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# Towards theory building in agile manufacturing strategies—Case studies of an agility taxonomy

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ABSTRACT

Agility is widely accepted in the manufacturing industry as a new competitive concept. However, how to develop a manufacturing strategy based around agility is not fully understood. A numerical taxonomy of agile manufacturing strategies was developed recently by the author, based on a large scale questionnaire study of UK industry. The taxonomy suggested the existence of three basic types of agility strategies: quick, responsive, and proactive. This paper presents a case-based investigation of the practical details of the three basic types of agility strategies. Typical cases from the basic strategy types were chosen and studied to establish why companies choose each type of the strategies, what distinctive agility drivers they are faced with and why, and whether and what typical action programs are used to implement the strategies. A cross-case analysis found that the choice of agility strategies is related to the nature of markets and competition, the characteristics of products (life cycles and degrees of maturity), and market positions of individual companies.



## 1. Introduction

Two elements are central to the definition of a manufacturing strategy. "Manufacturing task" (Miller and Roth, 1994), concerned with capabilities a manufacturing unit must have in order to compete given the overall business strategy, is represented by a list of competitive capabilities, ranked according to importance. "Manufacturing choices" (Flynn et al., 1999), on the other hand, are concerned with decisions made by a manufacturing unit with regard to its facilities, technology, ways of integration, capacity, organisation, workforce policies, and information systems. The theory is that good fitness between "task" and "choice" will lead to superior performance. The work of Miller and Roth (1994) is widely cited in the literature (Frohlich and Dixon, 2001). Based on 11 competitive capabilities and a taxonomical approach, it identified three types of strategies: marketeers, caretakers, and innovators, commonly used by North America manufacturers at the time. Significant changes have since taken place in the manufacturing industry. A follow-up study using the same set of capabilities (Frohlich and Dixon, 2001) found that while strategies for caretakers and innovators remained in existence the strategy for marketeers had been replaced by new forms of strategies. An important aspect that has not been considered is the emergence of agility as a new competitive concept in the 1990s. Agility recognises the significant impact of increasingly rapid changes from a dynamic business environment on manufacturing (Iacocca Institute, 1991) and argues for the emphasis of capabilities for dealing with rapid changes in a manufacturing strategy (Zhang and Sharifi, 2000; Sharifi and Zhang, 1999). Following the argument, manufacturing task and choices need to be aligned to provide companies with the capabilities of coping with and exploiting changes as opportunities, and good fitness between a manufacturing strategy and changes in the business environment is expected to lead to good performance (Sharifi and Zhang, 2001).

The last 15 years have witnessed the wide spread acceptance of agility as a new competitive concept. Despite this, the question of how to build agility in an organisation remains to be answered satisfactorily. Specifically, what are the capabilities to be developed given different sets of changes in the business environment? Are there different types of strategies that can be adopted? How are they to be chosen? What are the practices/techniques to be implemented for a chosen strategy? This paper presents a case-based investigation of three basic agility strategies, identified from a taxonomical study of UK industry (Zhang and Sharifi, 2007). Typical cases from the strategy types were studied to establish why companies choose each type of strategies, what distinctive agility drivers they are faced with and why, and whether and what typical action programs are used to implement the strategies.

## 2. Literature

Uncertainty has been a major topic for management research long before the term agility was introduced. Thompson (1967) suggested that the most important task for any organisation is to manage uncertainties. Drucker (1968) described the concept of

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entrepreneurial task as the search for changes, response to changes, and exploitation of changes as opportunities. Agility as a term reflects a comprehensive response to the business challenges of profiting from rapidly changing, continually fragmenting markets for high performance, high quality, customer configured goods/services (Goldman et al., 1995; DeVor et al., 1997). Work presented in the literature generally consists of researches that focus on manufacturing practices that could be used as enablers of agility and those that focus on integration frameworks to support the implementation. The former includes work on integrated product and manufacturing systems design (Kusiak and He, 1997; Wang et al., 2002; Zhang et al., 2007), dynamic process planning (Feng and Zhang, 1998; Lim and Zhang, 2003), responsive production scheduling (Maione and Naso, 2003; Lim and Zhang, 2004; Lim et al., 2009), flexible facility layout (Montreuil et al., 1999; Goh and Zhang, 2003; Anosike and Zhang, 2009), virtual enterprises (Cao and Dowlatshahi, 2005; Khalil and Wang, 2002), the optimisation of supply chains (Mason-Jones and Towill, 1999; Zhang et al., 2006; Akanle and Zhang 2008), the understanding of consumer dynamics (Zhang and Zhang, 2007), and the creation of empowered/flexible workforces and organisational structures (Crocitto and Youssef, 2003). The latter includes early works describing what agility is, what capabilities are relevant, and what characterises an agile enterprise (Iacocca Institute, 1991; Goldman et al., 1995; Kidd, 1995), as well as subsequent research proposing methodology to support implementations (Dove, 1996; Booth, 1996; Gehani; 1995; Gunasekaran, 1999). Recent work has placed emphasis on theory building with the support of empirical evidences. Sharifi and Zhang (2001), for instance, proposed to implement agility through the analysis of changes taking place in the business environment, the identification of agility drivers that are relevant, and the improvement of agility capabilities in response to the drivers. Yusuf and Adeleye (2002) tested hypotheses assuming linkages between different agility drivers and capabilities through a survey. Cao and Dowlatshahi (2005) examined the impact of information technology and virtual organisation on the performance of agile manufacturers. Most recently, Zhang and Sharifi (2007) discovered, through an empirical study, that there exist three distinctly different agility strategies, each emphasising a different set of capabilities.

## 3. The agility taxonomy

The taxonomy (Zhang and Sharifi, 2007) was developed based on a conceptual model of agility (Zhang and Sharifi, 2000). According to the model, a manufacturing unit experiences various changes in the business environment (referred to as "agility drivers") which drive it to prioritise "agility capabilities" that need to be developed to cope with and take advantage of changes. This in turn forces the unit to search for manufacturing practices ("agility providers") to obtain the required capabilities. In the context of manufacturing strategy, drivers are the essential driving forces for the unit to rethink about its strategy. Agility capabilities represent the set of capabilities that need to be chosen and prioritised to form the "task" in the strategy. Agility providers are a specialist set of tools and practices from which "choices" in the strategy could be developed. The list of drivers, capabilities, and providers used as constructs in the development of the taxonomy are provided in Table A1 of the Appendix. The constructs were developed from a literature review and refined through exploratory case studies and iterative tests. The detailed literature and development of the constructs are reported in Zhang and Sharifi (2007).

Data used in the development of the taxonomy was obtained from a questionnaire survey, designed to establish the degree of influence each agility driver had on each surveyed company, the importance attached by the company to each agility capability, and the importance placed on each of the agility providers. The sample included 900 UK firms, randomly selected from the Department of Trade and Industry database, with 25% each from auto-parts, aerospace, and electronics sectors, and the remaining from machinery, white goods, food/drink, rubber/plastics, and textiles. It comprised firms ranging from small businesses of less than 50 people to large businesses with over 2000 employees. Annual turnover ranged from under £3 m to over £120 m. The survey, including a pilot stage targeting 200 firms and a main stage targeting 700, resulted in a total of 79 responses, or a response rate of 8.8%. In terms of respondents, 25.9% held the titles of Manufacturing/Operations Directors, 17.2% Engineering Directors, 20.7% Managing Directors, 32.8% General Managers, and 3.4% Quality/Project Managers. Details of the instrument development and data treatment can be found in (Zhang and Sharifi, 2007).

The taxonomy was developed by clustering companies according to relative importance they place on seven agility capabilities: proactiveness, responsiveness to changes, flexibility, quickness, competency, customer focus, and partnership. Three distinct clusters were discovered. Table 1 shows the three clusters in terms of cluster centroid scores and relative ranking for the 7 capabilities. The probability that one or more of the cluster means differ from another is also depicted for each capability. The clusters differed on six variables at the 0.05 level of significance or less. They were interpreted based on (a) whether there are significant differences on the cluster means of the capability variables at 0.05 level or less and (b) relative ranking of the importance of a capability within a cluster. The first cluster was interpreted as "responsive players". They are preoccupied with flexibility and responsiveness to changes. They do not emphasise proactiveness and partnerships and they attach low importance to quickness. The second was named "quick players". They are oriented towards a strong customer focus and quickness. They do not emphasise flexibility and responsiveness to changes and they give the lowest priority to proactiveness and partnership. The third was referred to as "proactive players". They are characterised by high priorities on proactiveness and customer focus, high values for all capabilities, and high importance given to partnerships.

A canonical discriminant analysis was carried out to identify what underlining dimensions actually separated the three clusters, where each cluster was used as criterion variable coded into $3-1=2$ dummies and the 7 capabilities comprised the predictor set (Miller and Roth, 1994). Standardised estimates for both canonical structure loadings and canonical coefficients were obtained, the former representing the correlations of the original variables in the predictor set with an underlying unobserved dimension while the latter being analogous to beta weights in regression that can be used to predict cluster membership. Two canonical functions were found, each corresponding to an underlining dimension. One had a larger absolute correlation with proactiveness (0.643 vs. −0.216), partnership (0.588 vs. 0.025), flexibility (0.213 vs. −0.170), responsiveness to changes (0.371 vs. −0.272), and competency (0.206, −0.075), while the other with quickness (0.561 vs. 0.325) and customer focus (0.538 vs. 0.286). The five variables that function 1 has a stronger correlation with are concerned with capabilities for dealing with changes, either reactively or proactively. It was named "change proficiency" (Dove, 1996). The large canonical coefficients with proactiveness and partnership suggest that firms placing high emphases on the two capabilities will fall at the high end of the dimension. The smaller but positive canonical coefficients with flexibility and responsiveness suggest that firms putting high emphasis on these capabilities may appear somewhere in the middle, while those placing low emphasis on all will likely appear at the lower end. Function 2 has a strong positive correlation with quickness and customer focus and a weaker negative correlation with responsiveness and flexibility. This function is labeled as the "speed to customers" dimension which emphasises

**Table 1**
The three clusters in the taxonomy.

| Agility capabilities | Strategy group | | | | | | *F* value significance |
|---|---|---|---|---|---|---|---|
| | Responsive players ($n=9$) Group 1 | | Quick players ($n=14$) Group 2 | | Proactive players ($n=34$) Group 3 | | |
| *Proactiveness* | | | | | | | |
| Cluster mean* | 4.00 | (3) | 3.43 | (3) | **4.68** | (1,2) | 25.901 |
| Rank** | 4 | | 6 | | 2 | | 0.000 |
| Standard error*** | 0.17 | | 0.20 | | 0.08 | | |
| *Responsiveness* | | | | | | | |
| Cluster mean* | 4.22 | (2) | 3.57 | (1,3) | **4.44** | (2) | 10.471 |
| Rank** | 1 | | 5 | | 3 | | 0.000 |
| Standard error*** | 0.22 | | 0.17 | | 0.10 | | |
| *Competency* | | | | | | | |
| Cluster mean* | 4.11 | | 3.86 | | **4.38** | | 2.679 |
| Rank** | 2 | | 3 | | 4 | | 0.078 |
| Standard error*** | 0.20 | | 0.23 | | 0.12 | | |
| *Flexibility* | | | | | | | |
| Cluster mean* | 4.11 | (2) | 3.64 | (1,3) | **4.24** | (2) | 3.602 |
| rank** | 2 | | 4 | | 5 | | 0.034 |
| Standard error*** | 0.20 | | 0.20 | | 0.12 | | |
| *Quickness* | | | | | | | |
| Cluster mean* | 2.56 | (2,3) | 3.92 | (1) | **4.15** | (1) | 16.132 |
| Rank** | 7 | | 2 | | 7 | | 0.000 |
| Standard error*** | 0.24 | | 0.18 | | 0.13 | | |
| *Customer Focus* | | | | | | | |
| Cluster mean* | 4.00 | (2,3) | 4.64 | (1) | **4.79** | (1) | 13.926 |
| Rank** | 4 | | 1 | | 1 | | 0.000 |
| Standard error*** | 0.28 | | 0.13 | | 0.07 | | |
| *Partnership* | | | | | | | |
| Cluster mean* | 3.00 | (3) | 2.86 | (3) | **4.24** | (1,2) | 20.440 |
| Rank** | 6 | | 7 | | 5 | | 0.000 |
| Standard error*** | 0.24 | | 0.23 | | 0.14 | | |

* Average importance attached to each capability by cluster, on a five point Likert scale (1=not important, 5=critically important).
** The rank order of importance of this capability within cluster.
*** The standard error of the estimates of the mean for the group. The numbers in parentheses indicate the group numbers from which this group was significantly different at the 0.05 level.

the capability of firms to get to customers quickly. When plotted in a space formed from the two dimensions, quick players appeared on the top left, competing primarily along the "speed to customer" dimension; responsive players appeared in the mid-bottom, competing along the "change proficiency" dimension, while proactive players appeared on the upper-right corner, competing along both dimensions.

The work also compared statistical differences between clusters in terms of pressures from agility drivers and importances attached to agility providers, based on ANOVA and pare-wise test of mean differences. Quick players were found to feel high pressures from fewer drivers. Comparatively, responsive players feel high pressures across a wider range of drivers, and the proactive players across all drivers. In terms of providers, significant statistical differences across the three clusters were only found on a small number of items. A clustering analysis based on providers suggests that different action plans (i.e., combination of providers) may exist and may be used by each of the strategies.

## 4. Research design

This work is concerned with two sets of questions. First, what are the business characteristics of a typical company in each agility strategy (cluster)? What are the business context and scenario? What are its top concerns (agility drivers) and why? How does the concerns relate to its business characteristics? Why did it choose the corresponding strategy? How the choice relates to its characteristics? Second, are there typical action plans used in each agility strategy? What are the logics behind the choice of actions?

The questions are mostly of the type of "whys" and "hows", which are best answered through case studies (Yin, 1994). This research employed three typical cases, one from each agility strategy. The cases were chosen from around, and off-side of, each cluster centroid, so that they may represent typical scenarios of the corresponding clusters (the cases at the inner sides of cluster centroids and towards cluster boundaries were thought to represent transitions between strategies). Their scores for capabilities in the taxonomy are given in Table 2. The studies were carried out by structured interviews with senior directors who had been involved in strategy development. The interviews, accompanied by a tour of facility and access to documents, had five parts. The first concerns the company's background, market, competition, products, production, product development, technology, marketing, and strategy. The second concerns pressures from agility drivers. The interviewees were asked to rate the impact of each driver to their organisations and describe how each had affected them. The primary reasons behind this are explored. The third was about strategic capabilities the company emphasises. Detailed items of each of the seven capabilities, as listed in the Appendix, were considered and discussions centred on why they were emphasised. Discussions were also made about the overall corporate strategy. The fourth concerns agility providers, whether they were implemented or considered for implementation and why, if they were considered individually or as part of an action plan, what are the reasons for the initiation of the action plans. In the fifth part, companies' views about agility were discussed.

## 5. Case studies

### 5.1. Quick player

A manufacturer of high-tech optical/microwave devices for communication, the company was established to supply components

**Table 2**
The three cases and their capability scores against respective groups.

| Agility capabilities | Agility strategies—the groups and cases | | | | | |
|---|---|---|---|---|---|---|
| | Responsive group | Responsive case | Quick group | Quick case | Proactive group | Proactive case |
| *Proactiveness* | | | | | | |
| Degree of importance | 4.00 | 4 | 3.43 | 2 | 4.68 | 5 |
| Rank | (4) | (4) | (6) | (6) | (2) | (1) |
| Standard error* | 0.17 | | 0.20 | | 0.08 | |
| *Responsiveness* | | | | | | |
| Degree of importance | 4.22 | 5 | 3.57 | 3 | 4.44 | 5 |
| Rank | (1) | (1) | (5) | (4) | (3) | (1) |
| Standard error | 0.22 | | 0.17 | | 0.10 | |
| *Competency* | | | | | | |
| Degree of importance | 4.11 | 4 | 3.86 | 4 | 4.38 | 5 |
| Rank | (2) | (3) | (3) | (2) | (4) | (1) |
| Standard error | 0.20 | | 0.23 | | 0.12 | |
| *Flexibility* | | | | | | |
| Degree of importance | 4.11 | 5 | 3.64 | 3 | 4.24 | 5 |
| Rank | (2) | (1) | (4) | (4) | (5) | (1) |
| Standard error | 0.20 | | 0.20 | | 0.12 | |
| *Quickness* | | | | | | |
| Degree of importance | 2.56 | 3 | 3.92 | 4 | 4.15 | 4 |
| Rank | (7) | (6) | (2) | (2) | (7) | (7) |
| Standard error | 0.24 | | 0.18 | | 0.13 | |
| Customer focus | | | | | | |
| Degree of importance | 4.00 | 4 | 4.64 | 5 | 4.79 | 5 |
| Rank | (4) | (4) | (1) | (1) | (1) | (1) |
| Standard Error | 0.28 | | 0.13 | | 0.07 | |
| *Partnership* | | | | | | |
| Degree of importance | 3.00 | 3 | 2.86 | 2 | 4.24 | 5 |
| Rank | (6) | (6) | (7) | (6) | (5) | (1) |
| Standard error | 0.24 | | 0.23 | | 0.14 | |

for expensive radar systems used in the military market. In the past, 50% of capacity was supplied to the military market and the remaining to commercial. The downturn of military market in the 1990s had reduced the demand to 20% of capacity and the company forced to diversify towards commercial markets. The operation is batch production with a small proportion of jobbing. Product life cycles are short and the company tends to be concerned only with the rising stage of life cycles. As soon as products go to high volume they are no longer competitive, in which stage, the company let bigger manufacturers to take over and move on to new products. For this reason the company operates a policy which is first to market and high technology. In order to diversify towards commercial markets, the company had to increase the rate of new product introduction to satisfy an increasingly competitive market. The specifications of new products are determined by customers and products customised, using the same underlining processes. Production planning is based on a master process scheduling with no integrated sales/order systems. Marketing is considered important though the company relies on technical reputation to bring customers in. Technical capability is considered the core competency and leverage. Threats and opportunities in the market are detected through close contacts with customers.

*Drivers*: Drivers within the framework that gave a distinctly high impact to the company include the "growth of niche market", "rapid change in product models", "rapidly changing market", "innovation rate increase", "shorter new product time to market", "introduction of new information technology", and "environmental pressure". They depict a rapidly changing market with growing niches and increasingly high speed of innovation and NPI, though environmental and technology pressures are also eminent. The set of drivers is consistent with those of the whole quick group identified statistically (Zhang and Sharifi, 2007), although for the whole group "quicker product delivery" was also a major concern but for this particular company delivery pressure seems less imminent. The main concerns do relate to the business characteristics, in that the firm operates in a niche market with short product life cycles and takes revenues from the early part of product lives. The ultimate force was the shrinkage of military market back in the 1990s, which forced the company to diversify towards commercial markets. Growth of niches such as wireless communications between computers, personal communications, and radars on cars created enormous new opportunities.

*Capabilities*: The firm's strategy, according to the director, is to compete on fast product development and first to market. As to detailed capabilities within the framework, they emphasise "focus on customers", "quickness in NPD", "high rate of NPI", "product configuration flexibility", as well as the ability to anticipate changes in market, have a strategic vision, appropriate technology, and flexible empowered people. This is consistent with the statistics of quick group that emphasise "customer focus", "quickness", and "competency". The strategy is a clear response to the perceived drivers, i.e., competitions based around rapid innovation, rapid NPI, and the growth of niche market.

*Providers*: The Company's policy concerning customers is "to make it easy for customers to buy from us". The shift of markets forced it to "focus on customers". However, given that customer priorities for choosing products are performance, quality, cost, and reliability, it was considered important to incorporate customers in defining new products, but less important to involve them in planning and product development. The policy to suppliers is to build long term relationships. However, "price usually dominates". Less importance was attached with involving suppliers in defining new products, planning, and product development. Innovation, patents, and innovative new products are considered to be very important in maintaining a competitive advantage. AMT is used and products are customised using same underlining processes. The integration of different functions, processes, and departments is considered important for

improving performance, which is carried out by identifying major processes and reorganising around the processes using teams. Virtual enterprise is regarded as leverage but nothing has taken place, although there have been opportunities to work with companies in the Far East. With regard to information systems, the company has used IS for many years. It is planning to install an ERP system to integrate all systems. The perception is that this would improve the company's responsiveness, flexibility and quickness, reduce organisation barriers, understand the real desire of customers and unpredicted changes in market, integrate different activities, improve benchmarking and performance measurement, improve services from suppliers and to customers, and improve remote team working. These constitute an action plan that focuses on fast innovation and NPI, "encouraging innovation at all levels", "creating patents and innovative products", "sufficient technology capability", "AMT and mass customisation", "flexible teams and educated people", and "integrating using IS". This action plan appears to be consistent with capabilities the firm is trying to emphasise.

*Views about agility*: Agility is an important strategy, as the company put it, "changes in business are more often and likely happening to manufacturers and they must face it by being agile". The company sees agility as "quality, cost, and time". Its view about agility is as follows: "Agility in general can be equaled to things like responsiveness and flexibility, but in our case we believe it is coming up with technical solutions to customer requirements in an efficient way rather than providing technical products or parts, also being fast in responding. In the mean time be cost effective to provide the expected price of customer. In short, agility is the ability to support quality, cost, and time strategies of the company".

### 5.2. Responsive player

A manufacturer of special purpose instruments, the company merged with an American Corporation in the 1990s. The world market is occupied by three groups of manufacturers. In the first place is HP which has a market share of 40–50%. In the second group there were 6–7 players occupying 30% of the market. The company belongs to the third group of about 60 occupying the remaining 20% market. The operation is batch production on a "make to order" basis. Most products enjoy long life cycles (10 yr), while evolving with time. New variations are constantly generated but fundamental changes rarely happen. Unlike market leaders who may introduce new innovative products constantly, the company feels that a high turnover is needed in order to be able to take control of market and the technological aspects of the products. For this reason it operates a policy which is "following others (me too)" in market entry. In order to reduce development lead-time/cost, the company is trying to develop a product platform to carry the technology sides of products to future generations. New product specifications are determined by cost, technology, and customer expectations. The company is held back by some products in which technology is more important. Despite this, products are highly customised, made to customer orders with high variety of options, at a volume of 1–10. Production planning systems are essential to manage interactions with customers. The company recently switched to a new ERP system hoping to improve reaction to changes in plans with fast transfer of information and have more flexibility. Marketing is not rated highly although the perception is that it will become more important. A major differentiator in the market is providing total and one stop solution for customers. This was introduced by market leaders. A manufacturer with low flexibility would only be able to cover a limited range of customers. The company considered flexibility and reaction to customer opportunity as core competency. It captures market by offering short lead-times, variable volumes, and wide variety, which requires flexibility of workforce, materials, and production system. Threats and opportunities are detected by monitoring customer orders/commitment.

*Drivers*: Drivers within the framework that gave a distinctly high impact to the company include "global competition", "shorter new product time to market", "shorter delivery time", "higher quality expectation", and "introduction of new product technology". There is also an additional driver which is not present in the framework, "customer move towards one-stop purchase". The drivers depict a situation where pressures come from global competition, decreasing new products time to market, shorter delivery time, change of product technology, higher quality expectation, and customers move towards one-stop purchase, much of which seem to reflect competitions created by market leaders. The set of drivers is consistent with group statistics (Zhang and Sharifi, 2007), although there has been one or two firm specific ones. For the whole group, "cost pressure" was also a major concern but for this particular firm it seems less imminent. The main concerns do relate to their business characteristics, in that the firm operates in a mixture of mature and niche markets with long product life cycles and mature but changing products, competitions are multi-faceted, introduced by market leaders and involving both new product technology, time to market, delivery and quality, and the firm is a market follower that has to react to competitions imposed by leaders. According to the director, the ultimate driver behind this situation was the increase in new product programmes by big players, which has resulted in a merger of players into a smaller number of global businesses, making life even harder for smaller market followers.

*Capabilities*: The firm's strategy is to focus on flexibility and reaction to customer opportunity. As to detailed capabilities within the framework, they emphasise all elements of "flexibility" and "responsiveness to changes", a few of competency (vision, technology, efficiency, and quality), followed by operational and delivery speed and partnership, broadly consistent with the statistics of responsive group. The strategy is a clear response to the perceived drivers, i.e., competitions along multiple dimensions, constant new changes and initiatives introduced by market leaders.

*Providers*: The policy concerning customers is as follows: "strategic customers must be recognised and focused on". 10% of top customers are considered as the winning leverage for the future. Cost is still the top priority of customers in choosing products but the ability to provide one-stop total solution is resuming greater importance. It is important to incorporate key customers in defining new products and in product development, but not important to involve them in planning. The policy concerning suppliers is to build long term relationships. Suppliers are involved in defining new products, product development, and planning. Innovation is important in maintaining the competitive position, but the company does not yet have specific initiatives to enhance it. Integration of different functions, processes, and departments is considered for better performance. Flexible manufacturing processes and multi-functional team working are used and the company has achieved more with vertical integration. Virtual enterprise is considered a leverage. The company has experienced complete outsourcing, and has started a relationship with a Japanese partner to sell each other's products with own names. In this way, the company offers its customers a wider range of products and keeps customers with it. With regard to IS, the company committed a study to look at future needs in response to changes, and has started to implement a core system, to improve quickness, flexibility, and competency, understand changes in market, integrate activities, improve benchmarking and performance measurement, improve services given to customers, and improve remote team working. These present an

action plan that focus on flexibility and supply chain integration; ''involving customers in product development'' ''close integration with suppliers'', ''flexible manufacturing processes'', ''flexible team-based organisation'', ''continuously trained people'', ''IS supports product development, manufacturing and integration with customers/suppliers''. The action plan appears to be consistent with capabilities the firm is trying to emphasise.

*Views about agility*: Agility is considered an important strategy. As the company put it, ''for our business the concept fits and is necessary''. The company defines agility as ''tuning with changes in business''. Its view about agility is ''being flexible enough to respond to changes in customer and market requirements, having the required ability to capture the future and maintain it, being aware of the circumstances and business environment and accommodating the abilities to prosper''.

### 5.3. Proactive player

A manufacturer of cookers and ovens, the company is a UK market leader and ranked highly in Europe. Customers include end-user consumers and big retailers. The operation is batch production on a make to order basis. Most product lines, in terms of functionality, enjoy long life cycles (10–20 years), but new features and colours are added constantly. The company took new innovations initially that were unique, which put the company on top of the market. The company then followed the product lines by improving the products to introduce new ones in terms of colours and cheaper versions. As the market leader, it introduced fashion into the white goods industry, offering new features and almost unlimited number of colours to products, which had reduced product life cycles to 4 years. As such it operates a policy of ''first to market'' and derives more than 70% of its revenue from new products. The company's policy is to increase the rate of new product introduction still further to maintain the competitive advantage. Product development is pushed by fashion and innovation and specifications determined by market research and customer requirements. Products are based on modular designs and are mass-customised. Manufacturing system is organised into cells using Kanban, equipped with a semi-automatic flexible manufacturing system for the production of main components. Production is planned weekly and reviewed every 2 days. The company can answer to any new order daily and be totally flexible. Marketing is given a very high priority, for which the company had used techniques that were not used in this industry, such as those by the fashion industry. The market is highly competitive, considering that the total market shrank by 26% over the 1990s. The company considered its capability in product development as core competencies. It captures market by offering innovative features, fashion in colours, fast delivery, and product customisation.

*Drivers*: Specific drivers within the framework that gave a distinctly high impact to the company include ''growth of niche market'', ''rapid change in product models'', ''increasing cost pressure'', ''global competition'', ''new product time to market'', ''individualising products and services'', ''quicker delivery'', ''higher quality expectation'', and ''introduction to new information technology''. They depict a market with growing niche, increasing global competitions, increasing pressures on cost, quality, delivery, NPI, time to market, and product/service individualisation. The company admits that some of these have been initiated by themselves, such as the strategic offering of innovative features, fashion in colours, fast delivery, and product customisation. The set of drivers are typical of the proactive group (Zhang and Sharifi, 2007), and do relate to business characteristics of the firm, i.e., operating in a global market with increasing niches, long product life cycles, multi-faceted competition and being a market leader that has to constantly initiate changes to maintain leadership. According to the company director, a significant driver behind this was the shrinkage of market (by 26% in the 1990s), the emergence of fashion consciousness in customers, and the switching of retailers to just-in-time philosophy. The company has been part of the changes. The company's views are that changes have created new horizons of opportunities for the business and the company has exceeded the norms by originating changes.

*Capabilities*: The company uses a strategy focusing on being innovative, flexible, proactive, and continuous improvement. As to detailed capabilities, they emphasise ''focus on customer'', ''proactiveness'', ''responsiveness to change'', ''quickness (all elements)'', ''product volume flexibility'', ''product configuration flexibility'', ''partnership'', and competency (all elements). This is consistent with group statistics (Zhang and Sharifi, 2007) except that for flexibility this firm focuses on product volume and configuration instead of all. The strategy is a clear response to the perceived drivers and business characteristics, competing along all dimensions and constantly introducing changes to capture niches.

*Providers*: Focusing on and involving customers have been a policy. Customers are involved in defining new products, and in product development. Likewise, building strong partnerships with suppliers is top on the company's priority. The company involves suppliers in defining new products, planning, and product development. Innovation at all levels is a policy for maintaining its competitive advantage. New schemes are being introduced to encourage innovation. The company performs proactive R&D concurrently with marketing, design and manufacturing. It has implemented vertical integration and is progressing towards total integration. In terms of technology, the company uses AMT and flexible manufacturing processes and has implemented mass-customisation. Many practices concerning organisation and people are already implemented, with particular focus on management styles that are informal, coaching and inspiring people, dynamic organisation, practice to trust and empower people, the involvement of employees at all levels in decision making, the communication of company strategy, plans, problems, and new horizons of opportunities to employees. Virtual enterprise is an important concept. Several initiatives were in place in collaboration with manufacturers in the Far East and other parts of Europe. With regard to information systems, the company has used IS to facilitate integration with suppliers and partners and believes more needs to be done in using IS to support product development, and distribute information to empower people. These appear to have combined action plans of ''quick'' and ''responsive'' cases, with additional inclusion of practices that support proactiveness (management style, proactive R&D, etc.) and partnerships (using IS to integrate with suppliers and customers).

*Views about agility*: Agility is an important strategy to the company. As the interviewee put it, ''our strategy is generally about agility, innovation, flexibility, and continuous improvement''. The company's views about agility are very much along the proactive line: ''if you are sinking, it does not matter what you do, but when you are winning the race you have to be more careful and considerate, not in the way you are selling your products but the way you are doing it—that is the agility thing.''

## 6. Cross-case analysis

The business characteristics, drivers, strategies and capabilities, and action plans of the three cases are summarised in Table A2 of the Appendix. Each of the three cases has a unique and distinct set of characteristics. The quick case is a technology firm that operates in niche market, their product life cycles are short, and they make money from early part of product life cycles.

Their competition is predominantly focused on a single dimension, the speed of innovation, and NPI. The responsive case, on the other hand, operates in a mature market with some niches, their product life cycles are long, and they have mature products with new features. Their competition is multi-faceted along several dimensions simultaneously. They are a market follower that has to react to competitions introduced by market leaders. The proactive case operates in both mature and niche markets. Like the responsive player, their product life cycles are long and they have mature product lines but new variants/products are introduced constantly. Their competitions are even more multi-dimensional. They are market leaders and many of the new dimensions of competitions are actually introduced by them to keep ahead of the competition.

The drivers for the three cases reflect exactly their business characteristics. The quick case focuses on drivers relating to the growth of niches in the market and the competition on speed of innovation and NPI. The responsive case focuses on drivers relating to competitions along several dimensions, new product, delivery, and quality, whereas the proactive case focuses on an even wider set of competition dimensions, innovation, NPI, cost, customisation, delivery, quality, and technology. This confirms our findings from the questionnaire that ''quick players feel high pressures from fewer drivers, responsive players across a wider range of drivers, and proactive players across all drivers''. More importantly, behind each of the business scenarios, there appears to be a major force that has contributed to the formation of the situation. In the quick case, this was the shrinkage of military market back in the 1990s, which forced the company to diversify towards commercial markets and operate at small technology niches. In the responsive case, this was the increase of new product programmes by big players, which has resulted in a merger of players into a smaller number of global businesses, making competitions even tougher for the followers. In the proactive case, this was the shrinkage of market (by 26% in the 1990s), the emergence of fashion consciousness in customers, and the switching of retailers to just-in-time philosophy, which brought about both pressures and opportunities for market leaders to exceed the norms by originating changes.

Their strategic focuses reflect their business characteristics and drivers. The quick case, focusing on high rate of NPI and innovation, quickness in NPD, adopts a strategy of first to market, high technology, and rapid NPI. The responsive case, on the other hand, focuses on all elements of flexibility and responsiveness to changes. They adopt a strategy of following others and being flexible to react to opportunities. The proactive case advocates for almost all capabilities in order to sustain leadership by proactively introducing changes in the market.

It is interesting to note that we did not manage to find distinct action programmes to implement the strategies for each group statistically during the questionnaire stage and we suspected that there may be multiple action plans in each group which level out when analysed statistically. The case studies have confirmed that each case does have an action plan closely corresponding to their business characteristics, driver and capabilities. The quick case has an action plan that focuses on fast innovation and NPI, ''encouraging innovation at all levels'', ''creating patents and innovative products'', ''sufficient technology capability'', ''AMT and mass customisation'', ''flexible teams and educated people'', and ''integrating using IS''. This is consistent with their conceived competition on innovation and NPI. The responsive case adopts an action plan that focusses on flexible processes, people and organisation, supplier integration, and customer involvement. This is consistent with their needs to follow leaders and be flexible to react to changes. The proactive case adopts a plan that combines action plans of ''quick'' and ''responsive'' cases, with additional practices that support proactiveness (management style, proactive R&D, etc.) and partnerships (using IS to integrate with suppliers and customers). This reflects their needs to develop all capabilities and proactively initiate changes. It is also interesting to see that each case has a distinct perspective in viewing the agility concept, consistent with their characteristics and strategies.

## 7. Discussions and conclusions

The study of the three typical cases from the taxonomy suggests that top concerns for a company in terms of agility drivers do vary with business characteristics, specifically, the nature of market and competition, the characteristics of products (life cycles, maturity stages), and market positions. The choice of agility strategy seems to relate to the characteristics and drivers. The ''quick'' case, for instance, presented a company with short product life cycles, deriving revenues from early product lives, and focusing on niche markets. Main top concerns are ''growth of niche market'', ''increasing changes in product models'', ''rapidly changing market'', ''innovation rate increasing'', and ''decreasing new product time to market''. Its strategy emphasises ''focus on customers'' and ''quick new product development''. The ''responsive'' case, on the other hand, involves a company with relatively long product life cycles, operating at the mature stages of products (with frequent improvement), with a market involving both mature and niche elements. Competition is multi-faceted (rather than dominated by new product development as in the quick case). The company is a market follower that does not have enough technical ability to take a lead. Top concerns included ''global competition'', ''decreasing new products time to market'', ''shorter delivery time'', ''change of product technology'', ''higher quality expectation'', and ''customers move towards one-stop purchase''. As a market follower, the company's strategy emphasised ''flexibility'' and ''responsiveness to changes''. The proactive case is similar in terms of characteristics and top concerns to the responsive case; however, as a market leader the company adopts a strategy that not only places importance on quickness, flexibility, and responsiveness, but also on proactively creating changes and partnering with suppliers and customers. In terms of action plans, the study found in all three cases that companies do have action plans, and the plans appear to correlate with their characteristics, drivers, and strategies adopted. The quick case, for example, focus on innovation at all levels, patents, technology capability, AMT and mass-customisation, flexible teams and educated people to deliver the capabilities of ''customer focus'' and ''rapid new product development''. The responsive case emphasises ''involving customer in product development'', ''supplier integration'', ''flexible manufacturing processes'', ''flexible team-based organisation'', ''continuously trained people'', and using IS to support product development, manufacturing and integration with customers and suppliers, to deliver the ''flexibility'' and ''responsiveness'' capabilities. The proactive case combined programs used by quick and responsive cases with additional ones delivering ''proactiveness'' and ''partnership'' capabilities. This agrees with findings from the taxonomy that proactive players compete along both ''quickness'' and ''change proficiency'' dimensions while quick and responsive players compete along each of the dimensions.

The study focused on typical cases. It is expected that there will be variations within each cluster, particularly near the boundaries between clusters. It would be interesting to find how company characteristics, drivers, strategic focuses as well as action plans will vary across the boundaries of clusters, and what underlining forces are driving the transition.

## Appendix A

See Tables A1 and A2.

**Table A1**
Constructs used in the taxonomy.

**Agility drivers, $\alpha$=0.901** (0.903)
*Change in marketplace,* $\alpha$=0.766 (0.770)
- Growth of niche market
- Open new market and close of others
- Increasing rate of change of product models
- Product lifetime shrinkage
- Decreasing cost of entering niche market

*Change in competition basis,* $\alpha$=0.774 (0.765)
- Rapidly changing markets
- Increasing pressure on cost/profitability
- Innovation rate increasing
- Increasing pressure of global competition
- Decreasing new product time to market
- Responsiveness of competitors to changes
- Effectiveness of competitors' strategy, marketing, distribution, service

*Change in Customer Requirements,* $\alpha$=0.763 (0.769)
- Individualising products and service
- Quicker delivery time and time to market
- Quality expectation increase
- Increasing value of information/services

*Changes in technology,* $\alpha$=0.743 (0.747)
- Faster pace of development of product technology
- Faster pace of development in process technology
- Faster development of ICT technology

*Change in social factors,* $\alpha$=0.878 (0.879)
- Environmental pressure
- Workforce/workplace expectation
- Legal/political pressure
- Culture pressure
- Social contract change

**Agility capabilities, $\alpha$=0.704** (0.712)
*Proactiveness—the capability to act proactively instead of reactively in attacking threats and opportunities.*
*Responsiveness—the capability to identify, respond to and recover from changes.*
(Sensing, perceiving, and anticipating changes; immediate reaction to changes; recovering from changes)
*Competency—the capability to operate efficiently, produce high quality and high performance products, deliver on time, innovate, and manage core competency.*
(Strategic vision; sufficient technological capability; products/services quality; cost effectiveness; delivery reliability; innovation; knowledgeable, competent, and empowered people; operations efficiency)
*Flexibility—the capability to perform different tasks and achieve different objectives with same resources/facilities*
(Volume; product model; organisation; people)
*Quickness—the capability to operate at high speed*
(New products time-to-market; quickness in products services delivery; high rate of NPI)
*Customer focus—ability to have a strong customer focus.*
*Partnership—the capability to form concrete relationship with suppliers and partner*

**Agility providers, $\alpha$=0.935 (0.939)**
*Relationship with supplier/customer/competitors,* $\alpha$=0.599 (0.633)
- Partnering is the first alternative
- Virtual organisation model
- Reducing number of suppliers
- Suppliers are audited, ranked, and informed of decisions
- Involving suppliers in product development
- Involving suppliers in short and long term planning
- Suppliers are fed continually with adequate information
- Efforts to get close, negotiate, and co-operate with competitors

*Technology,* $\alpha$=0.542 (0.615)
- Adequate, sufficient, and right mix of techno.
- Adoption of AMT
- Mass customisation

*Integration,* $\alpha$=0.852 (0.856)
- Integration as a strategy
- Vertical integration
- Total integration

*Organisation,* $\alpha$=0.798 (0.813)
- Flat, flexible and team-based organisation
- Continuous reengineering
- Management philosophy informal, coaching, and inspiring people
- Free flow of information and communication
- Structured and flexible mfg processes in use and constantly change
- Organisation structure facilitates concurrency across the enterprise
- Organisation effective and dynamic to meet changing goals
- Management focusing on core-competency
- Regular benchmarking

*People,* $\alpha$=0.844 (0.850)
- Employees at all levels contribute to decision making
- Compensation is skill-based than task based
- Team-working is recognised and rewarded
- People trusted and empowered
- People receive continuous training and education
- People aware of company strategy, plans, problems, and opportunities

*Innovation,* $\alpha$=0.533 (0.538)
- Innovation at all levels encouraged and rewarded
- Proactive R&D performed concurrent with marketing, design, and mfg
- Patents and innovative products as a competitive weapon

*Relation with customer,* $\alpha$=0.844 (0.847)
- Focus on customer and customer satisfaction and delight as a strategy
- Customers receive solution to their needs and problems
- Customer requirements are proactively anticipated and understood
- Customers taken as partners
- Customers involved in product development
- Close information relationship with customer

*Information systems,* $\alpha$=0.852 (0.857)
- IS serves as an essential part of benchmarking
- IS is the major means of open communication and of total integration
- Investment in IS/IT is a strategic ways of achieving excellence
- Totally integrated IS network in use
- Information is distributed company-wide to empower people
- Enterprise information flow is considered as a bottleneck and limit
- Product development is based on IS which tracks processes
- Changes in business environment are continuously tracked using IS
- MIS compatible with Intl standard of data exchange such as STEP
- IS provides capability for info update for customers and suppliers

*Numbers are constructs reliabilities in Cronbach's alpha (based on data from survey), numbers in bracket are alpha based on standardized items.

**Table A2**
Details of the cases.

| | Quick case | Responsive case | Proactive case |
|---|---|---|---|
| Business character | High-tech, niche market | Mature and niche market | Mature and niche market |
| | Prod life cycle short | Long life cycle | Long life cycle |
| | Revenue from early prod life | Mature product | Mature prod with new features |
| | Technology leader | Multi-faceted competition | Multi-faceted competition |
| | | Market follower, pushed by leader | Market leader—creating changes |
| Drivers with high impacts | Growth of niche market | Global competition | Growth of niche market |
| | Rapid change prod models | Short new prod time to market | Rapid change prod model |
| | Rapidly changing market | Short delivery time | Increasing cost pressure |
| | Innovation rate increase | Higher quality expectation | Global competition |
| | Short new prod time to market | Intro of new prod tech and customer move | New prod time to market |
| | Intro of new info tech | to one-stop purchase | Individualising prod/services |
| | Environmental pressures | | Quicker delivery |
| | | | Higher quality expectation |
| | | | Intro of new info tech |
| Strategy and focused capabilities | *Strategy* | *Strategy* | *Strategy* |
| | First to market | Follow others, react to opportunities | Proactive to introduce change |
| | High technology | Flexible to offer short lead-time for a | Speedup NPI-features colours |
| | Rapid NPI, customise | wide variety, variable volumes, customise | Flexible and innovative |
| | *Capabilities* | | *Capabilities* |
| | Focus on customer | *Capabilities* | Focus on customer |
| | Quickness NPD | Flexibility (all) | Proactiveness |
| | High rate of NPI | Responsiveness (all) | Responsiveness (all) |
| | Prod configuration flexibility | Strategic vision | Quickness (all) |
| | Sense and anticipate change | Technology capability | Prod volume flexibility |
| | Strategic vision | Products/services quality | Prod configuration flexibility |
| | People flexibility | Operation efficiency | Partnership |
| | Empowered people | Quickness in new prod time to market | Competency (all) |
| | Sufficient technical capability | Quick delivery partnership | |
| Action plans | Innovate at all levels | Flexible manufacturing processes | Use practices used by quick and |
| | Patents and innovative prod | Flexible team-based organisation | responsive strategies, plus |
| | Sufficient tech capability | Integration with suppliers | Proactive R&D concurrently with |
| | AMT and mass customisation | Continuously trained people | marketing, design and manufacturing |
| | Flexible teams | Involve customers in product development | |
| | Educated people, integrate | | Partner with suppliers and customers |
| | Using information system | Collaborate with competitors | Informal management styles |
| | Comments: | Comments: | Dynamic organisation |
| | Value technology, innovation, people, and organisation, not supplier integration | Emphasise integration with suppliers, value people and organisation, innovation, and technology less important | Trust and empower people |
| | | | Involve employees in decision making Communicate company strategy, plans, problems and new horizons of opportunities to employees |
| | | | Comments: |
| | | | Combine quick and responsive action plans with proactiveness and partner |

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