (1997) and Schniederjans and Wilson (1991).

One additional extension that may broaden the possible application of this methodology in CEO selection and deal with possible issues of non-linearity in the metrics used, is an exploration of using metric weighting in the GP model rather than the suggested preemptive priorities. This can be accomplished by using the GP model's objective function in (6). The literature abounds with GP weighting procedures [see Schniederjans (1995, pp. 5–8)], and more detailed weighting information on personality characteristics applicable to CEO selection can be found in the literature as well [see Hamilton and Zanna (1972)].

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