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Configurations in Manufacturing Strategy: A Citation/Co-Citation Analysis

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Abstract:
Configuration models have generated a great deal of interest in the business strategy area, as witnessed by a special issue in The Academy of Management Journal Meyer et al., 1993.. Despite this, there has been no effort to examine the current state or future role of configurational research in the manufacturing strategy area. This paper attempts to fill this gap. The first half positions configurations as a unique way of studying strategic fit issues. The second half of the paper examines the current state of configurational research in the manufacturing strategy area. We compare and contrast existing typologies and taxonomies, identify trends, and highlight possible gaps in the literature. Finally, we discuss how configuration models can play an important role in the study of dynamic manufacturing issues; specifically, the develop- ment, implementation, and change of manufacturing strategies.

Keywords: *Manufacturing strategy configurations, Typologies, Taxonomies*

1. Introduction

While reviewing the status of manufacturing strategy theory and practice used in Skinner 1996. notes the difficulties manufacturers face in actually implementing a particular manufacturing task: Conceptually, the problem is to design a system to do a job, that job being defined by tradeoff choices. There are about fifty design variables and perhaps a menu of choices of about 60. But there is no handbook. He goes on to suggest that academicians should address this problem by ‘‘ boiling” the manufacturing tasks list down to about a dozen ‘generic’ tasks’’ and then addressing major decisions or choices within each type (Skinner, 1996).

Skinner’s call for detailed descriptions of manufacturing systems tied to generic tasks highlights just one potential use of configurations (Miller and Friesen 1984). Define configurations as ‘‘commonly occurring clusters of attributes or relationships that are internally cohesive’’, while Meyer et al. 1993. Describe them as ‘‘any multidimensional constellation of conceptually distinct characteristics that commonly occur together’’. The distinguishing characteristic of configuration models is the multidimensional profiles used to de- scribe organizational, strategy, or process types. The pedagogical and theoretical power of configurations are evidenced by the typology of strategic types of miles and Snow 1978. The generic strategies of Porter 1980 and the manufacturing strategy. Literature by the three strategy groups of Miller and Roth 1994 and the generic manufacturing types of Hill 1994.

The paper is divided into two parts. The first half positions configurations as a unique way of studying strategic fit issues. We start by reviewing the concepts of fit and equifinality, and the potential advantages of configurations in studying these issues. We then distinguish between two types of configuration models, taxonomies and typologies, using examples from both the business strategy and manufacturing strategy areas. We turn to the business strategy literature to understand the current state of methodological development in configurational research.

The second half of the paper examines the status of configurational research in the manufacturing strategy area. Our purpose here is to gain a better understanding of how existing works fit within the configuration perspective. We compare and contrast existing typologies and taxonomies, identify trends, and highlight possible gaps in the literature. Finally, we discuss how configuration models can play an important role in the study of dynamic manufacturing issues; specifically, the development, implementation, and change of manufacturing strategies.

2. Background

To understand the usefulness of configurations, it is first necessary to review the concepts of strategic fit and equifinality. Researchers have long distinguished between environmental *fit and* internal *fit* Miller, 1992; Lawrence and Lorsch, 1967; Thompson, 1967. According to Miller 1992, the concept of environmental fit ‘‘demands that organizations match their structures and processes to their external settings’’, while internal fit centers on the development of organizational structures and processes that are ‘‘internal complementarities''. Both environmental and internal fit are seen as central to organizational effectiveness, yet they can conflict with one another, as when efforts to maintain environmental fit prevent or destroy internal complementarities, or when the emphasis on internal consistency detracts managers from changes outside the organization The distinction between environmental fit and internal fit is shared, if not explicitly, by the manufacturing strategy literature, with works addressing environmental fit Skinner, 1969; Schroeder et al., 1986; Kotha and Orne, 1989; Beckman et al., 1990. Miller and Roth, 1994., and internal fit skinner 1974; Hill and Duke-Woolley, 1983; Schmenner, 1983.. In fact, one could argue that manufacturing strategies are useful only to the extent that they either improve the congruence between operations and its environment customers, other functional areas, etc.., or lead to greater consistency among the elements which define operations.

Kotha and Ornel 1989 and Miller and Rohth 1994 are representative of works addressing environmental fit issues for manufacturers. The focus of their research is on identifying overall manufacturing strategies and relating them to business unit or corporate requirements. Skinner 1974, Hill and Duke- Woolley 1983 and Schmenner 1983 deal with the issue of internal fit among the elements which define a manufacturing unit. To analyze internal fit, one must consider simultaneous, complex interactions among a wide range of interdependent variables within a unit, such as process choices, work force skills, planning and control systems, and other infrastructure variables. Where these elements 'fit together', as in the descriptions of Hill 1994 and the ideal job shop or line, the plant is said to have strong internal fit.

Equifinality Katz and Kahn, 1978; van de Ven and Drazin, 1985; Doty et al., 1993. Take the concept of fit a step further. The equifinality argument states that there are multiple, equally effective ways in which an organization can achieve environmental or internal fit van de Ven and Drazin, 1985. These alternatives typically are represented as patterns of context and structure' Katz and Kahn, 1978.. Furthermore, the set of viable patterns might be contingent on the contextual factors facing an organization Doty et al., 1993. The importance of strategic fit and equifinality has led to multiple ways of framing and testing the concepts. Venkatraman 1989 identifies six perspectives of strategic fit: fit as moderation, mediation, matching, co-variation, typologies, and gestalts taxonomies. Each perspective proposes different relationships between the variables of interest, and hence, modeling forms. In the two most commonly modeled perspectives, moderation and mediation, the functional relationship between two or a few variables of interest is highly specified, usually modeled as linear, and tested within the context of a particular criterion, such as return on investment or market share Arnold, 1982; Venkatraman, 1989. The assumption is that relation- ships between components can be viewed in isolation and that these relationships ''hold true irrespective of the nature of the organization'' Miller and Friesen, 1984.

Moderating and mediating models have been criticized due to the limited number of variables which can be analyzed at any one time and assumptions of linearity driven more by the statistical techniques than by theory miller 1981. Miller and Friesen 1984, Doty and Glick, 1994, when a theory is described in terms of multidimensional types—as in the cases of Miles and Snow 1978 and Miller and Roth 1994 moderating or mediating models may be wholly unsuited. Configuration models were developed in response to these limitations Venkatraman 1989, Miller 1981, 1996; Hinings and Greenwood, 1988 and Meyer et al, 1993. First, the configuration view asserts that organizations are best viewed as a *holistic synthesis* of multiple, interdependent characteristics. Miller 1996, note that configurations are particularly useful when the research goal is to determine dominant patterns in organizations, or when the relationships between individual variables are either ill-understood or too complex to be modeled using traditional approaches.

Second, the configuration perspective typically argues that there are a limited number of viable strategies, organization types, manufacturing tasks, etc., in a given situation Miller and Friesen 1984 and Miller 1986. This combination of parsimony and equifinality has made configuration models popular for both pedagogical and research purposes Miles and Snow, 1978; Mintzberg, 1984; Porter, 1980. It also makes configurations particularly well-suited to evaluating equifinality arguments Doty et al, 1993. Good typologies have three other characteristics. First, typologies should provide a generalizable, grand theory and middle-range theories applicable to individual types Doty and Glick, 1994. To illustrate, the implicit grand theory of process choice put forth by Hill 1994 is that manufacturing performance is optimized when 1. The manufacturing process is aligned with market requirements environ- mental fit, and 2. The elements which define the manufacturing organization are mutually supportive internal fit. Hill also outlines middle-range theory for five generic process types, suggesting the type of product, rate of new production introduction, order- winners, etc., appropriate to each.

	Typologies	Taxonomy
Definition	Multidimensional models of ideal types.	Classification systems that categorize phenomena into mutually exclusive and exhaustive sets.
Desired characteristics	Provide a generalizable grand theory and middle range theories applicable to individual types. Specify the individual dimensions that define the types. Empirically testable.	Classifying variables carefully selected based on existing theory and the task at hand. Groupings relatively unaffected by classification techniques or sample. Generate insight or advance a predictive task.
Key empirical test	Does greater alignment between an organization and a defined ideal type result in greater organizational effectiveness?	Are the proposed groups stable across techniques and sample data?
Selected works	Doty et al. 1993.; Richardson et al. 1985.; Kotha and Vadlamani 1995.	Miller and Roth 1994.; Ketchen and Shook 1996.

Table 1: A comparison of typologies and taxonomies

Second, good typologies specify the ‘‘unidimen- sional constructs that are the building blocks of traditional theoretical statements’’ Miller, 1996. For example, Hill 1994. Lists 25 dimensions level of capital investment, product volumes, key manufacturing task, etc. used to define ideal manufacturing types. Not only should the *importance* of these dimensions be established Bozarth and Berry, 1997, but research questions could be generated concerning the appropriate *values* for these dimensions across the various manufacturing types.

Finally, good typologies qualify as theoretical statements because the underlying hypotheses are empirically testable. Doty et al. 1993, Richardson et al. 1985, and Kotha and Vadlamani 1995 demonstrate this process. Doty et al. 1993 start by identifying 15 attributes which they use to define the four ideal types of Miles and Snow 1978. They go on to test four distinct models of internal fit, where ‘fit’ is based as the deviation between an organization’s attribute scores and those of an ideal or hybrid type Venkatraman, 1989. The results validate Miles and Snow’s typology by showing that less deviation between organizations and the proposed ideal types has a significant, positive impact on organizational effectiveness. Richardson et al. 1985 provide an analogous test for a typology of Canadian electronics firms. Using survey data from top managers at 160 manufacturers, Kotha and Vadlamani 1995 employ confirmatory factor analysis to show that 22 competitive methods new product development, operating efficiency, etc.. load in patterns supportive of the six generic strategies of Mintzberg 1988. While not as powerful a test as those of Doty et al. 1993.

The above works point out a common misconcep- tion about taxonomies and typologies; namely, that taxonomies are ‘empirical’ while typologies are ‘conceptual’. We concur with Meyer et al. 1993 who argue that ‘‘all useful typologies . . . are grounded in empirical experience’’. We would take it a step further, and suggest that a typology is not fully developed until it has been empirically validated. Unlike typologies, taxonomies do not define ‘ideal’ types. Rather, they attempt to classify organizations into mutually exclusive and exhaustive groups. Doty and Glick, 1994; McKelvey, 1982. Wheel-wright and Hayes 1985, for example, divide manufacturers into four stages based on manufacturing’s degree of participation in strategy formulation. Only in the final two stages does manufacturing achieve a high degree of environmental fit.

Arguably, the most important decision in developing a taxonomy centers around the choice of vari- ables used to classify organizations Miller, 1996; Ketchen and Shook, 1996. These variables must be carefully selected based on existing theory and the task at hand. Otherwise, taxonomy can be seen as ‘data dredging’ and may simply be an artifact of the data available. Miller 1996 for instance, laments the plethora taxonomies are based on an ‘arbitrary and narrow’ set of variables. He points out that ‘‘the utility of any classification scheme rely on its ability to generate insight or to advance a predictive task’’.

Good taxonomies also are relatively unaffected by the techniques or sample data used to create them. Researchers can address this issue by using alternative techniques and holdout samples when possible Punj and Stewart, 1983; Ketchen and Shook, 1996. Finally, it is important to realize that, while taxonomies often are derived using clustering or other multivariate techniques, they can be based on observation as well Woodward, 1965; Wheelwright and Hayes, 1985. It is the descriptive power of taxonomy, more so than the methods used to derive it that is important Miller, 1996.

3. Manufacturing Strategies

Despite the strong interest in configurational research in the business strategy area Meyer et al 1993; Miller, 1996, there has been no effort to examine the current state or future role of configuration models in the manufacturing strategy area. In this section, we review the status of configurational research in the manufacturing strategy area. Table 2 shows the existing models are divided into three taxonomies and five typologies. Six of the eight models describe strategy types, while two Hayes and Wheelwright, 1979, 1984; Hill, 1994 define manufacturing process types. Consistent with the earlier sections, we differentiate between taxonomies and typologies based on whether a model presents a classification scheme for existing organizations or identifies a set of ideal types Doty and Glick, 1994.

This survey indicates fewer configurations models in the manufacturing strategy area than might be expected. The reasons for this are twofold. First, the vast majority of works in the area tend to focus on highly-specified relationships between a few key constructs, such as quality-related efforts and organizational context Benson et al., 1991 business environment and performance Ward et al., 1995b, and advanced manufacturing technologies and organizational culture Zammuto and O’Connor, 1992., to name a few. While these works provide the essential building blocks needed to create taxonomies and typologies, they do not purport to give comprehensive, multidimensional descriptions of idealized types, nor do they seek to provide a comprehensive classification scheme. Second, our review does not address typologies and taxonomies developed for other operations decision areas, such as services Chase and Hayes, 1991; Roth and Jackson, 1995 and purchasing Monczka and Trent, 1991. Rather, we concentrate our analysis on manufacturing based configurations in order to identify trends, areas of overlap, and potential directions for future research.

Wheelwright and Hayes 198 represent early efforts to develop configuration models addressing strategic fit in manufacturing. The work of Wheelwright and Hayes 1985 is unique in that it is the only configuration model to focus on the manufacturing strategy process. The authors classify manufacturers into four types, based on the degree to which manufacturing participates in the business’ overall strategy process. The service related model put forth by Chase and Hayes 1991. is based in large part on the framework introduced there. Miller and Roth 1994 note the similarities be- tween their empirically-derived taxonomy and the untested taxonomy proposed by Stobaugh and Telesio 1983. Miller and Roth’s clustering of 164 large American manufacturers across eleven competitive priorities revealed three main manufacturing strategy types, which the authors labeled caretakers, marketeers, and innovators. The authors show that these types differ with regard to the improvement programs emphasized lead time reduction, new processor products and the importance placed on various performance results. They also compare their strategic types across market characteristics, noting that the three types differ in their ‘‘ability to differentiate themselves from competition with their products and services, and the scope of their product lines and markets’’ Miller and Roth, 1994.

Richardson et al 1985 propose and empirically test a typology describing the fit between the manufacturing task, corporate mission, and performance. Their work is the only one to introduce and test empirically a typology, albeit an industry-specific one. The authors developed six distinct corporate mission profiles and four manufacturing task profiles using thirteen and nine dimensions, respectively. Using the term focus to refer to ‘‘the extent to which attention is paid to the most important variables’’ Richardson et al. 1985 measure cooperate focus CFOCUS and plant focus PFOCUS as the deviation between the respondent’s expressed importance scores and those of the closest fitting mission or task’’. A final measure of fit CHIGH, scored 0 or 1 was calculated based on the perceived match between each pair of corporate mission and manufacturing task profile. Kotha and Orne 1989 present a typology which attempts to link conceptually business strategies and manufacturing strategies at the SBU level, using concepts first proposed by Porter 1980. Their model proposes eight generic manufacturing strategies based on high/low combinations of process structure complexity, product line complexity, and organizational structure. Kotha and Orne’s model can best be described as fit by matching, since performance benefits are not considered explicitly Venkatraman 1989 Consistent with the concept of equifinality, the authors argue that any one of the generic manufacturing strategies can be successful, provided it matches and is supportive of the business strategy. Empirical validation is mentioned as a direction for future research.

The most recent manufacturing strategy typology addressing environmental fit is provided by Ward et al. 1995c. Their model attempts to describe commonly used paths to competitive advantage for manufacturers, and is notable for its deliberate integration of models and measurements from the business strategy and organization theory literature. Specifically, Ward et al.’s configuration model describes manufacturing organizations across four areas: competitive strategy, environment, structure and strategic manufacturing capabilities. The authors use the work of Dess and Beard 1984 on organizational task environments to define the competitive strategy and environmental dimensions, and the model of Miller 1986 on organizational structure to define the structural dimensions. Hayes and Wheelwright 1979 Hayes and wheelwright 1984 and hill 1994. Hayes and Wheelwright 1979 identify four major process types: job shop, batch, assembly line and continuous flow. The authors even list eight manufacturing decision categories that could be used to describe these types, including ‘organization and production planning/materials control’ Hayes and Wheelwright, 1984. However, they fall short of using these categories to develop detailed, internally consistent, descriptions of the major process types. In fact, researchers seeking to empirically test the product–process matrix Safiza deh et al., 1996; McDermott et al., 1997 depended more on Hill 1994 to define process types. Hill 1994 describes five generic process types across 25 dimensions intended to capture product and market requirements, manufacturing characteristics, investment and cost issues, and infrastructure choices. We classify Hill’s model as a typology because the author offers ideal, albeit subjective, values for each of the dimensions across the five generic process types. As in Richardson et al. 1985 and Doty et al. 1993 internal fit can then be evaluated based on the degree to which a particular manufacturer deviates from an ideal type Venkatraman 1989.

When compared to earlier works, Ward et al. 1995a, Ward et al. 1995b, Ward et al. 1995c, Kotha and Orne 1989 and Miller and Roth 1994. Suggest a trend toward better integration of concepts, measurements, and methods across the business strategy and manufacturing strategy areas. The use of common constructs, measurements, and research methods is promising because it allows manufacturing strategy researchers to tap into tested measures and techniques, it provides for a common language between the business strategy and manufacturing strategy areas, and it ensures a broader audience for manufacturing-oriented configuration models.

Generally, it divides the existing manufacturing strategy taxonomies and typologies into empirically tested versus untested models. We consider a model ‘tested’ if the model has been subjected to detailed, rigorous empirical validation using recognized research methods Ketchen and Shook, 1996; Punj and Stewart, 1983; Venkatraman, 1989; Doty et al, 1993; Doty and Glick, 1994. As Fig. 1 shows only the manufacturing ideas of Richardson et al 1985, Miller and Roth 1994, Heys and weelwright 1979 and Hayes and Wheelwright 1984 have been subject to such testing. For example, used clustering techniques followed by canonical discriminant analysis to derive and then interpret their three cluster model, and compared the resulting strategy types across variables not used in the initial clustering effort.

The product process matrix of Hayes and Wheelwright 1979 has been tested by Safizadeh et al 1996 and McDermott et al 1997, who suggest that recent developments in technology and management practices are changing many of the tradeoffs associated with the matrix. However, neither work directly evaluates the underlying typology of manufacturing processes. The remaining models remain conceptual in nature, depending on some combination of personal observation, field research, and existing literature to support the model development.

At least three factors have contributed to the preponderance of untested configuration models. First, most of the older models Stobaugh and Tele- sio, 1983; Wheelwright and Hayes, 1985; and Hill 1994 which first appeared in 1988. Clearly were aimed at practitioners and those teaching manufacturing strategy. For whatever reasons, the authors did not follow up with empirical analysis, and the vagueness of some key concepts e.g performance made testing difficult. Newer typologies, such as those of Kotha and Orne 1989, Ward et al. 1995a ward et al 1995b and 1995c are noticeably tighter with regard to derivation and specificity of the underlying constructs and models.

A second factor has been the relative slowness of the manufacturing strategy discipline to adopt empirical research methods Flynn et al, 1990; Berry et al, 1991. Finally, as Ketchen and Shook 1996 and Doty et al 1993 Illustrate, there is still a great deal of development going on within the business strategy discipline itself concerning the appropriate methods for evaluating typologies and taxonomies.

Much confusion has arisen in the manufacturing strategy area due to the failure to carefully consider the level of analysis. For example, the concept of manufacturing focus is an inherently *plant-level* phenomenon Skinner, 1974, 1996. It emphasizes performance tradeoffs and the need to maintain internal fit between the product sets, processes, and infrastructures within a plant Skinner, 1974 and 1996. Schroeder and Pesch, 1994; Bozarth, 1993. It is not surprising then that manufacturing focus is a major part of the typology put forth by Hill 1994.. Plant focus becomes less relevant when the analysis shifts to the SBU, *multi-plant* level Kotha and Orne, 1989; Ward et al., 1995a,b,c; Stobaugh and Telesio 1983, Wheelwright and Hayes, 1985 Miller and Roth 1994. Here, the environmental fit between the overall manufacturing strategy, other functional areas, the environment, and/or business strategy is paramount. Researchers need to understand these differences in order to recognize the complementary nature of SBU- and plant-level configuration models.

As the above discussion suggests, the type of fit addressed by each model is closely associated with the level of analysis. Six of the eight configuration models deal primarily with environmental fit at the SBU/firm level and only Hill 1994. It deals with internal fit issues in any depth. Since both environmental and internal fit are important to developing and implementing manufacturing strategies, these raises a concern: will an overemphasis on SBU-level configurations cause researchers to overlook the plant-level issues which make manufacturing strategy distinct from business strategy?

4. Future Directions: The Dynamic Nature of Manufacturing Strategies

In this section, we consider that the role configuration research can play in addressing the dynamic nature of manufacturing strategy. In particular, we discuss about how configurations have been used to further our understanding of manufacturing strategy development, implementation, and change. A review of the manufacturing strategy literature suggests that works regarding the *content* of manufacturing strategy. What are the strategies, structures, technologies, etc., are best in a particular environment?. Outnumber those dealing with the *process* of manufacturing strategy How should firms go about developing and implementing manufacturing strategies? This is particularly true for configuration models, with Wheelwright and Hayes 1985 being the only one to offer any description of the manufacturing strategy process.

Despite calls for both process and content research Adam and Swamidass, 1989. Most of the research on manufacturing strategy development and implementation is still highly conceptual. For in- stance, Skinner 1985, Schmenner 1990, and Hill 1994 offer high-level models of the strategy development process, while Ferdows and DeMeyer 1990 and Hayes and Pisano 1996 discuss paths manufacturers can take in developing long-term capabilities. We are aware of only two empirically based works dealing with manufacturing strategy development Marucheck et al 1990 and Benningson 1996 both of which are based on the case study method. What is not been studied in any depth is the contingency aspects of manufacturing strategy development and implementation. For example, how is the manufacturing strategy development process affected by the organization structure, environment, or other elements? Is the quality-dependability–speed–cost progression of capabilities championed by Ferdows and DeMeyer 1990 applicable to all, or even most, manufacturers? Are there multiple, equally viable paths of capabilities development Hayes and Pisano 1996. Which could be captured in a configuration model? Just as current configuration models have helped define the content of manufacturing strategy, there are significant opportunities to develop and test configuration models dealing with strategy development and implementation.

Another area of growing interest is the movement of organizations *between* configuration states Greenwood and Hinings, 1993. Manufacturing examples would include the move from a marketeer to innovator strategy Miller and Roth, 1994, or from a job shop to batch manufacturing process Hill, 1994. As above, the emphasis on change shifts the focus from a content-oriented view of manufacturing strategy to a dynamic, process-oriented view. How and why do manufacturers move from one state to another? Typologies and taxonomies can be particularly advantageous in studying such changes. First, configuration models identify the *many* elements which together determine environmental or internal fit, and which must be changed if an organization is to go from one configuration state to another. Traditional moderating or mediating models do not provide this multidimensional perspective. Second, configuration models provide a mechanism by which researchers can measure the impact of environmental fit and internal fit on change. To illustrate these points, consider two examples relating environmental fit and internal fit to organizational change as follows.

Greenwood and Hinings 1993 hypothesized that business organizations are characterized by inertia; i.e., they will tend to remain within a particular configuration state unless prompted to change. One question this raises is, how poor does the environmental fit between the manufacturing and business strategies have to be before a manufacturer adopts a different manufacturing strategy? Works such as Kotha and Orne 1989, Ward et al 1995a, Ward et al 1995b and Ward et al 1995c can be used to develop measures of environmental fit using techniques outlined by Venkatraman 1989 and Venkatraman and Prescott 1990. The relationship between environmental fit and change can be examined empirically. Early works by Skinner 1974 Schmenner 1983 and Hill and Duke-Woolley 1983 describe, how manufacturing plants can becomes unfocused over time i.e., lower internal fit. While increased levels of global competition Roth et al, 1993 should make it harder for internally unfocused manufacturing units to survive, greater uncertainty and market turbulence should result in more manufacturing units in transitional states where poor internal fit can occur. Typologies such as that of Hill 1994 could be used to test the importance of internal fit in turbulent environments.

5. Conclusions

In this paper, we have reviewed current state of configuration research in the manufacturing strategy area. As the review showed, significant progress has been made, but there are still a number of promising directions. These include: 1. Greater integration with the business strategy literature and more empirical testing of the existing typologies and taxonomies. 2. More emphasis on internal fit within manufacturing units, especially in light of new manufacturing and information technologies Zammuto and O'Connor, 1992; Goldhar et al., 1991; Goldhar and Lei, 1995. 3. The use of configuration research methods to examine development, implementation, and change in manufacturing strategy. As a method for modeling and examining strategic fit issue, configuration models have unique properties which make them popular with researchers and practitioners. Skinner's opening comments give just one example of the role configuration models can play in the further development of the manufacturing strategy area.

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