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# A computerized knowledge management system for the manufacturing strategy process

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**Abstract**

This paper presents Co-MASS, a computerized knowledge management system for the collaborative development of manufacturing and operations strategy. The system supports the social and knowledge processes of collaborative strategy development by integrating a domain-specific modelling formalism based on the resource view of the firm, an associated structured dialogue scheme, an argumentation-enabling mechanism, and an efficient algorithm for the evaluation of alternatives. The competence-based manufacturing strategy paradigm behind its design rationale, its main elements, and a use case in a real setting are presented. Evaluation results provided positive feedback for the usability of the system, the discourse structure and the functionality of the user interface. The main contribution of our system lies in the integration of knowledge management, decision support and argumentation features, which constitutes a novel approach to develop manufacturing strategy.


*Keywords:* Collaborative problem solving; Manufacturing strategy; Knowledge management; Strategic decision making

## 1. Introduction

The development of an organisation's strategy, at both corporate and functional level, is a complex and ill-structured task, usually undertaken by a team of managers with diverse backgrounds representing different units [1,2]. Independent of the planning horizon and the scope of the final decision, strategy formulation is a knowledge-intensive process that may be reduced to problem resolution, no matter whether it concerns opportunity seizing, goal attainment or defensive moves. Empirical research suggests that to accommodate different views through the process of retrieving, considering and evaluating alternatives, the strategy formulation process moves from a divergence of opinions and views towards their convergence to agreed action items [2]. Obviously, the more different perspectives are initially taken into account, the greater the complexity of convergence, but the smaller the chances of addressing the wrong problem and reaching an inadequate solution [3,4].

At the functional level, the manufacturing and operations strategy formulation process has attracted considerable interest over the last 20 years. In this direction, a number of authors, influenced by the application of the ''rationalist'' paradigm of strategy, have proposed tools and procedures for assessing the manufacturing function's internal and external environment at a particular instance in time, and for identifying the actions needed to achieve fit among them (e.g. [5–10]). In all cases, there is the inherent assumption that all manufacturing-related knowledge can be gathered, qualified and codified by a single person, or in a series of facilitated sessions involving manufacturing-language literate managers. In practice, however, the manufacturing function of the modern corporation is closely related to other functions, such as marketing and product development [9], and the overall formulation of its strategy is a slow iterative process, usually requiring the involvement of managers with diverse backgrounds being situated in remote sites, which may even be in different countries [11]. Yet, given the dynamic and unpredictable nature of environmental changes, as well as the dynamic evolution of the related resources, purely rationalistic approaches to manufacturing strategy formulation seem to be insufficient

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[12]. In practice, it has been noticed that the manufacturing strategy process of successful firms is a mixture of rationalistic analysis and evolutionary sense-making, both becoming effective by an underlying processualist/learning perspective [13,14].

This perspective to the manufacturing strategy process entails a different philosophical stance, as far as its design rationale and its leveraging mechanisms are concerned. The design objective is not only how to reach an agreed action plan efficiently, but it is of the same importance to consider the learning that occurs within the process. The latter requires a consideration of the way manufacturing strategists interact during decision making [15]. Towards this end, the intensions and the successful application of various "soft-OR" methods in diverse strategic domains (see, for instance, [16,17]) suggest that the collective learning nature of the manufacturing strategy process can be greatly benefited by the collaborative development and manipulation of a structured problem model [18]. The model, whose "formality" may range from a structured problem-specific language to a mathematical formalism, can act as an intermediary or "transitional object" [19] for knowledge elicitation and conversion.

To facilitate the collaborative and learning-enhancing manufacturing strategy process in multi-sited enterprises, we have developed collaborative manufacturing strategy system (Co-MASS), a model-driven knowledge management system that relies on internet technologies. Co-MASS supports the social and knowledge processes of the manufacturing strategy development process by integrating a domain-specific modelling formalism based on the resource view of the firm, an associated structured dialogue scheme with an argumentation enabling mechanism, and an efficient algorithm for the evaluation of alternative suggestions/models. The paper presents the manufacturing strategy perspective behind the system's design rationale, its knowledge representation schema and main modules, and a use case from its evaluation in a third-party pharmaceuticals manufacturer.

## 2. The competence perspective of manufacturing strategy

Manufacturing strategy is the pattern of decisions and related actions, of both structural and infrastructural nature, which determine the capability of a firm's manufacturing system and specify how it will operate to meet a set of manufacturing-related objectives, which are in turn consistent with the overall company objectives [20]. The *content* of manufacturing strategy refers to the structural decisions on facilities, production processes and sourcing, as well as to the infrastructural decisions on organisation, HR policies, production planning and control systems, and performance measurement. The manufacturing-related objectives are usually associated to *cost*, *quality*, *speed*, *flexibility* and *dependability* [14].

The *process* of manufacturing strategy refers to the way the above decisions are made. As with business strategy, at the two extremes, this process may have the form of a purely rationalistic structured planning methodology, such as those described in [7,9] and [20], or it may be the result of a series of on-the-fly problem-(re)solving decisions of manufacturing issues and a set of organisational practices to make sense of them (emergent strategy). In the majority of cases, the firm's realized strategy is a mixture of the outcomes of both forms [14,21]. A systemic and holistic framework that integrates both perspectives is provided by the competence theory [22]. In this, organisational competence is the ability of an organisation to sustain coordinated deployments of resources and capabilities (assets) in ways that directly contribute to achieve its goals. The coordinated deployment of assets is governed by the company's (or function's) strategic logic, which represents the shared ideas of the people in the organisation about the nature of the organisation's goals, the assets required for achieving these goals, and the ways assets will be coordinated in pursuing these goals.

In the same perspective, which integrates the activity-based view of the value network [23] with the resource-based view [24], manufacturing's main objectives (cost, flexibility, dependability, speed, quality) and their associated performance measures at-large can be directly associated with manufacturing competences [20]. For example, a firm that can manufacture goods at low cost could be said to have a low-cost production competence. In the competence perspective, manufacturing strategy is the outcome of the shared beliefs (strategic logic) of its stakeholders, whose decisions and activities result in the accumulation of tangible (facilities, manufacturing processes, etc.) and intangible (knowledge, experience, etc.) resources. Companies obtain their competitiveness through the co-evolution of activities and resources [25]. The combination of a specific set of assets, as well as their accumulation level, define at any instance not only the competitive position of the manufacturing function, but also the overall competitive position of the firm. In addition, the assets of a firm determine the range and the economics of the activities in which it can engage at any point in time [26]. Therefore, the current assets position of the firm plays an important role on the choice of the future competitive targets/objectives as specific resources augment or limit the decision space of future corporate strategies. For instance, a firm that has invested in capacity can easily adopt cost leadership strategies by building more capacity and by being supported by its infrastructural attributes (e.g. production planning and control systems), which have been tuned to large scale operations. However, the same firm will have a difficulty in adopting a mass-customization strategy after developing structural and infrastructural resources for mass production.

Based on the above, it becomes apparent that in the competence-based perspective, manufacturing strategy formulation is equivalent to a process of managing the loop formed between the perceived current state of the manufacturing-related assets and a desired state, as perceived within the current context of its strategic logic. The main problem is that the different stakeholders of this functional strategy have different versions of strategic logic, which result in different organisational assessments and strategic objectives. Different percep-