Decision Sciences
Volume 33 Number 1
Winter 2002
Printed in the U.S.A.

Strategic Manufacturing Planning Systems and Their Linkage to Planning System Success

Karen E. Papke-Shields
Information and Decision Sciences Department, Franklin P. Perdue School of Business, Salisbury State University, Salisbury, MD 21801, e-mail: kepapke-shields@ssu.edu

Manoj K. Malhotra
Department of Management Science, Darla Moore College of Business Administration, The University of South Carolina, Columbia, SC 29210, e-mail: malhotra@darla.badm.sc.edu

Varun Grover
Department of Management, Clemson University, Clemson, SC 29634, e-mail: vgrover@clemson.edu

ABSTRACT

Academics and practitioners alike are focusing more attention on manufacturing strategy after having recognized the important role it plays in shaping the success of industrial firms. Even though research in this area has increased in the last decade, the focus of much of that work has been on the content rather than the process of the manufacturing strategy. Consequently, this study attempts to understand the important elements of the strategic manufacturing planning process and its effectiveness. Borrowing from the extant literature in the fields of strategic management and information systems, we propose a research model that relates strategic manufacturing planning system design to planning system success. Using structured questionnaires, empirical data is collected from over 200 manufacturing executives to test the model hypotheses. Planning process in manufacturing was found to be a bottom-up approach from a corporate or business perspective, which differs from the top-down planning process prevalent in strategic information systems planning process. Findings also indicate that greater planning system success in manufacturing is associated with a planning system that combines some "rational" elements (formality, comprehensiveness, control focus, longer horizon) with others that lend adaptability (wider participation and more intense interaction). But the strategic manufacturing planning system is more than just a collection of independent planning characteristics. Instead, it can be viewed as a gestalt planning system whereby planning characteristics move together in affecting overall planning system success.

Subject Areas: Manufacturing Strategy, Strategic Planning, and Structural Equation Model.

INTRODUCTION

Practitioners and academics alike recognize that the content of the manufacturing strategy (the goals developed for the manufacturing function and the plans to achieve those goals) is important since it defines the capabilities and limitations of the manufacturing function. Research in this area, which has increased dramatically in the last decade, indeed supports this assertion (e.g., Miller & Roth, 1994; Schroeder, Anderson, & Cleveland, 1986; Vickery, Dröge, & Markland, 1993). Since how the manufacturing strategy is developed is expected to affect the outcome of that process (content) (Dean & Sharfman, 1993), there has also been agreement that the process of developing the manufacturing strategy is important. However, despite its recognized importance, very little research has focused on the process of formulating or implementing the manufacturing strategy (Adam & Swamidass, 1989; Anderson, Cleveland, & Schroeder, 1989; Leong, Snyder, & Ward, 1990).

This study addresses these issues and research needs by attempting to understand how the planning process is undertaken in manufacturing functions. Several pertinent questions direct such an inquiry. Can we characterize the salient dimensions of the process used to predominantly guide strategic planning in manufacturing firms? Can manufacturing planning system success also be defined in terms of multiple dimensions that are distinctly different from one another? How are the process dimensions important in determining success and how do they differ from or are similar to those that have been reported in the prior strategic management and information systems literature? This paper answers these questions through an empirical assessment of the manufacturing strategic planning systems currently being used in practice. This information should begin filling the gap between the need to understand the manufacturing strategy planning process and the field's current knowledge base, as well as provide recommendations for both managers and academics.

In the following section, we review the relevant literature that is used as the basis of this study. We subsequently propose the research model of strategic manufacturing planning process and its relationship to planning system success, and develop the related hypotheses. Then, the survey methodology that is used for data collection is described, which is then followed by a detailed analysis of results. Finally, the results and the implications of our research for manufacturing practice are discussed.

LITERATURE REVIEW

In understanding how strategic planning is done in the manufacturing area, there is much that we can learn from the large body of knowledge that exists in other fields such as strategic management and information systems. On an aggregate, research in these related fields has focused on the planning system, which coordinates and guides the planning process (e.g., Dutton & Duncan, 1987; Kukalis, 1991; Segars, Grover, & Teng, 1998), and its implications for performance (e.g., Fredrickson & Mitchell, 1984; Kukalis, 1991; Segars et al.). This literature stream is thus the one used to motivate our research model and the related hypothesis, although we integrate manufacturing-related research wherever appropriate.

Planning Characteristics

How each firm conducts their strategic manufacturing planning (SMP) is captured, in part, by the "strategic planning system," which is the pattern of planning characteristics that organizes and coordinates the activities of those involved in the planning (Lederer & Sethi, 1996; Lorange & Vancil, 1977). In the strategic management, information systems, and manufacturing strategy literature, several characteristics of the strategic planning system have been identified. These include the flow, formality, comprehensiveness, focus, intensity, participation, and length of planning horizon. Each of these characteristics is defined in Table 1.

In manufacturing, however, the research has been more exploratory in nature. Most existing research on the planning systems or processes used by businesses to develop their manufacturing strategies has either been driven by case studies (i.e., Blenkinsop & Duberley, 1992; Marucheck, Pannisi, & Anderson, 1990; Persson, 1991; Schroeder & Lahr, 1990; Voss, 1992) or through frameworks (i.e., Fine & Hax, 1985; Garvin, 1993; Hill, 1994; Jouffroy & Tarondeau, 1992; Menda & Dilts, 1997). These frameworks tend to be similar and emphasize a top-down approach and congruence between the marketing and manufacturing strategies. Several tools have been reported to aid in development of the manufacturing strategy such as Platts and Gregory's (1990) manufacturing audit and Crowe and Cheng's (1996) use of quality function deployment in SMP.

With respect to specific aspects of the SMP process, Marucheck et al. (1990) examined strategy formulation and implementation processes in six firms. They observed that SMP tended to be top-down (planning flow), done on a regular basis (intensity), and formal with respect to procedures and documentation (formality). Anderson, Schroeder, and Cleveland (1991) also examined several process variables. They observed that the manufacturing strategic planning was linked to the budgeting process (focus) and documented and disseminated either verbally or in written form in only 43% of the firms (formality).

Planning Effectiveness

The argument used for justifying strategic planning at the business and functional levels is that planning should enhance organizational performance. Much of the prior research examining planning system characteristics in developing the business or information systems strategies has assessed the benefits through business financial performance (e.g., Fredrickson, 1984; Fredrickson & Mitchell, 1984; Wood & LaForge, 1981). However, there has been a tenuous link between planning and business performance (Miller & Cardinal, 1994; Pearce, Freeman, & Robinson, 1987). Financial performance does not take into account other tangible and intangible benefits (Hax & Majluf, 1984; King, 1983; Lorange, 1980; Steiner, 1979). It is an indirect result of strategic planning, being influenced by not only the outcome of the planning process but also by its implementation and myriad other factors (King, 1983).

A direct measure that assesses the planning system's benefits is more appropriate (King, 1983; Premkumar & King, 1991; Ramanujam & Venkatraman, 1987). When performance is measured by a direct measure, such as the effectiveness or

Table 1: Planning characteristics.

Construct	Domain	Prior Conceptualizations
Flow	Locus of authority for strategic planning	Dutton & Duncan, 1987; Lorange, 1980
Formality	Extent to which the planning process is structured, through written procedures, schedules and other documents, and the extent of documentation resulting from the planning process	Anderson et al., 1991; Armstrong, 1982; Das, Zahra, & Warkentin, 1991; Dutton & Duncan, 1987; Kukalis, 1991; Marucheck, Pannesi, & Anderson, 1990
Comprehensiveness	Extent to which all possible strategic alternatives are identified and considered	Fredrickson & Mitchell, 1984
Focus	Extent to which control or efficiency, usually seen as a tight link with budgets, rather than creativity is emphasized	Chakravarthy, 1987; Lorange, 1980
Intensity	Magnitude of resources committed to planning as evidenced by frequency and richness of meetings	Dutton & Duncan, 1987
Participation	Variety of individuals involved in strategic planning	Dutton & Duncan, 1987; Dyson & Foster, 1982; Hart, 1992
Horizon	Length of time considered in strategic planning	Kukalis, 1991; Steiner, 1979

success (used interchangeably in this paper) of the planning system, the link between planning and performance has been found to be more consistent in the strategic management and information systems fields (e.g., Premkumar & King, 1994; Ramanujam & Venkatraman; Segars & Grover, 1998). Table 2 shows the dimensions of planning system success (PSS) that have been conceptualized in prior literature. Planning system success or effectiveness can be captured by the attainment of goals or targets, the improvements in the planning system capabilities, and the perceived alignment of the business and manufacturing strategies. The latter has been identified as one of the most important goals with respect to developing a manufacturing strategy (Hill, 1994).

Within manufacturing literature, few studies have assessed planning effectiveness and when done, it is in a very exploratory way. For example, Anderson et al. (1991) assessed the degree of satisfaction of the manufacturing executive with the business and manufacturing strategy formulation and implementation process, and the degree of satisfaction with the manufacturing strategy. Although satisfaction is a direct result of the process and may capture some aspects of "objective fulfillment," it may not fully capture the potential benefits associated with planning (Ramanujam, Venkatraman, & Camillus, 1986).

Table 2: Dimensions of planning system success.

Construct	Domain	Prior Conceptualizations
Objective Fulfillment	Degree of attainment of commonly accepted targets	Cameron & Whetton, 1983; Raghunathan & Raghunathan, 1994; Ramanujam & Venkatraman, 1987
Capability Improvement	Degree of improvement in the capabilities of the planning systems	Cameron & Whetton, 1983; Raghunathan & Raghunathan, 1994; Ramanujam & Venkatraman, 1987
Strategy Alignment	Congruence between the business and manufacturing strategy	Hayes & Wheelwright, 1984; Hill, 1994; Cleveland, Schroeder, & Anderson, 1989; Vickery et al., 1993; Segars & Grover, 1998

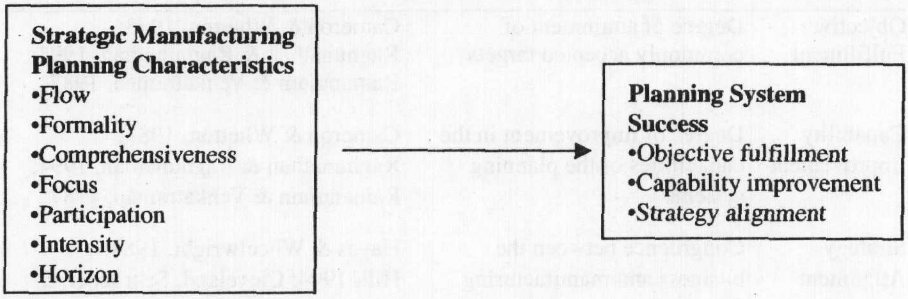
THE RESEARCH MODEL

All manufacturing functions carry out some degree of strategic planning, although the process may vary greatly between different firms. For example, planning in one manufacturing function may be very structured while planning in another organization is a series of ad hoc decisions. Yet, our research model posits that how planning is done will affect its effectiveness (Figure 1). The appropriateness of different planning approaches has been the source of an ongoing debate in the strategic management field. The two schools of thought on strategy development processes that have received the majority of attention are "planning" and "learning." These two schools of thought seem to represent polar extremes (Camillus, 1982; Fredrickson & Mitchell, 1984). Those in the "planning" school posit that a more structured, controlled planning process carried out by specialists should be used, whereas those in the "learning" school assert that planning cannot be deliberately controlled and stress the importance of wide participation. Thus, these two schools of thought vary with respect to the planning system expected to be effective.

However, Lorange and Vancil (1977, p. 144) stated that "A planning system has two major functions: to develop an integrated, coordinated, and consistent long-term plan of action, and to facilitate adaptation of the long-term efforts of the corporation to changes in the environment." This implies that an effective planning system could be neither polar extreme but a combination of them. Such a system has been discussed with respect to the SMP process. Giffi, Roth, and Seal (1990), in examining world-class manufacturers, discussed steps in a process that reflect a rational approach yet state that SMP must be a "living, dynamic process" with "constant review and monitoring of the strategy . . . to make modifications, as required, on a timely basis" (p. 109).

Recent studies in strategic management and information systems indicate that such strategic planning is being used and can be effective. In a study on strategic information systems planning (SISP), a hybrid of these two schools of thought, which combines some aspects of a "rational" planning system (top-down flow, formal, comprehensive, control focus) with elements that maintain "adaptability" (high intensity and greater participation), was observed to be most effective (Segars

Figure 1: The proposed research model.



et al., 1998). In addition, Glaister and Falshaw (1999) observed that strategic planning in U.K. companies is a formal and deliberate process but has not "resulted in rigidity and inflexibility," likely due to wide participation and regular reviews of the plans. The argument for a planning approach that combines aspects of "rationality" with those that provide flexibility is cogent, powerful, and has empirical support in different contexts.

The manufacturing strategy, which is the outcome of the SMP process, articulates the goals and direction for the manufacturing function as well as the myriad individual plans on how those goals will be achieved. To facilitate such an outcome, the planning process should have initiative and direction from the top (Leong et al., 1990; Marucheck et al., 1990; Menda & Dilts, 1997; Skinner, 1969). The decisions included in a manufacturing strategy include both structural and infrastructural areas. They represent a wide range of the more resource-intensive and long-term decisions in an organization, such as location, facility, and human resource decisions (Hayes & Wheelwright, 1984; Hill, 1994; Skinner). An effective strategic manufacturing process will be more controlled, systematic, and comprehensive, ensuring that all such issues are identified, addressed, and thoroughly examined (Anderson et al., 1991; Dutton & Duncan, 1987; Marucheck et al.; Tunalv, 1990). This would also ensure that the resulting decisions represent an integrated manufacturing strategy, similar to Hayes and Wheelwright's "internally supportive" approach. The effective process will also be linked to the budgeting process given the resource requirements commonly associated with strategic manufacturing decisions (Anderson et al., 1991).

Effective planning will also benefit from communication and coordination among a wide range of individuals with relevant information (Platts, 1994; Tunalv, 1990). This should be facilitated by planning done on a regular basis through more frequent and rich meetings (Marucheck et al., 1990), coupled with formality. Greater width and depth of participation is also important because staff and lower level managers have a valuable knowledge of the capabilities and constraints of the manufacturing system (Mills, Platts, & Gregory, 1995). These arguments and the empirical support for a "rational adaptive" planning approach in different contexts lead to the following set of hypotheses about the expected relationship between each planning characteristic and PSS.

H1a: The more top-down the strategic manufacturing planning flow, the greater the planning system success.

H1b: The more formal the strategic manufacturing planning system, the greater the planning system success.

H1c: The greater the comprehensiveness of the strategic manufacturing planning system, the greater the planning system success.

H1d: The greater the control focus of the strategic manufacturing planning system, the greater the planning system success.

H1e: The greater the intensity of the strategic manufacturing planning system, the greater the planning system success.

H1f: The greater the breadth and depth of participation in the strategic manufacturing planning process, the greater the planning system success.

H1g: The longer the strategic manufacturing planning horizon, the greater the planning system success.

However, just as Lorange and Vancil (1977) recommended a "planning system," Segars et al. (1998) observed that strategic information systems planning is more than just a collection of independent planning characteristics. Indeed, they term the planning approach a "rational adaptive" system. This implies that the characteristics of planning covary in a systematic way. Predicting outcomes through the gestalt effect of these characteristics would therefore be a more powerful way to predict planning outcomes. Evidence from both strategic planning and IS planning supports this thesis. Although the limited SMP research has examined only a few independent planning characteristics, initial findings (i.e., Anderson et al., 1991; Maruchek et al., 1990) suggest that such an approach will be effective in SMP. Thus, the second hypothesis reflects the expectation that the SMP approach is a gestalt planning system, where planning characteristics move together in affecting PSS.

H2: A "rational adaptive" strategic manufacturing planning system (top-down, formal, comprehensive, control-focus, intensive planning system with wide participation and a long planning horizon) will lead to greater planning system success.

METHODOLOGY

Operational Measures

Sample items were generated given the domain of each construct as discussed previously. Existing scales were used and adapted for the planning system design and PSS constructs. The final survey instrument is included in the Appendix. Segars et al. (1998) operationalized formality, flow, comprehensiveness, intensity, participation, and focus. All of their multi-item scales exhibited strong measurement properties (composite reliability ranging from .71 to .88), and were consequently adapted to reflect SMP as discussed in the manufacturing strategy literature. A multi-item scale for measuring planning horizon, based on objective measures used previously (Kukalis, 1991; Lindsay & Rue, 1980), was used in this research to attain consistency in measures for analysis purposes. However, an objective measure was also included, and a high correlation (.55, p-level < .0001) was found between the mean of the multi-item scale and the objective measure.

The measures of the three dimensions of planning success were also adapted from prior research. Given the strong measurement properties of the measures of "objective fulfillment" and "capability improvement," they have been adapted for the current research (Raghunathan & Raghunathan, 1994; Ramanujam & Venkatraman, 1987; Ramanujam et al., 1986). The scale for the perceived alignment of the business and manufacturing strategies, which is considered an important outcome of the planning process in the manufacturing strategy literature (Hayes & Wheelwright, 1984; Hill, 1994; Skinner, 1969) was adapted from the scale developed by Segars and Grover (1998) as a part of their direct measure of planning effectiveness in information systems.

Data Collection

Data to test the hypotheses were collected via a survey of U.S. manufacturers. The unit of analysis was a strategic business unit (SBU), which is a division, subsidiary, or single product line (Hayes & Wheelwright, 1984), since this is the level at which strategic planning for manufacturing is expected to occur. Since prior research has indicated a difference in strategic planning between large and small firms (Lorange & Vancil, 1977; Marucheck et al., 1990), the sample consists of medium to large ($50 million or more in sales) manufacturing firms or SBUs. The sample frame was the 1996 National Edition of the *Harris Manufacturing Directory*, which has been used in prior manufacturing strategy research (e.g., Safizadeh, Ritzman, Sharma, & Wood, 1996; Ward, Leong, & Boyer, 1994), and provided necessary information at the SBU level. The targeted respondent was the highest ranking manufacturing executive at the SBU level, which was often the vice-president of manufacturing. The surveys were sent to 681 firms where such an individual could be identified.

The survey instrument was pre-tested with 16 manufacturing vice-presidents by interviewing each of them after he or she had completed the survey. Slight modifications were made to a few items, and the scales demonstrated acceptable internal consistency. Following the mailing of the surveys, eight surveys were returned as undeliverable and 209 responses were received, which represents a response rate of 30%. Sixteen of the respondents provided insufficient data for one of the measures and were dropped from the analysis. Thus, the final sample consisted of 193 business units. In addition, a survey was sent to a second individual (identified by the initial respondent as being equally knowledgeable about the planning process) in 48 of these originally responding firms to assess interrater agreement via the "within-group interrater agreement index" (r_{WG}) (James, Demaree, & Wolf, 1984, 1993).

The profile of respondents in the final sample is given in Table 3 and shows that a wide variety of manufacturing organizations were included. Respondents represent all SIC groups, except for "Leather and leather products," had varied

Table 3: Profile of survey respondents.

Characteristic		Frequency[a]	Percentage
Sales ($million)	50-100	53	22.9
	101-250	71	38.1
	251-500	24	13.2
	501-1,000	26	15.2
	1,001-3,000	14	8.1
	>3,000	4	2.5
Number of employees	100-500	80	41.1
	501-1000	75	38.6
	1001-1500	22	11.7
	1501-2000	4	2.5
	2001-2500	4	2.0
	2,501-3000	3	1.5
	>3000	5	2.5
Products[b]	1	37	19.8
	2	62	31.4
	3	40	20.8
	4	37	19.8
	5	17	8.2
Processes[c]	1	38	20.0
	2	28	15.1
	3	51	25.9
	4	74	39.0

[a] not all totals equal 193 because of missing responses

[b] 1 = customized product manufactured to customer specifications; 2 = standard product with options modified to customer specification; 3 = standard product modified to customer specification; 4 = standard product with standard options; 5 = standard product with no options (Safizadeh et al., 1996)

[c] 1 = products are produced in small batches, similar equipment performing the same functions grouped together; 2 = products are produced in moderately large batches, similar equipment performing the same functions are grouped together; 3 = products are produced in batches, work centers are laid out in the sequence in which the products are manufactured; 4 = products are produced in large batches or in a continuous flow, work centers are laid out in the sequence in which the products are manufactured (Safizadeh et al., 1996)

sales (from approximately $50 million to over $3 billion), and produced a variety of products using a variety of processes. The vice-president of manufacturing or equivalent was reached in the vast majority of cases, since the level of the respondent was one or two levels below the head of the firm. Finally, a check for non-response bias indicated that respondents did not differ significantly from non-respondents with respect to SIC representation, sales, or number of employees.

RESULTS

Measure Refinement and Validation

Assessment of the measurement properties of each scale includes an evaluation of unidimensionality, internal consistency reliability, interrater agreement, and convergent and discriminant validity via confirmatory factor analysis (CFA) (Hair, Anderson, Tathum, & Black, 1995; Segars, 1997; Sharma, 1996). This assessment, done with SAS and based on the covariance matrix, was conducted separately for each theoretical group (planning characteristics and PSS), where the measurement models included all multi-item measures (manifest variables) of the related latent constructs (Figures 2 and 3). In both cases, the metric of each factor was established by fixing the factor loading of one item to 1.0 (second item, selected arbitrarily) (Sharma, 1996). In addition, proper model identification was established in both cases since at least three items are used per construct, all residual terms are uncorrelated with other terms, and the models are recursive. In all cases where refinement was indicated, items were deleted only if such action was theoretically sound (Anderson, 1987; Segars, 1997), and then deletions were done one at a time and the fit of the revised model assessed before further action (Segars & Grover, 1993). Before conducting the CFA, the data was examined for normality, a condition necessary for CFA. No serious violations of normality were observed using box plots, stem-and-leaf analysis, and Q-Q plots, and skewness and kurtosis were within normal ranges.

The fit indices for the planning characteristics suggest that improvement could be made in the measures (Table 4). Examination of the factor loadings (Figure 2), asymptotically standardized residual values, and modification indices suggests that four items should be dropped from the scales (FL1, CR1, P3, and C1). In all cases, the items appeared to differ in their focus from the other items, and dropping the items did not decrease content validity of the scales. Some evidence of cross-loading was also found in the modification indices for two other items (FR4 and P1). However, these scales demonstrated high internal consistency (via composite reliability) and had strong item loadings. Therefore, the effect was believed to have occurred due to redundancy in the items in each scale and the expected high correlation between constructs. Although dropping these items would improve the model fit, the content validity would be decreased. Given the measurement properties, they were retained. The respecified measurement model for the planning characteristics indicated an acceptable fit (Table 4) (Browne & Cudeck, 1993; Chau, 1997; Hartwick & Barki, 1994; Segars & Grover, 1993). Although the chi-square statistic is significant ($\chi^2 = 401.6$, $df = 254$, $p < .001$), researchers tend to use other heuristics given the sensitivity of this statistic to sample size (Sharma, 1996).

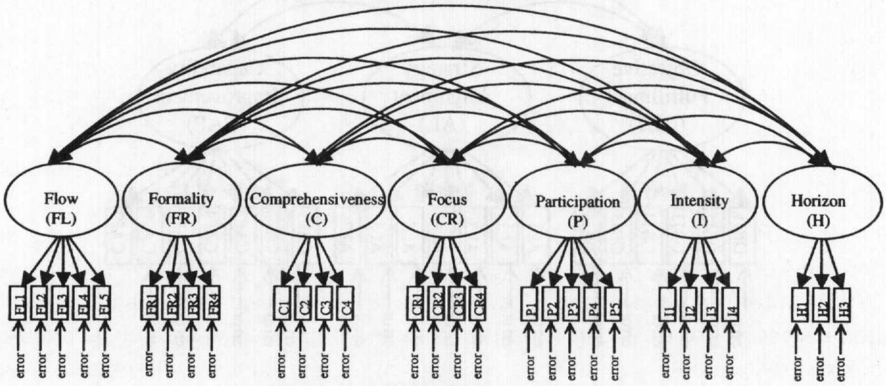
The same process was followed for the PSS group. The initial fit indices indicated that improvement could be made in the measures. Examination of the factor loadings (Figure 3), asymptotically standardized residuals, and modification indices suggest that three items (AL5-AL7) intended to measure strategy alignment were not measuring the same construct as the other four items. While the first four items focus on agreement in strategic priorities and direction, the items in question address educating top management and technology. This focus is likely

Figure 2: CFA for planning characteristics.

Construct Correlations

	FL	FR	C	CR	P	I
FR	.03					
C	**.49**	**.33**				
CR	**.51**	-.01	**-.49**			
P	**.42**	**.44**	**.52**	**-.62**		
I	**.48**	**.24**	**.53**	**-.50**	**.70**	
H	**.48**	**.33**	**.65**	**-.40**	**.53**	**.55**

boldface—all values significant at *p*-level < .001



Standardized Factor Loadings

	Construct						
Item	FL	FR	C	CR	P	I	H
1	-.08[a]	**.45**	**.67[a]**	-.08[a]	**.78**	**.87**	**.49**
2	-.54[b]	.73[b]	.79[b]	-.58[b]	.55[b]	.78[b]	.80[b]
3	**-.50**	**.80**	**.70**	**-.82**	**.28[a]**	**.65**	**.67**
4	**-.95**	**.69**	**.67**	**-.71**	**.66**	**.72**	
5	**-.48**				**.71**		

boldface—all values significant at *p*-level < .001
a: item dropped in final measurement model
b: factor loading fixed at 1.0 to set scale metric

important with respect to strategic information systems planning, from where the measure was adopted, but do not reflect alignment as discussed in the manufacturing strategy literature. Thus, these items were dropped, and the revised model demonstrated acceptable fit (Table 4).

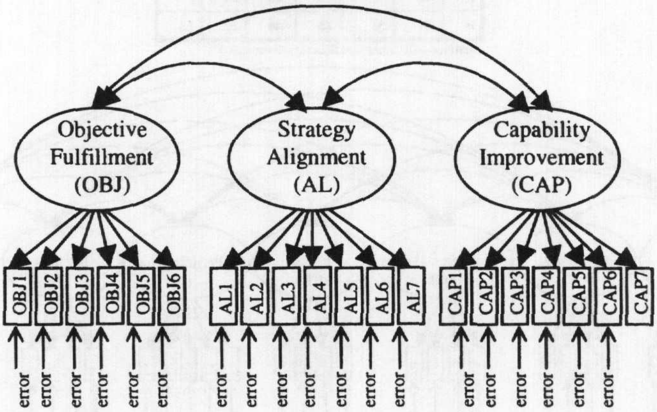
In all cases, the final scales demonstrated acceptable unidimensionality and internal consistency reliability (range of composite reliability: .70 to .90; individual values reported for each scale in the Appendix). Evidence of convergent validity was seen via the significance of all factor loadings (at $p < .001$ level). Evidence of discriminant validity was found via the significance (at $p < .001$ level) of all chi-square pairwise comparisons within each theoretical group (21 comparisons for planning characteristics and three for PSS). Finally, interrater agreement, assessed via "within-group interrater agreement index" (James et al., 1984, 1993) appeared acceptable for all measures (range of r_{WG}: .60 to .87; individual values reported for each scale in the Appendix). Thus, these measures seem appropriate in a manufacturing setting.

Figure 3: CFA for planning system success dimensions.

Construct Correlation

	OBJ	AL
AL	**.86**	
CAP	**.81**	**.76**

boldface—all values significant at *p*-level < .001



Standardized Factor Loadings

	Construct		
Item	**OBJ**	**CAP**	**AL**
1	**.71**	**.82**	**.72**
2	**.72**[b]	**.65**[b]	**.84**[b]
3	**.34**	**.64**	**.84**
4	**.71**	**.82**	**.77**
5	**.65**	**.77**	**.78**[a]
6	**.51**	**.75**	**.74**[a]
7		**.59**	**.63**[a]

boldface—all values significant at *p*-level < .001
a: item dropped in final measurement model
b: factor loading fixed at 1.0 to set scale metric

The measurement model for the three latent constructs addressing planning effectiveness reveals that, although distinct constructs, they are highly correlated (Figure 3). Ramanujam and Venkatraman (1987) observed a similar strong relationship between two of the constructs used in this study (capability improvement and objective fulfillment). More recently, Segars et al. (1998) found that the covariation of similar constructs was captured by a second-order factor. Given the high correlations between the three constructs of planning effectiveness and these prior findings, these constructs were reduced from multi-item to single-item measure by computing a factor score of each construct for each observation in the sample. In

Table 4: Confirmatory factor analysis results.

Initial Measurement Model Fit [a]	Modifications: Item	Modifications: Indication	Modifications: Action	Final Measurement Model Fit
Planning System Characteristics				
$\chi^2 = 706.4$, $df = 356$, $p < .0001$	FL1	non-sign. loading[b], cross-loading	drop FL1	$\chi^2 = 401.6$, $df = 254$, $p < .0001$
AGFI = .76 CFI = .83	CR1	non-sign. loading, cross-loading	drop CR1	AGFI = .82 CFI = .92
RMR = .09 NFI = .71	P3	weak loading (.28), cross-loading	drop P3	RMR = .07 NFI = .80
RMSEA = .07 NNFI = .80	C1	cross-loading	drop C1	RMSEA = .05 NNFI = .90
adj $\chi^2 = 1.98$ IFI = .83				adj $\chi^2 = 1.58$ IFI = .92
Planning System Success				
$\chi^2 = 447.6$, $df = 167$, $p < .0001$	AL7	cross-loading	drop AL7	$\chi^2 = 192.8$, $df = 116$, $p < .0001$
AGFI = .75 CFI = .87	AL6	cross-loading	drop AL6	AGFI = .90 CFI = .95
RMR = .06 NFI = .81	AL5	cross-loading	drop AL5	RMR = .04 NFI = .89
RMSEA = .09 NNFI = .85				RMSEA = .06 NNFI = .95
adj $\chi^2 = 2.68$ IFI = .87				adj $\chi^2 = 1.66$ IFI = .96

[a]measurement model fit indices and suggested cut-offs:
AGFI = Adjusted Goodness of Fit (>.80)
RMR = Root Mean Square Residual (<.10)
RMSEA = Root Mean Square Error of Approximation (<.08)
adj χ^2 = chi-square/degrees of freedom (<2.0)
CFI = Comparative Fit Index (>.90)
NFI = Normed Fit Index (>.90)
NNFI = Non-Normed Fit Index (>.90)
IFI = Incremental Fit Index (>.90)

[b]"loading" refers to path loading, standardized path loading in parenthesis

other words, PSS became a latent construct with three items (alignment, objective fulfillment, and capability improvement) based on estimated reliabilities of the measurement model, thus representing an aggregate and error-free estimation of each respondent's score along these dimensions.

Strategic Manufacturing Planning Approach and Planning System Success

The research model proposes a strong positive relationship between each of the planning system characteristics (flow, formality, comprehensiveness, focus, intensity, horizon, and participation) and PSS (H1a-H1g). These independent relationships were assessed with a direct effects model (Figure 4), where each planning characteristic is related to PSS. In addition, each planning characteristic is allowed to covary with all other planning characteristics since a strong relationship between them is expected and they are exogenous variables. The factor loading for the item with the largest standardized path loading in the measurement model was fixed to 1.0 for each factor to alleviate scale indeterminacy problems (see the Appendix for specific items). Finally, proper model identification was demonstrated as discussed previously.

The fit indices indicate an acceptable fit of this model to the data (Figure 4) although the chi-square statistic was significant ($\chi^2 = 499.4$, $df = 322$, $p < .001$), which again is not unexpected given sensitivity to sample size as previously discussed. Examination of the modification indices did not reveal any improvements that could be made by adding or deleting paths. The factor loadings for the three PSS items reduced from the multi-item measures of objective fulfillment, capability improvement, and strategy alignment were all highly significant (standardized factor loadings: objective fulfillment = .89, capability improvement = .79 and strategy alignment = .80, p-level < .001 for all). The strength of the relationship between each planning characteristic and PSS was evaluated via the path loadings. The findings provide moderate support for the model since two paths were highly significant (participation [H1f] and horizon [H1g]), and one was moderately significant (intensity [H1e]) (Figure 4 and Table 5). Strong correlations between the planning characteristics suggest that the other planning characteristics may have indirect effects through the significant characteristics. The planning characteristics in total account for about 33% of the variance in PSS based on the standardized factor loadings.

The second hypothesis refines the first in that the planning characteristics are expected to act as a gestalt system on PSS rather than independently. This system perspective was tested via a second-order factor model where planning system design, a separate unobservable construct that captures the pattern of covariation among the planning characteristics, is expected to have a strong positive relationship with PSS (Figure 5). Again, the factor loading for the item with the highest standardized loading in the measurement model was fixed to 1.0 for each factor to establish the scale metric, and proper model identification was supported as discussed previously.

Following the procedure outlined by Venkatraman (1990), the appropriateness of this model is determined by comparing the second-order factor model (Figure 5) to the direct effects model (Figure 4). Since the second-order factor model

Figure 4: Direct effects model.

Construct Correlation

	FL	FR	C	CR	P	I
FL						
FR	-.03					
C	-.29	.36				
CR	-.01	.50	.44			
P	-.41	.40	.50	.61		
I	-.24	.48	.46	.51	.68	
H	-.34	.48	.57	.39	.50	.55

boldface—all values significant at *p*-level < .001

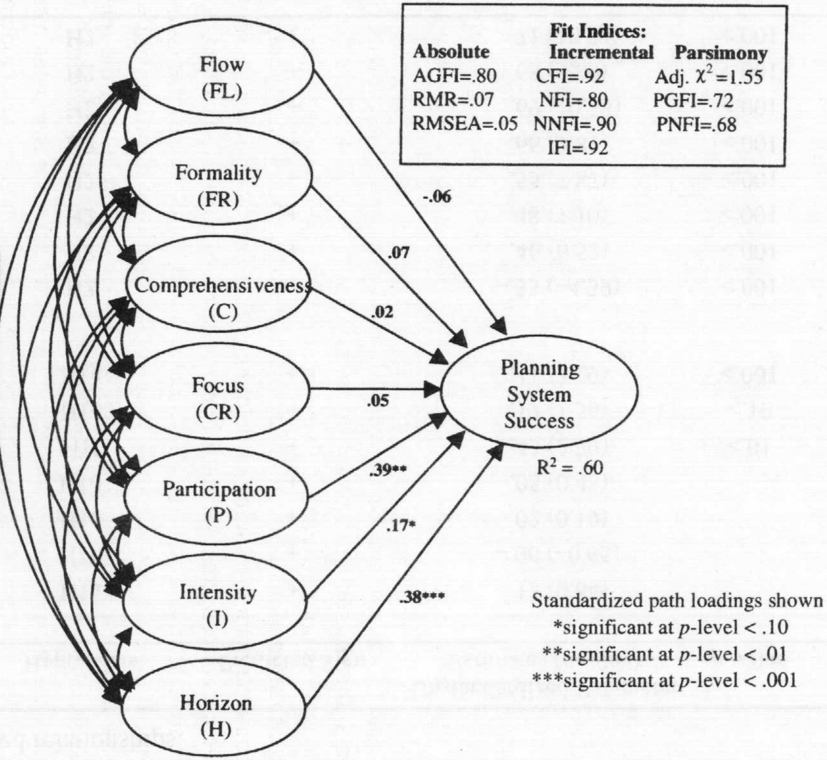
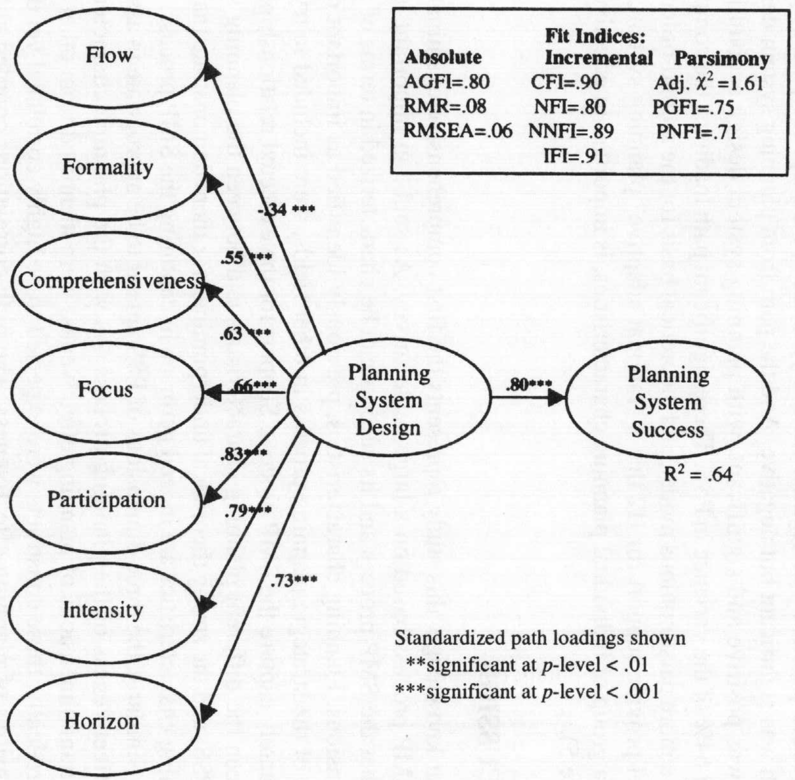


Table 5: Hypotheses and empirical results for proposed relationships.

Outcomes	Predictor	Hypothesis	Predicted Sign	Unstandardized Parameter Estimates (*t*-value)	*p*-value	Support?
Direct Effects Model						
Planning System Success	Flow	H1a	+	.13 (0.84)		No
	Formality	H1b	+	–.06 (–0.65)		No
	Comprehensiveness	H1c	+	.02 (0.19)		No
	Focus	H1d	+	.05 (0.48)		No
	Participation	H1f	+	.43 (2.79)	<.01	Yes
	Intensity	H1e	+	.17 (1.56)	<.10	Yes
	Horizon	H1g	+	.41 (3.29)	<.001	Yes
Second-Order Factor Model						
Flow	Planning System Design	H2	+	–.33 (–4.39)	<.001	No
Formality	Planning System Design	H2	+	.46 (6.52)	<.001	Yes
Comprehensiveness	Planning System Design	H2	+	.48 (7.10)	<.001	Yes
Focus	Planning System Design	H2	+	.55 (7.87)	<.001	Yes
Participation	Planning System Design	H2	+	.66 (9.81)	<.001	Yes
Intensity	Planning System Design	H2	+	.69 (10.33)	<.001	Yes
Horizon	Planning System Design	H2	+	.63 (9.00)	<.001	Yes
Planning System Success	Planning System Design	H2	+	.71 (10.74)	<.001	Yes

Figure 5: Second-order factor model.



is simply a more parsimonious way to explain the covariation among first-order factors, the overall fit cannot be better than the direct effects model. The absolute and incremental fit indices indicate the fit is comparable to that of the direct effects model and is an acceptable fit to the data despite a significant chi-square statistic ($\chi^2 = 553.0$, $df = 342$, $p < .001$). In addition, the parsimonious fit measures indicate that the second-order factor model is a better fit than the direct effects model when the number of coefficients is considered. These findings indicate that the pattern of covariation among the planning characteristics is captured as a separate unobservable construct, which we term as the "planning system design."

In addition, all of the path loadings in the model were significant (Figure 5). The path loadings from planning system design to each of the planning characteristics were positive and significant as hypothesized except for planning flow, which was significant but negative. And the path from planning system design to PSS was positive and significant, with planning system design accounting for about 64% of the variance in PSS. These significant path loadings, the comparable fit of a more parsimonious model, and theoretical basis for the second-order factor model provide support for H2 that a "rational adaptive" planning system, rather than a group of individual planning characteristics, is important in effective SMP (Table 5).

DISCUSSION

To our knowledge, this study represents the first comprehensive examination of the SMP process based on a large-scale survey. As such, an important issue is whether the SMP process and its success can be characterized in terms of salient dimensions. Planning characteristics, previously identified as important dimensions of the strategic planning process in other fields, were included in trying to adequately capture the SMP process. Support for the expected relationships, both between the different planning characteristics and between the planning system and PSS, and the strong theoretical underpinnings for them demonstrate that these planning characteristics are indeed germane in capturing the SMP process.

Similarly, the three dimensions of PSS appear to be appropriate in assessing the effectiveness of the planning process. As with the planning characteristics, important dimensions of planning effectiveness were identified from other fields. Theoretically, these constructs were expected to be highly correlated yet distinct dimensions of planning effectiveness. The high correlations coupled with evidence of discriminant validity and support for expected relationships provide evidence that objective fulfillment, capability improvement, and strategy alignment are salient dimensions of effectiveness of the SMP process. Thus, planning characteristics and PSS dimensions that are germane for capturing the SMP have been identified.

Given the appropriateness of the dimensions of the planning process and planning effectiveness, the next question addresses the role of planning characteristics in determining success. Moderate support for the first hypothesis and strong support for the second hypothesis seem to suggest that the "rational adaptive" approach, except for top-down planning flow, is the most effective way to develop the manufacturing strategy. Effective SMP appears to need a structure in place to ensure that the numerous and varied strategic issues are visited regularly, strategic alternatives are identified and evaluated for an adequate planning horizon, sufficient input is received, and the decisions are operationally feasible through a link to financial planning (Menda & Dilts, 1997; Platts, 1994; Anderson et al., 1991; Skinner, 1969). This approach was also associated with greater planning success with respect to strategic information systems planning (Segars et al., 1998). Although there are many differences between strategic concerns with respect to manufacturing compared to information systems (since information systems is commonly a support function with a focus on end-users throughout the organization), the process of developing more effective strategies seems to be fairly consistent.

However, the one difference that was observed is that a bottom-up approach appears to be preferable in SMP while a top-down planning flow was present in strategic information systems planning (Segars et al., 1998). One possible explanation for this finding is the level at which the planning is being done. Strategic information systems planning is done at the corporate or business level, which is the level at which the need for top-down planning flow has been discussed primarily. Strategic manufacturing planning, on the other hand, occurs at the functional level. Although Skinner (1969) and others have suggested the importance of a top-down approach in SMP, others in the field have suggested the use of "bottom-up entrepreneurial planning" rather than "top-down staff-dominated planning," which shifts responsibility to the manufacturing managers (Giffi et al., 1990). The findings in our study reflect this approach, indicating a reduced role of top management in developing the manufacturing strategy. This finding, coupled with Anderson et al.'s (1991) findings that within the manufacturing area most strategies were developed by manufacturing executives either in isolation or with the involvement of lower level managers, lead us to conclude that SMP is more bottom-up from a corporate or business perspective but top-down within manufacturing.

IMPLICATIONS FOR PRACTICE

Despite the attention to strategic planning by academics in the fields of strategic management and information systems and the call for more research in this area in the manufacturing strategy literature, SMP has been relatively ignored. Yet the findings of this study indicate that the process by which the manufacturing strategy is developed does influence the success of the planning process which, in turn, is expected to affect the strategy content (Dean & Sharfman, 1993). This research should benefit managers by helping them understand important aspects of how they should plan and create the manufacturing strategy, and how the planning system should be designed in order to align the business and manufacturing strategies, fulfill certain objectives such as long-term performance and problem area avoidance, and improve capabilities such as anticipating surprises/crises and identifying new business opportunities and problem areas (Table 6). However, managers need to recognize that costs associated with changing the planning approach (such as changes in culture or structure) may outweigh the possible benefits.

Table 6: Managerial implications of planning system design findings.

Hypothesis	Finding	Implication
H1a: There will be a positive relationship between planning flow (top-down) and planning system success (PSS).	When coupled with other aspects of "rational adaptive" planning, a negative relationship exists between top-down flow and planning system success (PSS).	Bottom-up planning, initiated within manufacturing and at levels below top management, brings to light more current and relevant issues in strategic manufacturing planning (SMP).
H1b: The more formal the strategic manufacturing planning system, the greater the PSS.	When coupled with other aspects of "rational adaptive" planning, a positive relationship exists between formality and PSS.	A structured process of developing a manufacturing strategy, with guidelines and written results, should be used.
H1c: The greater the comprehensiveness of the strategic manufacturing planning system, the greater the PSS.	When coupled with other aspects of "rational adaptive" planning, a positive relationship exists between comprehensiveness and PSS.	Identification and evaluation of alternatives in developing the manufacturing strategy should be more exhaustive and less "satisficing."
H1d: The greater the control focus of the strategic manufacturing planning system, the greater the PSS.	When coupled with other aspects of "rational adaptive" planning, a positive relationship exists between control focus and PSS.	Strategic manufacturing planning should be linked to financial planning and variances between planned actions and outcomes should be monitored.
H1e: The greater the intensity of the strategic manufacturing planning system, the greater the PSS.	When coupled with other aspects of "rational adaptive" planning, a positive relationship exists between intensity and PSS.	Review and evaluation of the strategic manufacturing plan should occur on a continuous or frequent basis through face-to-face meetings.
H1f: There will be a positive relationship between participation in the strategic manufacturing planning process and PSS.	When coupled with other aspects of "rational adaptive" planning, a positive relationship exists between participation and PSS.	Input from diverse interests both inside and outside of manufacturing should be involved in strategic manufacturing planning.
H1g: A positive relationship will exist between strategic manufacturing planning horizon and PSS.	When coupled with other aspects of "rational adaptive" planning, a positive relationship exists between the length of the planning horizon and PSS.	Future consequences of strategic manufacturing decisions should be evaluated through a long look into the future.

LIMITATIONS, CONTRIBUTIONS, AND FUTURE RESEARCH DIRECTIONS

There are certain limitations in this study that need to be recognized. First, as is common with survey-based research, we rely on a single respondent from each organization in testing the hypotheses. However, we did assess interrater agreement by comparing the responses of the original respondent with those of an individual the original respondent considered equally knowledgeable. Second, measure refinement and validation, and hypothesis testing were conducted using the same sample. Although not ideal, this situation is commonly faced given the sample size needed for both steps and the difficulty in obtaining such large samples (e.g., Narasimhan & Das, 1999; Ward, Duray, Leong, & Sum, 1995). However, item deletion was done only in cases where a theoretical reason could be identified. We believe that the measures provide an important first step in the measurement of SMP system characteristics and their outcomes, and can be further refined in future research.

An important contribution of this study is that it furthers our initial understanding of the manufacturing strategy process by introducing commonly accepted planning system characteristics and PSS dimensions into the SMP literature. Despite calls for more research in this area, the characteristics of the SMP process included in prior research were few and inconsistent, and the effectiveness of different planning approaches was assessed on a very limited basis. Planning characteristics and effectiveness constructs from the strategic management and information systems fields proved to be appropriate in the manufacturing strategy area. Future research in this area could replicate these dimensions and build on them by identifying other dimensions important to the manufacturing strategy process. For example, the concept of planning intensity might be expanded to reflect the importance of information and information technology in the planning process by including a variable such as "planning information intensity." Or, the integration of SMP with tactical planning may be examined. Such characteristics might improve the fit of the model but, more importantly, may indicate managerial interventions that could improve the planning process.

Given that this research is an extension of research conducted in other fields, it is important to identify similarities and differences between findings in those fields and the manufacturing area. The most important similarity has already been discussed, which is the support for a "rational adaptive" approach in developing the manufacturing strategy. Our findings are similar to those in other fields that differ from manufacturing strategy in the scope and level of the strategic planning. However, there are several differences that should be noted. First, this study includes the dimension of the planning horizon, which was not included in work by Segars et al. (1998). Again, this was expected to be an important aspect of the manufacturing strategy process given the long-term nature of many of the decisions. And, this was supported via the strong path loading in both the direct and second-order factor models. In addition, a top-down planning flow was expected to be more beneficial. However, as discussed previously, our findings show that a bottom-up approach is associated with the "rational adaptive" approach, which leads to greater planning effectiveness.

Although this research has begun to increase our understanding of the SMP process, much can still be learned. Beyond replicating the planning system design and success dimensions, aspects of the manufacturing environment that may be related to how SMP is done should be identified and examined. For example, sources of complexity and/or dynamism, the degree of flexibility, or product sophistication may be important characteristics of the manufacturing context affecting the effectiveness of the "rational adaptive" approach. Research in strategic management has supported both the traditional view that a more rational approach is not feasible or effective in more uncertain environments (e.g., Fredrickson, 1984; Mintzberg, 1990), and the more current view that a more rational approach is necessary in such environments because it provides structure (e.g., Ansoff, 1991; Dean & Sharfman, 1993). Further research may reveal which view prevails in manufacturing, as well as characteristics of organizational structure or technological advances that could assist practitioners in effectively using a rational SMP system in a variety of environments.

Finally, it is useful to note that while enhanced business performance is the reason given for strategic planning, it is only an indirect result of the planning process used. The broader framework of planning should include manufacturing strategy content (the outcome of the process), PSS, implementation of the strategic decision, and business performance. For instance, Premkumar and King (1991) discussed some of these relationships in the IS domain, proposing links between the planning process, planning output (the plan), and planning outcome (result of having developed and implemented the plan). Similar studies in the manufacturing domain provide opportunities for future researchers to examine a broader set of interrelated constructs in studying the relationship between strategic manufacturing planning and business performance. Only then will strong prescriptive implications of this stream of work emerge. [Received: September 11, 1999. Accepted: February 11, 2002.]

REFERENCES

Adam, E. E., Jr., & Swamidass, P. M. (1989). Assessing operations management form a strategic perspective. *Journal of Operations Management*, *15*(2), 181-203.

Anderson, J. C. (1987). An approach for confirmatory measurement and structural equation modeling of organizational properties. *Management Science, 33*, 525-541.

Anderson, J. C., Cleveland, G., & Schroeder, R. G. (1989). Operations strategy: A literature review. *Journal of Operations Management, 8*(2), 133-158.

Anderson, J. C., Schroeder, R. G., & Cleveland, G. (1991). The process of manufacturing strategy: Some empirical observations and conclusions. *International Journal of Operations and Production Management, 11*(3), 86-110.

Ansoff, H. I. (1991). Critique of Henry Mintzberg's 'The design school: Reconsidering the basic premises of strategic management.' *Strategic Management Journal, 12*, 449-461.

Armstrong, J. S. (1982). The value of formal planning for strategic decisions: Review of empirical research. *Strategic Management Journal, 3*, 197-211.

Blenkinsop, S. A., & Duberley, J. P. (1992). Formulating strategy: A POM perspective. In R. H. Hoolier, S. J. Boaden & S. J. New (Eds.), *International operations: Crossing borders in manufacturing service*. New York: New Holland.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen & J. S. Long (Eds.), *Testing structural equation models*. Newbury Park, CA: Sage.

Cameron, K. S., & Whetten, D. A. (1983). Some conclusions about organizational effectiveness. In K. S. Cameron & D. A. Whetten (Eds.), *Organizational effectiveness: A comparison of multiple methods*. New York: Academic Press.

Camillus, J. C. (1982). Reconciling logical incrementalism and synoptic formalism: An integrated approach to designing strategic planning processes. *Strategic Management Journal, 3*, 277-283.

Chakravarthy, B. S. (1987). On tailoring a strategic planning system to its context: Some empirical evidence. *Strategic Management Journal, 8*, 517-534.

Chau, P. Y. K. (1997). Reexamining a model for evaluating information center success using a structural equation modeling approach. *Decision Sciences, 28*(2), 309-334.

Cleveland, G., Schroeder, R. G., & Anderson, J. C. (1989). A theory of production competence. *Decision Sciences, 20*(4), 655-668.

Crowe, T. J., & Cheng, C-C. (1996). Using quality function deployment in manufacturing strategic planning. *International Journal of Operations and Production Management, 16*(4), 35-48.

Das, S. R., Zahra, S. A., & Warkentin, M. E. (1991). Integrating the content and process of strategic MIS planning with competitive strategy. *Decision Sciences, 22*(5), 953-984.

Dean, J. W., & Sharfman, M. P. (1993). The relationship between procedural rationality and political behavior in strategic decision-making. *Decision Sciences, 24*(6), 1069-1084.

Dutton, J. E., & Duncan, R. B. (1987). The influence of the strategic planning process on strategic change. *Strategic Management Journal, 8*, 103-116.

Dyson, R. G., & Foster, M. J. (1982). The relationship of participation and effectiveness in strategic planning. *Strategic Management Journal, 3*, 77-88.

Fine, C. H., & Hax, A. C. (1985). Manufacturing strategy: A methodology and an illustration. *Interfaces, 15*(6), 28-46.

Fredrickson, J. W. (1984). The comprehensiveness of strategic decision processes: Extension, observations, future directions. *Academy of Management Journal, 27*(3), 445-466.

Fredrickson, J. W., & Mitchell, T. R. (1984). Strategic decision processes: Comprehensiveness and performance in an industry with an unstable environment. *Academy of Management Journal, 27*(2), 399-423.

Marucheck, A., Pannesi, R., & Anderson, C. (1990). An exploratory study of the manufacturing strategy process in practice. *Journal of Operations Management, 9*(1), 101-123.

Menda, R., & Dilts, D. (1997). The manufacturing strategy formulation process: Linking multifunctional viewpoints. *Journal of Operations Management, 15*(4), 223-241.

Miller, C. C., & Cardinal, L. B. (1994). Strategic planning and firm performance: A synthesis of more than two decades of research. *Academy of Management Journal, 37*(6), 1649-1665.

Miller, J. G., & Roth, A. V. (1994). A taxonomy of manufacturing strategies. *Management Science, 40*(3), 285-304.

Mills, J., Platts, D., & Gregory, M. (1995). A framework for the design of manufacturing strategy processes: A contingency approach. *International Journal of Operations and Production Management, 15*(4), 17-49.

Mintzberg, H. (1990). Strategy formation: Schools of thought. In J. W. Fredrickson (Ed.), *Perspectives on strategic management.* New York: Harper Business.

Narasimhan, R., & Das, A. (1999). An empirical investigation of the contribution of strategic sourcing to manufacturing flexibilities and performance. *Decision Sciences, 30*(3), 683-718.

Pearce, J. A., Freeman, E. B., & Robinson, R. B. (1987). The tenuous link between formal strategic planning and financial performance. *Academy of Management Review, 12*(4), 658-675.

Persson, I. (1991). Developing a manufacturing strategy within a capital-investment process: A case study. *International Journal of Operations and Production Management, 11*(3), 32-42.

Platts, K. W. (1994). Characteristics of methodologies for manufacturing strategy formulation. *Computer Integrated Manufacturing System, 7*(2), 93-99.

Platts, K. W., & Gregory, M. J. (1990). Manufacturing audit in the process of strategy formulation. *International Journal of Operations and Production Management, 10*(9), 5-26.

Premkumar, G., & King, W. R. (1991). Assessing strategic information systems planning. *Long Range Planning, 24*, 41-58.

Premkumar, G., & King, W. R. (1994). The evaluation of strategic information system planning. *Information & Management, 26*, 327-340.

Raghunathan, B., & Raghunathan, T. S. (1994). Adaptation of a planning system success model to information systems planning. *Information Systems Research, 5*(3), 326-340.

Ramanujam, V., & Venkatraman, N. (1987). Planning system characteristics and planning effectiveness. *Strategic Management Journal, 8*, 453-468.

Ramanujam, V., Venkatraman, N., & Camillus, J. C. (1986). Multi-objective assessment of effectiveness of strategic planning: A discriminant analysis approach. *Academy of Management Journal, 29*(2), 347-372.

Safizadeh, M. H., Ritzman, L. P., Sharma, D., & Wood, C. (1996). An empirical analysis of the product-process matrix. *Management Science, 42*(11), 1576-1591.

Schroeder, R. G., Anderson, J. C., & Cleveland, G. (1986). The content of manufacturing strategy: An empirical study. *Journal of Operations Management, 6*(4), 405-415.

Schroeder, R. G., & Lahr, T. N. (1990). Development of manufacturing strategy: A proven process. In J. E. Ettlie, M. C. Burstein, & A. Fiegenbaum (Eds.), *Manufacturing strategy: The research agenda for the next decade.* London: Kluwer Academic.

Segars, A. H. (1997). Assessing the unidimensionality of measurement: A paradigm and illustration within the context of information systems research. *OMEGA, 25*(1), 107-121.

Segars, A. H., & Grover, V. (1993). Re-examining perceived ease of use and usefulness: A confirmatory factor analysis. *MIS Quarterly, 17*(4), 517-525.

Segars, A. H., & Grover, V. (1998). Strategic information systems planning success: An investigation of the construct and its measurement. *MIS Quarterly, 22*(2), 139-164.

Segars, A. H., Grover, V., & Teng, J. T. C. (1998). Strategic information systems planning: Planning system dimensions, internal coalignment and implications for planning effectiveness. *Decision Sciences, 29*(2), 303-345.

Sharma, S. (1996). *Applied multivariate techniques*. New York: John Wiley & Sons.

Skinner, W. (1969). Manufacturing—Missing link in corporate strategy. *Harvard Business Review,* May-June, 156-167.

Steiner, G. A. (1979). *Strategic planning: What every manager must know.* New York: The Free Press.

Tunalv, C. (1990). Manufacturing strategies and decentralization. *International Journal of Operations and Production Management, 10*(2), 107-119.

Venkatraman, N. (1990). The concept of fit in strategy research: Toward verbal and statistical correspondence. *Academy of Management Review, 14*(3), 423-444.

Vickery, S. K., Dröge, C., & Markland, R. E. (1993). Production competence and business strategy: Do they affect business performance? *Decision Sciences, 24*(2), 435-455.

Voss, C. A. (1992). Manufacturing strategy formulation as a process. In C. A. Voss (Ed.), *Manufacturing strategy: Process and content.* London: Chapman & Hall.

Ward, P. T., Duray, R., Leong, G. K., & Sum, C. C. (1995). Business environment, operations strategy, and performance: An empirical study of Singapore manufacturers. *Journal of Operations Management, 13*, 99-115.

Ward, P. T., Leong, G. K., & Boyer, K. K. (1994). Manufacturing proactiveness and performance. *Decision Sciences, 25*(3), 337-358.

Wood, D. R., & LaForge, R. L. (1981). Toward the development of a planning scale: An example from the banking industry. *Strategic Management Journal, 2*, 209-216.

APPENDIX: MEASUREMENT OF RESEARCH CONSTRUCTS

Planning System Design Characteristics: 7-point scales with endpoints *strongly disagree* and *strongly agree*

Please indicate the extent to which you agree or disagree with the following statements pertaining to strategic manufacturing planning (SMP) in your firm.

Flow (FL) [a] (composite reliability = .71; r_{WG} = .60)

1. Strategic manufacturing planning is initiated at the highest levels.[b]
2. The planning flow within our organization can be characterized as "top down." (.29)[e]
3. Planning for manufacturing is initiated by requests/proposals from line managers.[d] (.24)
4. The extent of bottom-up initiation is high. [c, d] (.92)
5. The primary role of upper management is to endorse rather than formulate SMP.[d] (.23)

Formality (FR) [a] (composite reliability = .77; r_{WG} = .63)

1. Policies and procedures greatly influence the process of SMP within our firm. (.20)
2. Our process of strategic manufacturing planning is very structured. (.53)
3. Written guidelines exist to structure SMP in our firm. [c] (.64)
4. The process and outputs of strategic manufacturing planning are formally documented. (.47)

Comprehensiveness (C) [a] (composite reliability = .81; r_{WG} = .70)

1. We attempt to be exhaustive in gathering information relevant for SMP.[b]
2. Before a decision is made, each possible course of action is thoroughly evaluated. [c] (.59)
3. We attempt to determine optimal courses of action from identified alternatives. (.60)
4. We will delay decisions until we are sure that all alternatives have been evaluated. (.50)

Focus (CR) [a] (composite reliability = .75; r_{WG} = .66)

1. In our SMP process we encourage control over creativity and idea generation.[b]

2. Control systems are utilized to monitor variances between planning actions and outcomes. (.32)
3. Our SMP is tightly integrated with the firm's financial planning routine.[c] (.68)
4. The manufacturing strategy process is tied to the annual budgeting process. (.51)

Participation (P)[a] (composite reliability = .79; r_{WG} = .70)

1. Our process for SMP includes numerous participants.[c] (.63)
2. SMP is a relatively isolated organizational activity.[d] (.32)
3. The participation of specialists in SMP is high.[b]
4. Line managers and staff are involved in the SMP process. (.45)
5. The level of participation in SMP by diverse interests in the manufacturing function is high. (.49)

Intensity (I)[a] (composite reliability = .84; r_{WG} = .63)

1. We constantly evaluate and review strategic plans.[c] (.75)
2. We frequently adjust strategic plans to better adapt them to changing conditions. (.61)
3. Strategic manufacturing planning is a continuous process. (.42)
4. We frequently schedule face-to-face meetings to discuss strategic planning issues. (.52)

Horizon (H) (composite reliability = .70; r_{WG} = .64)

1. The length of the planning horizon is short.[d] (.25)
2. In SMP, attempts are made to consider implications far into the future.[c] (.42)
3. Our planning horizon is fairly long, covering periods of five years or more. (.52)

Objective measure: What is the time horizon of your firm's strategic manufacturing planning?

[a]This scale has been borrowed and/or adapted from prior research
[b]This item was dropped from the scale following refinement
[c]This item was constrained in the causal models to establish scale metric
[d]This item is reverse coded
[e]Item reliability for items retained in the final measure in parenthesis

Planning System Success

Indicate the extent of fulfillment of the following planning objectives for your firm.

Objective Fulfillment (OBJ)[a] (composite reliability = .79; r_{WG} = .82) 7-point scales with endpoints *entirely unfulfilled* to *entirely fulfilled* in response to:

1. Enhancing management development. (.49)
2. Predicting future trends. [c] (.52)
3. Short-term performance. (.13)
4. Long-term performance. (.52)
5. Evaluating alternatives based on more relevant information. (.44)
6. Avoiding problem areas. (.28)

Strategy Alignment (AL)[a] (composite reliability = .90; r_{WG} = .87) 7-point scales with endpoints *entirely unfulfilled* to *entirely fulfilled* in response to:

1. Understanding the strategic priorities of top management. (.62)
2. Adapting goals/objectives of manufacturing to the changing goals/objectives of the firm. (.77)
3. Maintaining a mutual understanding with top management on the role of the manufacturing function in supporting organizational strategy. [c] (.81)
4. Identifying manufacturing-related opportunities to support the strategic direction of the firm. (.56)
5. Educating top management on the importance of manufacturing.[b]
6. Adapting manufacturing technology to strategic change.[b]
7. Assessing the strategic importance of new manufacturing technologies.[b]

Please indicate the degree of improvement or deterioration experiences with respect to the Strategic Manufacturing Planning (SMP) system in your firm.

Capability Improvement (CAP)[a] (composite reliability = .87; r_{WG} = .74) 7-point scales with endpoints *much deterioration* to *much improvement* in response to:

1. Ability to anticipate surprises and crises. (.52)
2. Flexibility to adapt to unanticipated changes. (.44)
3. Ability to identify new business opportunities. (.40)
4. Ability to identify key problem areas. (.52)
5. Ability to enhance the generation of new ideas. (.60)
6. Ability to foster organizational learning. [c] (.57)
7. Ability to foster management control. (.37)

[a]This scale has been borrowed and/or adapted from prior research
[b]This item was dropped from the scale following refinement
[c]This item was constrained in the causal models to establish scale metric
[d]This item is reverse coded
[e]Item reliability for items retained in the final measure in parenthesis

Karen E. Papke-Shields is an assistant professor of information and decision sciences at Salisbury University. She received her PhD in production and operations management from the University of South Carolina. Her teaching and research interests include operations strategy, strategic manufacturing planning, alignment of the business and operations strategy, ERP implementation, and business process reengineering. She has published in *Journal of Operations Management* and *Production and Inventory Management Journal,* and is a member of the Decision Sciences Institute, POMS, APICS, and INFORMS.

Manoj K. Malhotra is Business Partnership Foundation Fellow, Professor, and Chairman of the Management Science Department at the Moore School of Business, University of South Carolina (USC), Columbia. He holds an engineering undergraduate degree from The Indian Institute of Technology (IIT) Kanpur, India, and a PhD in operations management from The Ohio State University. He is certified as a Fellow of the American Production and Inventory Management Society (CFPIM). His research has thematically focused on the deployment of flexible resources in manufacturing and service firms. He has published articles in *Decision Sciences*, *European Journal of Operational Research*, *IIE Transactions, International Journal of Production Research*, *Journal of Operations Management,* and *Production and Operations Management Journal,* among others. Dr. Malhotra is an area editor for *POMS Journal*, an associate editor of *Journal of Operations Management*, and an editorial review board member of *Journal of Managerial Decision-Making*. He is also an active referee for several other journals in the field, and has served as the special focus co-editor for issues of *Decision Sciences* (1999) and *Journal of Operations Management* (2002). He is a member of POMS and the Mid-Carolina chapter of APICS, and an instructor of professional level CPIM certification.

Varun Grover is the William S. Lee Distinguished Professor of Information Systems in the Department of Management at Clemson University. He holds a B.Tech. in electrical engineering from the Indian Institute of Technology, New Delhi, an MBA from SIUC, and a PhD degree in MIS from the University of Pittsburgh. Before coming to Clemson, Dr. Grover was on the faculty of the University of South Carolina's Moore School of Business for 12 years, where he was a professor of information systems and Business Partnership Foundation Fellow, and also held the title of Distinguished Researcher. Dr. Grover has published extensively in the information systems field on business reengineering, electronic commerce, strategic and inter-organizational systems, and the organizational impacts of information technologies. He is a recipient of the Outstanding Achievement Award from the Decision Sciences Institute, and has also received recognitions for his research from PriceWaterhouse Coopers, AIS and Anbar Intelligence. During his tenure at the Moore School of Business at USC, Dr. Grover won numerous teaching awards and participated in courses/seminars in Austria, the Dominican Republic, India, and Canada. He is an active member of AIS, the Decision Sciences Institute, INFORMS and ACM.