COMPROMISE MANAGEMENT : PROPOSED TOOL FOR MANAGING TRADEOFFS

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ABSTRACT

This paper is a conceptual study of trade-offs and compromises, both from the perspective of their formulation at the strategic level and of their daily use in workshops. It suggests tools that can be used for better compromise management within organizations. This paper makes four propositions: (1) trade-offs are a form of common knowledge embedded and encultured in organizational systems, (2) trade-offs form configuration that are time- and context-sensitive, (3) configuration tables presented in this paper are one way of modelling the contextual sensitivity and the connectivity of trade-offs, and (4) cladistics classification is one way of modelling the dynamic structure of trade-offs. These propositions are illustrated by an in-depth case study and by a survey of the hand tool industry.

I. INTRODUCTION

Trade-offs in operations strategy are currently the subject of new conceptual studies, led primarily by Slack (1998) and Da Silveira and Slack (2001). Trading-off means to balance two situations against each other in order to get an acceptable result. In constrast, a compromise is an agreement between two people or groups in which both sides agree to accept less than they first asked for and to give up something they value. In other words, in every compromise there is the expression of one or several trade-offs by individual parties. Consistently with Da Silveira and Slack (2001), the objective of this paper is to propose tools and techniques for managing tradeoffs in various situations faced by managers. It holds that trade-offs are central to operations strategy. This paper is a contribution toward a better definition of trade-offs and compromises with the utltimate objective to provide tools and techniques that managers can use for compromise management.

This is a research study is application of that theory on operational and strategic decisions. It starts with a literature review of trade-offs in the decision science literature and in the operations strategy literature. The differences between the quantitative and the qualitative trade-offs discussed by both sides are analyzed and used to refine the definition and modelling of strategic trade-offs.

This paper is primarily conceptual, although the propositions that are formulated are illustrated with one in-depth case study and data from another research project, not initially designed to study trade-offs.

II. LITERATURE REVIEW

Trade-offs in decision Science

Trade-offs are commonly discussed in decision science. However, trade-offs are typically discussed and modelled in specific situations, e.g. an economic order quantity model. For example Roemer, Ahmadi and Wang (2000) modeled the trade-off between product development time and costs to select optimal overlapping strategies between the design and the development stages. Another example is a study of the trade-off between inventory levels and the delivery leadtime offered to customers in achieving a target level of service (Glasserman and Wang, 1998). Although examples of research papers focusing on trade-offs could be multiplied in this paper, there has not been in decision science any conceptual work attempting to build a "theory of trade-offs". However, the decision science literature on trade-offs can easily be presented in two categories:

- Optimization problems with a monetary objective function
- Preference modelling problems

In the first case, optimization problems, the problem of decision makers is to position themselves at an optimal point defined as a minimum cost or a maximum profit point. For example, in the economic order quantity model, the objective is to find the best combination between setup costs and inventory carrying costs. As inventory carrying costs decrease setup costs increase automatically, but the rate of decline of carrying costs is higher than the rate of increase of setup costs up to the optimal point. This later property is noteworthy as it indicates clearly that in this first class of trade-off problem, there is no ambiguity nor uncertainty regarding the trade-off. What is being reduced –carrying costs- offsets what is being increased, and these changes are measured.

In the second case, decision makers are faced with the additional difficulty of dealing with non homogenous and conflicting objectives. The investor's dilemma is the most standard example: achieving a high return on investment is desirable, as is taking little risk when investing. However, low risk investments bring low returns, and high returns only come with high risk. The concept of expected monetary value (typically derived from a decision tree) can be used as a benchmark for decision making in some simplified situations (dominance). However, in the most general case, to make a decision requires to express one's preference between two or more conflicting objectives, which necessitates the combination of different scales: e.g. a return in percent and a measure of risk. It is for this purpose that utility functions are introduced in a decision model: their goal is to expresse on a single scale the utility associated to different alternatives, and to select the highest utility alternative. In its most simple form, an additive utility function can be used between several conflicting objectives in a situation of risk neutrality. For more subtle situations where risk postures are non neutral (e.g. risk aversion), more advanced utility functions can be used: this is the field of multiattribute

utility theory (MAUT). Clemen and Reilly (2001) provides a good survey of utility functions and their application to decision making. Although utility functions are the theoretical solution for decision making problems involving trade-offs between different decision variabes, their formulation and use is based on a number of assumptions. Research by cognitive psychologists has shown that in the most general case, decision makers make decisions in a way that is not consistent with the assumptions legitimizing the use of utility functions. For example, Tversky and Kahneman (1981) presented two key issues:

- Framing effect: a decision maker risk attitude can change depending on the way the problem is presented.
- Certainty effect: individuals tend to place too much weigh on certain outcome relative to uncertain outcomes.

Trade-offs in Operations Strategy
As in the case of the decision science literature, trade-offs have been discussed for long in the operations strategy literature, but rarely as such, i.e. for the purpose of developing a theory of trade-offs. In his literature review about trade-offs in operations strategy, Slack (1998) identifies three different schools of thought:

- Traditionalists, based on the work of Skinner, hold that it is impossible to be good at everything, and thus, positioning and trade-offs in operations strategy are essentially the same thing. Both consist in choosing the best alternative in a situation of limited resources and capabilities.
- New fundamentalists, following the World Class Manufacturing impetus hold that trade-offs and positioning are

mere illusions. They quote the example of Japanese companies which have succeeded at being good at everything, and stress that it is possible to improve performance along different dimensions simultaneously. Their key recommendation is to overcome barriers to improvements with new technologies. An illustration of this approach is illustrated by Jackson, Stoltman, Taylor (1994) in the case of inventory management.

- The compromising school, which includes the work of Slack, Hayes, Pisano and New, distinguish positioning and trading-off as two fundamental issues in operations strategy and discuss the concept of "trajectories of improvement".

Slack (1998) uses two case studies to address four research questions about trade-offs. His conclusions are:

- Managers tend to mix different types of objectives when defining and discussing trade-offs. In addition to the traditional operations strategy objectives (cost, quality, time, flexibility) that are expected, managers include objectives such as "market reaction", "working capital requirement", etc. However, the conclusion of Slack is that between the two companies (in the textile and the food industry), there were some common trade-offs. Slack suggests that it could be possible to identify through more research generic trade-offs.
- In this study, there were no clear association between trade-offs and a set of compentencies, although flexibility was often mentioned.
- Managers decide to focus on a specific trade-off on the basis of two key criteria: the trade-off sensitivity is the potential to

improve one element of performance by changing the other. The trade-off rigidity is the difficulty of making a change. Managers prefer to address sensitive, non rigid trade-offs. Slack mentions another criteria, the importance of the trade-off (i.e. its impact on strategy), but his study allowed no conclusion regarding the relevance of this criteria.

• Managers confirmed that the trade-off concept was useful in terms of dealing with complex and inter-related strategic decisions, and more especially to analyze and discuss the "downside" of selected strategic directions.

An important debate in operations strategy is that related to the existence of trade-offs. For the new fundamentalists, trade-offs simply do no exist, and unecessarily constrain strategic thinking. A number of research studies have defended this position. Szwejczewski, Mapes, and New (1997a) start with the premise that conventional manufacturing wisdom is that to achieve good delivery performance, plant management should quote long lead time. This view implies a trade-off between lead time and delivery performance. The result of the research invalidates this notion and the existence of the lead time/delivery performance trade-off. The research results actually indicate that plants quoting shorter lead time perform better in terms of delivery performance.

In a different survey, Szwejczewski, Mapes, and New (1997b) ranked the performance of 782 manufacturing plants from the UK along several factors in order to discover which pair of performance measures formed trade-offs. The result of this survey is that a number of performance measures (value

added per employees, delivery reliability, lead time, rate of new product introduction) are correlated with one another, indicating a consistency/complementarity between these objectives. Negative correlations, and thus the existence of trade-offs, were only observed for plants characterized by a broad product variety. The conclusion of the authors is that by organizing operational units with narrow product ranges, trade-offs can be avoided.

Although these research results give some weight to the thesis that trade-offs are illusions, other confirm the existence of trade-offs. Bayus (1997) developed a model of the performance trade-off between speed-to-market and new product introduction. His model allows to specify an ideal trading-off strategy in different contexts. In the field of supplier selection a number of studies have used quantitative tools to model preferences and trade-offs: conjoint analysis (Tice et al., 1996) and data envelopment analysis (Braglia and Petroni, 2000). Koste and Malhotra (2000) analyzed trade-offs among the elements of flexibility in the automotive industry. Their conclusion is that even in a similar industry, companies from different countries adopt very different strategies to developing their manufacturing flexibility.

Despite the controversy surrounding trade-offs, Da Silveira and Slack (2001) continued the analysis initiated by Slack (1998) and explored further the trade-off context. Their research is based on 5 case studies of companies based in the UK and Brazil. From these case studies, they formulate 12 propositions regarding trade-offs:

1. Manufacturing trade-offs do exist.

2. Manufacturing trade-offs are seen as

compromises primarily between competing objectives, though other types of trade-offs exist.

3. The structure of trade-offs can be visualized as base, pivot and function (see figure 1)

4. Trade-offs are easier to visualize in less complex systems

5. Manufacturing trade-offs are dynamic

6. One can improve but not eliminate trade-offs

7. Some trade-offs are seen by managers as existing more in people's perceptions than in reality.

8. Different trade-offs may have common or similar sources, effects or management strategies.

9. The relative importance of trade-offs varies between companies.

10. The importance of trade-offs is determined by external (market and strategy) factors.

11. The relative sensitivity of each trade-off will vary between companies.

12. The sensitivity of trade-offs is determined by the internal variables – resources, capabilities and attributes.

III. ANATOMY OF TRADE-OFFS

Qualitative and Quantitative Trade-offs
A first difficulty with operations strategy trade-offs is their qualitative nature. Although a number of research studies have operationalized trade-offs with some quantity (e.g. correlation between performance measures), strategic trade-offs are usually discussed and debated within organizations, but are not quantified. This can create a certain ambiguity and fuzzyness regarding what a trade-off is. The representation

scheme proposed by Da Silveira and Slack (2001) helps to overcome this hurdle:

Figure 1. A model of manufacturing trade-offs from (Da Silveira and Slack, 2001)

Competing Objective 1

Competing Objective 2
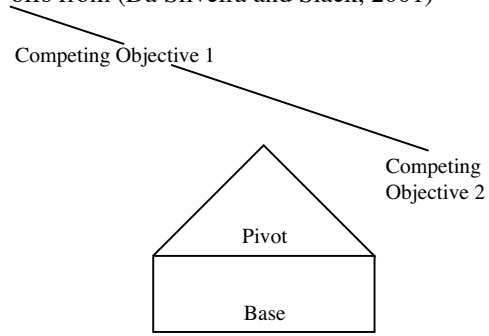
Pivot

Base

According to Da Silveira and Slack's terminology, the base of the pivot is the content of an operation, that is its resources and capabilities. The pivot, a component added by the interviewees of Da Silveira and Slack, are the "attributes" of the operation, defined as "the effectiveness with which the content of the operation is deployed". The pivot is what forms the trade-off. Finally, the function represent the impact of the trade-off on the different performance measures at stake.

It is worth reconciling this model of trade-off with the approach used in decision science, for instance with the traditional inventory management trade-off. On one hand, managers can choose to carry large inventory. Different processes and technologies can be used to manage inventory, resulting in different carrying cost. On the other hand, managers may choose to hold a minimum inventory by ordering more often, or by improving set-up times. In this case, managers have also a portfolio of processes and technologies to chose from in terms of managing ordering or set-up costs. These operation decisions consitute the base of the trade-off.

In different company, it is clear that the trade-off will differ in criticality, importance, rigidity, etc. For instance, the trade-off will be different for the inventory of supplies in the automotive industry and the inventory of perishable goods in the food processing industry. This difference, and the extent to which processes, technologies and capabilities are used to address the trade-off is the pivot of the trade-off. In decision science, it is the expression of the cost functions for carrying inventory and ordering/setting up. The pivot represents how the elements of the base are combined with one another.

Finally, the function of the trade-off describes what is the impact on performance and models the marginal rate of substitution. In decision science, this rate is always stated, either as the (variable) slope of the total cost function in the case of the inventory trade-off or within a utility function. However in operations strategy the marginal rate of substitution is rarely stated: it is qualitatively understood that it is positive or negative.

Trade-offs and Quantitative Models
In the previous section, qualitative and quantitative trade-offs were reconciled. There are no major differences between the model suggested by Da Silveira and Slack and a typical model built in decision science. This leads to the following question: should we build a decision science model, and attach quantitative values to base, pivot and function systematically? The advantages of doing so are obvious in the context of this paper with the objective of facilitating compromise management within operational units. If a trade-off decision is modelled, structured, and the marginal rate of substitution known, there can be no dis-

agreement on to what constitutes the ideal strategic compromise for an organization. That this approach would be beneficial cannot be questioned, as the positive impact of decision science models at the strategic level has already been established, for instance by Krumm and Rolle (1992) who reports the benefits derived from the adoption of decision science at Dupont. Clemen and Reilly (2001) provides an in-depth coverage of the reasons and benefits of adopting a structured approach to decision making. Since the superiority of the decision science approach is established, one may wonder why it is rarely, if ever, used in operations strategy trade-offs? There are a number of reasons that can be put forward:

- The exercise of structuring a trade-off problem, collecting data, and the group negotiations that take place in this process are costly. Although a structured trading-off model is theoretically elegant, it can be much more expensive than a qualitative agreement on what the trade-off should be.

- The exercise of structuring a trade-off problem requires time, which creates a fundamental mismatch with the dynamic nature of trade-offs. If trade-offs are dynamic, that is if their importance and pivot evolve with time and context, strategic decision makers will end up piling up studies addressing trade-offs decisions with short life spans, which is likely to be costly. When one talks of compromise management, that is decisions regarding which trade-offs are considered and which preferences are given priorities, it is impossible to dissociate this task from a time dimension and from a contextual dimension. This contextual sensitivity

of trade-offs is confirmed by five propositions of Da Silveira and Slack.

- Da Silveira and Slack report that different trade-offs may have common or similar sources, effects or management strategies. This reveals of problem of connectivity between trade-offs: a cost/quality trade-off decision (either to prefer quality or to increase quality capabilities) has an impact on a lead time/punctuality of delivery trade-off. The potentially high connectivity between trade-offs decisions is not addressed by decision science model when trade-offs are studied in isolation (it is if multi attribute utility theory is used). However, at the strategic level, the overall integration of the decision made need to be taken into account. The notion of trade-off connectivity is consistent with Da Silveira and Slack's observation that trade-offs are more easily observed in low complexity manufacturing systems.

- An additional issue is that some trade-offs are seen by managers as existing more in people's perceptions than in reality. This issue is addressed by the structuring phase when building a decision model, and as stated earlier, the group processes involved in this structuring can be expensive and time-consuming. What is noteworthy is the existence of considerable ambiguity regarding which trade-offs are real and which trade-offs are perceived. This is reinforced by proposition 2, which stresses that trade-offs can be expressed at different levels (between strategic goals and financial measures, between broad and specific objectives) and in different fashions. This means that there is a need for a better structuring of trade-offs decisions.

Based on the limitations formulated above, this paper suggests that operations strategy trade-offs present characteristics that are currently not treated by decision science models. These limitations are articulated around two further propositions: (1) the difference between strategic and operational trade-offs needs to be taken into account, and (2) compromise management is more about "improvement trajectories" than about marginal rate of substitution.

Trade-offs decision as common knowledge
Strategic and operational trade-offs have different scopes and long term orientation. The economic order quantity model is an operational trade-off: it indicates how much items to order given a current technical infrastructure, that is the base and pivot of the trade-off are fixed in the short term. The same inventory management problem can be analyzed at the strategic level: the decision then is not how much to order, but should the company modify the base, pivot, and preferences between performance objectives that are currently used? Short-term operational trade-offs are easily resolved with a decision science approach. On the other hand, longer term strategic trade-offs can be structured and modelled, for instance with an influence diagram or a decision tree, but the recommendation (the best alternative) is only part of managing an organisational compromise. The other part of the problem is to make sure that everybody in the organization understands the choice that was made and that all members of an organization align their actions with this decision.

For instance, if a company has decided to prefer quality over cost, it is important that in the organization, everybody agree on this

choice and take it into account in daily operational decisions. The quality/cost trade-off is especially topical as there has always been a controversy toward a definition of what constitute quality. For some, quality simply means matching customers expectations. What this philosophy entails is to avoid the cost of over-quality: there is no point in exceeding the quality required by customers if they do not pay a premium for it. Other managers define quality as constantly exceeding customer expectations as a strategic motive. This second philosophy indicates a preference for quality over cost; unless it is moderated by cost control objectives in which case it indicates a will to have a balanced approach, that is to perform well along two performance measures. Regardless of what the actual strategy is, it is crucial that all employees understand what the choice is and act in accordance with it.

This example shows that in the manipulation of the trade-off concept and in the formulation of organizational compromises, there is an aspect linked to shared knowledge and organizational culture. This paper proposes that to manage compromises and trade-offs, it is essential to realize that one is not only solving a decision problem but also building a social form of knowledge which forms the backcloth of operations' effectiveness.

The recent focus on knowledge management has resulted in a great number of classification and definitions of knowledge. A number of these definitions are useful to better characterize the knowledge that is manipulated through strategic trade-offs.

Collins (1993) broadly defines encultured knowledge as knowledge linked to social groups and society, and points out that this knowledge is not explicit. Blackler (1995) refines this definition and presents encultured knowledge as knowledge related to the

process of achieving shared understanding, embedded in cultural systems, and likely to depend strongly on language, and hence to be clearly socially constructed and open to negotiations. Blackler also defines embedded knowledge as knowledge that resides in systemic routines, relies on the interplay of relationships and material resources, may be embedded in technology, practices, or explicit routines and procedures. Fleck (1997) provides a definition for meta-knowledge that encapsulates both concepts of encultured and embedded knowledge. Meta-knowledge is embodied in the organization and is composed of general cultural and philosophical assumptions. It can be local or cosmopolitan and is acquired through socialization. Blumentritt & Johnson (1999) define common knowledge as knowledge that is accepted as standard without having been made formally explicit, often in the form of routines and practices. Common knowledge is learned through working in a particular context. In the rest of this paper, strategic trade-offs will be considered as a form of common knowledge, with the undertanding that this terminology highlights the following properties:

- Common knowledge is embedded in practices, i.e. it is not necessarily formalized and it is not necessarily consciously applied. This means that ambiguity and dissent may surround common knowledge, especially in complex organizational systems.
- Common knowledge is part of organizational culture. It is socially constructed, which means that its production may not be as rational and structured than one could expect. In a dysfunctional organization, it is likely that people disagree strongly on common knowledge.
- Common knowledge is contingent: common knowledge is called upon by organizational members in a variety of situations to guide their actions. In some

cases, recommended action may be clear. In other cases, it may be difficult to apply common knowledge.

Trade-offs Configuration

In the previous section, strategic trade-offs are presented as common knowledge to explain why they cannot be managed solely with a formal, explicit procedure. It explains why we need more than decision science models to manage trade-offs and compromises. Although describing trade-offs decisions as a form of common knowledge helps to tackle the ambiguous nature of qualitative, socially-constructed trade-offs, the issue of understanding the connectivities between different trade-offs has not been addressed.

The second key proposition of this paper is that trade-offs form configurations. This means that it is impossible to manage trade-offs in isolation but only in the context of an existing configuration.

Configuration theory is a field of organisational science that originated with the observation that typologies of strategy have never been related to structure (Miller, 1986). The attempts to do so gradually refuted the assumption that structure followed strategy, and the focus of researchers shifted to the discovery of the ties that unite strategy and structure. This led to the discovery that given a particular strategy, there are only a limited number of suitable structures and vice versa. The concept of a configuration was born:

" We use the term "organizational configurations" to denote any multidimensional constellation of conceptually distinct characteristics that commonly occur together", (Meyer et al., 1993).

Although the first configurations can be traced back to the work of structural theorists such as Mintzberg, Miles and Snow, the father of configurational theory is Miller. Miller stresses two notions which are at the core of the essence of configurations: multidimensionality and congruence.

"We believe that elements of structure cohere within common configurations, as do those of strategy. Furthermore, these configurations are themselves interlinked in that these are natural congruences between particular strategic, structural, and indeed environmental configurations", (Miller, 1986 emphasis added).

Recently, configuration theory has been recognized as emerging area in study in operations management (Boyer et al., 2000), primarily because configuration models are well suited to studying complex, multivariate organizational phenoma. Thus, configuration models are well suited to adress the 8th proposition of Da Silveira and Slack, that is different trade-offs may have common or similar sources, effects or management strategies. In other words, when dealing with a trade-off decision, the identification of an optimal solution is constrained by the notion of congruence with an existing configuration. The basic idea of configuration theory is that one can look at organizational systems from a strategic or a structural perspective: what is revealed is the same configuration. Similarly, one can look at operational systems with "trade-offs glasses" and observe the same configuration.

Illustration of Trade-offs as configuration of common knowledge

The concept of trade-offs as configuration of common knowledge is illustrated through a case study of a special project in a French company with a dual manufacturing activity. The first division dealt with precision machining. The second division assembled,

tested and fine tuned customized production machines. The project at stake was managed in the second division. The company initially started as a precision machinist and built a reputation for quality sold at a reasonable premium. The second division was created much later and faced a strong growth in sales, as customers appreciated the high quality and reliability of the machines.

IV. CASE STUDY BACKGROUND

Historically at the company, delayed delivery of custom machines was commonplace. Idle time occurred during production. The company recognized that on-time delivery was a critical issue in maintaining a competitive advantage and that customers were putting an increasing pressure on the company to respect delivery dates. Thus, the time-based competition paradigm (Stalk, 1988) seemed perfectly appropriate as a strategic improvement direction for the custom machine division. However, time-based competition was initially formulated by consultants and academics for repetitive, make-to-stock manufacturing environments. To the company's management, the extent to which time-based competition would work in their non-repetitive, project-based, make-to-order manufacturing environment was not clear.

In the summer of 1994, a customer who wanted a meat-cutting machine approached the company. The company bidded FRF 150 000 with a twelve weeks lead-time. They won the bid but the order that was returned specified a deadline of three weeks. The order sat with no action initiated. A project manager saw the order three days later and recognised an opportunity to apply time-based competition principles. The project manager believed that in the company's extremely competitive market on-time delivery could be the company's special niche.

Following renegotiations with the customer, the company and the customer mutually agreed to have the machine delivered in five weeks in return for a premium equivalent to 15% of the original bid price. The agreement confirmed a strong customer need regarding on-time delivery, much to the surprise of the commercial division, which believed that the company could solely compete on cost and quality.

In order to meet the delivery date, the company changed the way the order was handled, and the project manager implemented the following practices:
- He notified the pertinent departments of the deadline. This was to make sure that all involved parties would join in the challenge of delivering on time.
- He took the risk of ordering parts and components known for their long lead times before the design was finished, to make sure that they would arrive in the factory when they were needed.
- In the original plan, the design phase was specified as 6 weeks because the company did not have an experienced design engineer available for the first 4 weeks. The company decided to subcontract the design job. The contractual agreement stated that if the design was completed in one week, the company would pay the subcontractor FRF 16,200. If the design was completed in eleven days, the company would pay FRF 12,000. No payment would be made after the eleventh day. The design engineer completed the job in one week.
- Employees focused on the project as a team. They were informed of the deadline objectives and encouraged to communicate any problem likely to slow assembly immediately to the project manager.
- The project manager made the necessary design revisions on-the-fly, that is with-

out sending blueprints back to another designer.

The machine was completed and delivered in five weeks. Based on this case, the company recognised that time is an important factor in the custom machine market. Customers were willing to pay a premium for expediency. The project also confirmed that shorter delivery time were possible with a streamlined work approach utilising teams. This apparent success was very temporary as three days after delivery, the machine was returned to the factory for (1) violating the food processing industry health standards, (2) violating safety norms for machines including cutting tools, and (3) for a number of quality problems linked to the cutting tool. The machine was eventually revised and modified and sent back to the customer and met their specifications without any difficulties. A number of employees who has been critical of the TBC experiment used this quality failure to stress that short lead time and punctuality of delivery were impossible in their industry.

Case Analysis

The company top-management and project management were interviewed five years after the completion of project. No other attempts to replicate the TBC experiment were made by the company. Top management was interviewed about (1) what they believed were important trade-offs within the company before the TBC experiment and (2) after the TBC experiment.

The interview was semi-structured and asked managers to identify important trade-offs by matching generic strategic objectives: cost (C), punctuality of delivery (D), quality (Q), speed of delivery (S), and product range/variability (V). This research design is similar to the one used by Da Silveira and Slack (2001) purposefully, and primarily to guarantee some consistency between the managers that were interviewed.

The interviewees agreed that an extensively discussed trade-off was the one between quality and variability (QV). The interviewees had some degree of familiarity with their competition and they stressed that on some markets, they are often bidding against companies that have voluntarily reduced their product range to sell either a specific type of process or a specific technology. In contrast to the focused innovation of these competitors, the interviewees declared that the consensus was not to offer semi-customized capital goods but products that were truly the fruits of a one-off project. Instead of presenting itself as a designer and manufacturer of customized machines, the company preferred to indicate in its commercial brochure that its mission was the delivery of engineered solutions for production operations. The interviewees indicated that there had been constant debates within the company as to whether or not it would preferable to adopt a focused innovation strategy (Sivaloganthin and Shahin, 1999) or to select one past innovative design and try to market it at a larger scale. They all agreed that the difficulty of delivering high quality machine came primarily from their extremelly broad product range. However, they all agreed that the strategy of the company was to balance performance along both dimension: variability and quality.

Similarly, the cost/variety (CV) trade-off was an important source of discussion within the company. The debate on this trade-off followed a parallel with the QV trade-off as managers agreed on the fact that if was the company was to reduce product variability, it would greatly simplify the issue of managing manufacturing cost. It would especially be less exposed to high technical risk when bidding, could capitalize more on learning

curve effects, and would compete better on the cost dimension. However, the company compromise was to agree on a preference for variety over cost. Their strategy for dealing with the complexity resulting from preferring variety was addressed by implementing organizational processes targeting better bidding and investing in expert systems technologies to assist the bidding process (i.e. raising the base of the trade-off).

The third trade-off that was deemed important by management before the TBC experiment was that between cost and quality (CQ). Given the preference for product variability, management belived that manufacturing cost and quality were dimensions that they could not target together. Management expressed a preference for quality, i.e. it was more important for them to maintain the quality/reliability image associated with their products than to compete primarily on cost. Management stressed that this was an important trade-off as most of their commercial engineers and commercial agents perceived that competing on cost was the priority. To deal with this deviation from objectives, management introduced an informal policy that price bids would only be revised if technical specifications were modified (i.e. a price decrease has to be justified by a decrease in specifications by the customer).

Before the TBC experiment, managers said that punctuality of delivery and speed of delivery were minor considerations, and not the subject of debates or discussions within the company. For example, the project manager who initiated the TBC experiment reported the following anecdote. When discussing with senior managers and other project managers and expressing his concern about the chronic delays of the company (in one case, a machine was delivered almost two years after the due date!), the other managers disagreed strongly with the notion that the company was performing poorly in terms of punctuality of delivery. When faced with the evidence, that is that the custom machine division never met a deadline, managers replied that delays did not originate in the company but were the results of change of specifications by the customer. Although this was an issue, there was no evidence or performance data to establish responsibility in delays.

A number of managers did not revise their perceptions of trade-offs after the TBC experiment. For them, the TBC experiment was a failure because the project was managed by a young, inexperienced project manager. For them, the company was performing well on punctuality and speed of delivery.

Other, including the project manager, had a different interpretation of the TBC experiment. These managers agreed that performance along the punctuality and speed of delivery had to be improved, especially for the sake of improving customer relationships and developing more long-term business relationships with them. A manager quoted the example of a large customer accepting to pay according to schedule to help the distressed cash position of the company despite the fact that the company was missing a deadline: it was through reassurance that the delay could be absorbed at the next process stage that the payment was authorized.

What these managers learn from the TBC experiment was that:
• The trade-off between punctuality of delivery and speed of delivery is relatively unimportant. Working faster is possible through a modification of work methods. Short lead times are more difficult but

not impossible to manage.

- A key trade-off is the quality/speed of delivery (QS). In the TBC experiment, the project manager broke a latent trade-off of the company. Given the complexity of the product, a trade-off embedded in the work practice of the company was to systematically prefer quality to punctuality of delivery. This means that employees regurlarly delayed a task for the purpose of assimilating the problem and reflecting upon it. When they feel confident that their approach was the best alternative, they did the job. With the TBC experiment, the project manager inverted this preference for quality. Although he managed to elicitate collaboration for the sake of meeting a short deadline, he did not elicitate any collaboration on the quality dimension. To what extent the

failure of the TBC experiment is due to his lack of experience, to resistance from work colleagues, or to the impossibility of accelerating the completion of complex projects is open to debate. The key learning is that through his approach with the TBC experiment, the project manager moved away from a viable configuration to a non viable one, and revealed a trade-off (QS) of importance, embedded in practices, that had never been perceived as important. It illustrates the difficulty of dealing with common knowledge.

Table 1 and 2 below illustrates some of the lessons learnt about configuration of trade-offs. Table 1 reveals that when combining QV and CV trade-offs decisions, only 4 configurations are feasible out of 6 possible. Each of these configuration correspond to

Table 1: QV & CV trade-offs possible configuration

		QV	
	Preference for Quality	*Balanced Approach*	*Preference for variability*
Preference for variability	**Not viable (Inconsistent)**	Focused innovation "Exotic" orders are occasionally accepted	Deal with high complexity and high risk as part as their strategy
Preference for cost	Enter the standard machine market	Focused Innovation "Exoctic" orders are not bidded for	**Not viable** (Incompatible trade-offs)

CV (label for the left-side rows)

Table 2: QV & QS possible configurations

		QV	
	Preference for Quality	*Balanced Approach*	*Preference for variability*
Preference for quality	High Quality Strategy	Focused Innovation Competing on quality	Traditional one-off project organizations
Balanced Approach	TBC in the made to order industry	TBC & Focused Innovation	TBC in the Engineered to Order Industry Feasibility?

QS (label for the left-side rows)

clear strategies. Table 2 explores the possible configurations when making decision dealing with QV and the QS trade-offs.

Generic Trade-Offs

Da Silveira and Slack (2001) suggest that a typology of strategic trade-offs should be developed to be integrated in manufacturing strategy theory. Although the tables developed above are built on generic trade-offs suggested by Da Silveira and Slack, it is questionable that a universal scheme can be used to study all manufacturing industries for two reasons.

First, the configuration that are viable and the strategy that are adopted are very specific to the products being manufactured, as illustrated in tables 1 and 2. Strategic trade-offs deal with the positioning of the company on a standard, focused, or broad product range. Although this issue is generic, there is no reasons why what is not feasible in the capital goods industry would not be feasible in the food processing or the white goods industry.

The second reason is the constant tendency of managers to label trade-offs according to their perceptions. For instance, the project manager of the TBC experiment consistently talked about a knowledge reuse versus speed of delivery trade-off. In the case write-up above, this was described under the QS trade-offs. Clearly in the case of the project manager the precise labelling of the trade-off translates the frustation to have failed to reuse knowledge that was available within the company. The knowledge reuse/speed of delivery trade-off, although generic in the Engineered-to-Order industry, has little reason to be relevant in other industries. It remains however an interesting

way of diagnosing an operations problem.

Therefore, in terms of managing organizational compromises, it is doubtful that a generic trade-offs scheme is feasible. The third proposition of this paper is that the use of configuration tables such as tables 1 and 2 do a good job to address the contextual sensitivity of trade-offs, and their connectivity, and therefore are a useful tool to manage organizational compromises.

Phylogeny of Trade-offs

The benefits of using configuration tables is to treat trade-offs as configurations of common knowledge, and to taken into account their contextual sensitivity. However, configuration tables do not address the dynamic nature of trade-offs, i.e. their time sensitivity. This is in fact a general critic of configuration theory as it usually ignores the evolution of systems from one configuration to another.

In the case of the TBC experiment, time sensitivity is an important issue, as the project manager failed to understand that there was a cultural, embedded trade-off between quality and speed of delivery. Putting more emphasis on speed of delivery could be a viable strategy only to the extent that the trade-off rate between speed and quality is not too important. In other words, the project manager failed to incorporate lessons from the past when devising a new competitive strategy, and took the wrong "trajectory for improvement".

Leseure (2000) presents the cladistics classification technique as a method to classify manufacturing systems as configurations (called organizational species) along a time dimension. The fourth proposition of this paper is that when managing organizational

Table 3: Generic trade-offs in the hand tool industry

	CD	CQ	CS	CV	DQ	DS	DV	QS	QV	SV
Scale Producers I			10	11			01		01	01
Market oriented Producers			10	11			01		11	01
Focused plants				10					10	
Niche producers		01		10					10	
Modern factories				11					11	
Scale Producers II				10			10		10	10

compromises, the past history of trade-offs decisions, and departure from certain configurations should be well understood. This past history of trade-offs is the trade-off phylogeny in the terminology of cladistics, or the "trajectory of improvement" discussed in the literature review. This concept is illustrated in the next section.

Illustration of Trading-offs phylogeny
Figure 2 presents a classification of hand tools factories built with cladistics. Full de-
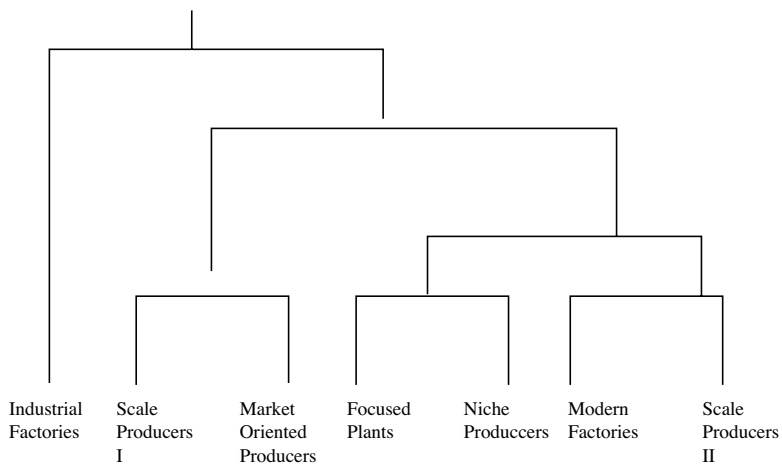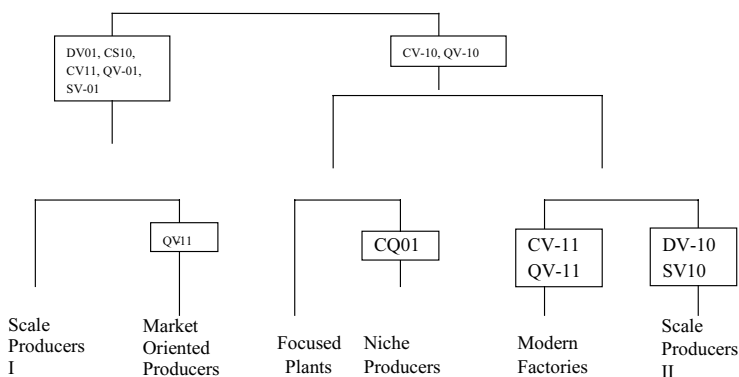
Figure 2. Classification of Hand Tool Factories

Figure 3 – Classification based on trade-off data.

tails about the nature of the different types of systems (the configurations) and their defining characters can be found in (Leseure, 2000).

Table 3 describes the trade-offs configurations of each species according the following terminology. The absence of number in a cell indicate either (1) that the trade-off is not important or (2) that the trade-off is not specified, i.e. companies have a certain flexibility in the decision. A code of 10 indicates a preference for the first objective. For example, the code CS-10 indicates a preference for competing on cost rather than speed. The code CS-01 would indicate a preference to compete on speed rather than cost, and the code CS-11 an attempt to perform well on both dimensions.

Figure 3 shows that if the classification is built solely on the trade-off data, the same structure (phylogeny) is revealed. This confirms the idea that trade-offs form configurations which are congruent with other configurations (as the one presented in figure 2).

V. CONCLUSION

In this paper, strategic trade-offs are presented as forming configurations of common knowledge embedded in operational systems. In many daily actions and decisions a group can apply a strategic orientation or preference more or less consciously. It is because trade-offs become assimilated in corporate culture that understanding them, and therefore managing them, is a difficult task. The conclusion that analyzing trade-offs, either by building configuration tables or analyzing the phylogeny of trade-offs as illustrated in this paper can allow management to close the gap between formulating strategies and managing the culture within operational systems.

This paper advances four propositions that should validated by further research. Indeed, Further research can be conducted to verify the propostions made in this paper. Case studies should be used to validate the usefulness of modelling trade-offs as configuration of common knowledge. Moreover, the development of configuration tables could be the field of more fundamental research in decision science.

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