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The end is (not quite) nigh! The impact of mass customisation on manufacturing trade-offs


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Abstract: Management literature has suggested that the advent of mass customisation marks the end for trade-offs between customisation and other competitive priorities (Pine et al, 1993; Westbrook and Williamson, 1993; Tu et al, 2001). However, evidence supporting this proposition is anecdotal. This paper examines the impact of product customisation on four competitive priorities, drawing upon the results of a survey conducted in 2003 of 101 UK manufacturing firms from eight industry sectors. The study indicates significant compatibility between customisation and quality, flexibility, delivery reliability and non-manufacturing costs. On the other hand, trade-offs remain between customisation and manufacturing costs and delivery lead times. The results contradict the initial proposition that customisation can be ‘free’, and have important implications for firms embarking upon a mass customisation strategy.

Keywords: Mass customization, trade-offs, manufacturing strategy, empirical research
1.0 Introduction

Mass customisation denotes the ability to provide customised products and services at a comparable price and speed of equivalent standardised offerings. The introduction of innovative product strategies, advanced manufacturing technologies and organisational structures has minimised the traditional sacrifices of customised products. This has lead scholars to claim that mass customisation offers superior customer value compared to other strategies (Gilmore and Pine, 2000; Tu et al, 2001).

The advent of mass customisation has important implications for the debate surrounding manufacturing trade-offs. The literature suggests that mass customisation effectively eliminates the trade-off between customisation and other competitive priorities (Pine et al, 1993; Westbrook and Williamson, 1993; Tu et al, 2001). However such a position is largely based on anecdotal evidence, formed through the examination of a few well known case studies (Pine, 1993; Kotha, 1995; 1996; Berman, 2002). Indeed the few empirical studies that do examine the relationship between product customisation and other priorities indicate the reverse situation, that customisation is not ‘free’ but traded-off with lead-time, cost and other factors (New, 1992; Filippini et al, 1998). The purpose of this paper is to evaluate empirically whether the degree of product customisation affects four competitive priorities: cost, quality, delivery and flexibility. Consistent with related research (Duray et al, 2000; Duray, 2002) the current study identifies three degrees of product customisation: full, partial and standard.

This study contributes to the literature in three areas. First, it provides empirical evidence for the largely anecdotal claims of mass customisation. The study provides systematic evidence of the degree to which customisation can be considered ‘free’. Second, the study answers the
call for increased empirical research in the area of mass customisation (Tu et al, 2001). If mass customisation is to gain further acceptance within the field of operations management, rigorous research is required to assess and extend previous anecdotal studies. Third, the study contributes to the wider debate surrounding the existence of trade-offs. Conflicting evidence appears to support both arguments for (New, 1992; Mapes et al, 1997; Filippini et al, 1998) and against (Schonberger, 1986; Ferdows and De Meyer, 1990; Flynn et al, 1999) the existence of manufacturing trade-offs. The current study provides further evidence within a specific instance of trade-off; the conflict between product customisation and other identified priorities.

2.0 Literature review

2.1 Mass customisation

Firms have entered a new era in operations management, which includes the requirement of mass customisation (Brown, 2000). Futurist Alvin Toffler was one of the first to glimpse this new paradigm (Kotha, 1995), to see beyond mass production. Toffler noted a trend towards “de-massification” (1981, p192), a move towards customisation using continuous flow processes. The theme was taken up by Stanley Davis (1987) who coined the term mass customisation: “mass customisation of markets means that the same large number of customers can be reached as in mass markets of the industrial economy, and simultaneously they can be treated individually as in customized markets of pre-industrial economies” (Davis, 1987, p.169). In other words, mass customisation combines the best of the craft era, where products were individualised but at high cost, with the best of mass production, where products were affordable but highly standardised (Fralix, 2001). This shift is shown in figure 1.
In an ideal world, firms would mass-produce standardised goods as efficiently as possible to gain economies of scale (Meredith et al., 1994). However, a shift towards mass customisation is justified, based on three main reasons. First, there has been a collapse in mass markets (Kotler, 1989; Mueller-Heumann, 1992; Hart, 1995; Kara and Kaynak, 1997). The advent of a post modernistic culture means that customers are no longer satisfied with a ‘one size fits all’ product (Pine, 1993). Instead, they demand increased levels of variety and personalisation (Firat and Schultz, 1997). Second, new production and information technologies enable firms to produce to customer specification at the low cost and high speed of standardised offerings. In particular, e-commerce has changed the way firms interact with customers and suppliers, providing a quick and efficient means of introducing customisation (Lee et al., 2000; Bhat and Emadad, 2001). Third, mass customisation may be seen as a response to shortening product life cycles and increased global competition (Ahlstrom and Westbrook, 1999; Berman, 2002).

The concept of mass customisation appears to contradict the traditional notion of trade-offs. Customised products are conventionally positioned in the top left hand corner of Hayes and Wheelwright’s (1979) ‘product-process matrix’. The authors argue that products that are non-standard, or one of kind, necessitate low volumes and job shop production processes. There is, then, an implied trade-off between the degree of product customisation and the efficiency of the production process, high levels of customisation are not commensurate with economies of scale; customisation is traded off with time and cost. Mass customisation turns this logic on its head. The introduction of innovative product strategies (Pine, 1993, Eastwood, 1996, Duray, 2002), advanced manufacturing technologies (Hart, 1995, Lau, 1995,
Kotha, 1996) and organisational structures (Vickery et al, 1999) mean that customised products are no longer confined to the top left hand corner. Instead, mass customisation is positioned below the diagonal, approaching the bottom left hand corner. Low product standardisation is now coupled with line or continuous flows. Thus, customisation is no longer in trade-off with other priorities, firms can seek high performance in customisation along side high performance in cost and delivery.

2.2 Trade-offs

The concept of trade-off in manufacturing can be traced back to Skinner’s pioneering work in the field of manufacturing strategy. Skinner recognised that while the production function should support the overarching corporate strategy, it cannot achieve high levels of performance for multiple competitive priorities (Skinner, 1969). In other words, priorities such as cost, time, quality, technology and customer satisfaction are in conflict, improvement in one necessitates a decrease in performance in another (Slack, 1991).

Skinner’s original work was subsequently refined, however the core concept of trade-offs as necessary choices between priorities has been retained. Skinner (1974) argues for the focussed factory, plants should focus on a narrow range performance measures while compromising, or trading-off, less important priorities. Further support for the concept of focus is offered by Hayes and Wheelwright (1984) and Fine and Hax (1985, p29): “Normally manufacturing objectives are expressed in terms of four major dimensions of performance measurement…Important trade-offs must be made among these objectives; it is impossible to excel in all of them simultaneously”. Parallels to the notion of trade-offs are found in the field of strategy. Porter (1985) posits a trade-off between low cost and differentiation; firms
must make a choice between these two types of competitive advantage, the pursuit of both will ultimately result in mediocrity and below average performance.

Two approaches to manufacturing trade-offs have emerged in recent years. The first approach holds that trade-offs can be eliminated; manufacturers can achieve high levels of performance for all priorities. In an analysis of ‘World Class Manufacturing’ Schonberger (1986) contends that highly competitive firms have abandoned the notion that competitive priorities must be in trade-off, but rather may be viewed as cumulative. In other words, high performance in one priority can lead to high performance in other priorities. Ferdows and De Meyer (1990) develop this argument; their ‘sand cone’ model suggests that capabilities can be built in a logical sequence, starting with quality, advancing to delivery, flexibility and finally cost. The rigid flexibility model (Collins and Schmenner, 1993; Collins et al, 1998) also recognises the complementarity between competitive priorities. However, unlike the sand cone model, it does not impose such a rigid structure on the sequence of capability building, instead, firms must be sufficiently responsive to perform highly on any dimension.

Several scholars have found empirical support for the concept of cumulative capabilities. In a study of manufacturing performance, Roth and Miller (1992) found that one group of companies outperformed the others across four competitive priorities: cost, quality, dependability and flexibility. Their results suggest that some firms have effectively eliminated trade-offs between priorities. White (1996) found significant relationships between a number of pairs of competitive priorities. Employing a meta analysis of several empirical works, the author concludes that although the research supports the notion of cumulative capabilities, the order of capability building need not be as rigid as the sand cone model suggests. Firms are not constrained to starting with quality, but may begin with
flexibility or delivery. In support of the concept of world class manufacturing, Flynn et al (1999) found synergies between most competitive priorities including cost, quality, dependability and flexibility.

The second approach represents something of a compromise between the original ideas of Skinner and the position adopted by Schonberger. It is recognition that while certain competitive priorities are compatible, trade-offs can never be completely eliminated. In a vigorous attack on Schonberger, New (1992) found that while new manufacturing practices had overcome several trade-offs, many remained. New (1992, p31) concluded, “…perhaps it would be a good idea for journalists [in reference to Schonberger] to stick to journalism rather than indulge in gross simplifications for the sake of sensationalism without any research basis”.

In support of this approach Mapes et al (1997) found that the relationships between competitive priorities were moderated by product variety. Product variety is linked to decreased performance in several priorities including cost, quality and delivery. Filippini et al (1998) found that while 80% of plants studied demonstrated high performance in at least two competitive priorities, none of the plants demonstrated high performance across all six priorities. In particular trade-offs were found in the areas of delivery reliability and quality capability. Adopting a case based approach, Da Silveira and Slack (2001) note that all cases acknowledge the existence of trade-offs, that the idea that trade-offs could be eliminated was “simplistic”. However the case firms also recognised that trade-offs are dynamic and can be changed over time.
A strategy of mass customisation necessitates that the first approach to trade-offs is accurate: “The development of the continuous-improvement and mass customization models show that companies can overcome the traditional trade-offs. In other words, companies can have it all” (Pine et al, 1993, p111). However the development of mass customisation is based primarily on a few well known case studies (Pine, 1993; Kotha, 1995; 1996; Berman, 2002). There is little empirical evidence to suggest that trade-offs between customisation and other competitive priorities have been overcome. Indeed, the limited empirical evidence available contradicts the notion that customisation can be ‘free’. For instance, New (1992) found that despite advances in manufacturing, trade-offs still existed between customisation and lead-time, and, customisation and price. Moreover, Filippini et al (1998) found product customisation was a significant factor in discriminating trade-off situations. Firms producing customised products were more likely to incur higher levels of trade-offs than firms producing standardised products. The purpose of this study is to evaluate empirically whether the advent of mass customisation has eliminated manufacturing trade-offs between product customisation and other competitive priorities.

Common to much of the trade-off literature are four key competitive priorities: cost, quality, delivery, and flexibility. That is not to deny the existence of other trade-offs, but that these four are widespread in the literature and appear consistent with recent research (Da Silveira and Slack, 2001). If we are to accept the claims of mass customisation, these four priorities should be compatible with product customisation. This leads us to formulate the following hypotheses:

**H1: Customisation does not increase costs**

**H2: Customisation does not reduce quality**
H3a: Customisation does not increase delivery lead times

H3b: Customisation does not reduce delivery reliability

H4: Customisation does not reduce flexibility

3.0 Methods

3.1 Sample design and data collection approach

The five hypotheses were tested through a mail survey that collected information about a firm’s environment, capabilities, products, trade-offs and performance. The sample of firms was drawn from a database held by Conquest Business Media. Conquest Business Media, publishers of The Manufacturer and other similar publications, hold a UK manufacturing database tracking 11,901 firms. Respondents were selected by job function (head of production or equivalent), plant size (at least 50 employees) and industry (SIC code: 28.00 fabricated metal products, 29.00 machinery and equipment not elsewhere classified, 30.00 office machinery and computers, 31.00 electrical machinery and apparatus not elsewhere classified, 33.00 medical, precision and optical instruments, watches, 34.00 motor vehicles, trailers and semi-trailers, 35.00 other transport equipment, 36.00 furniture). It has been suggested elsewhere that customisation is prevalent in these industries (Duray et al, 2000; Duray, 2002). These criteria generated a possible 1196 contacts from which 500 respondents were selected at random.

Pilot testing of the survey was conducted in two phases. First, the draft questionnaire was sent to 15 academic colleagues and industry contacts. Rather than completing the questionnaire, this group were asked to comment on all aspects of the design, content and scaling. Several significant changes were made as a result of this feedback. Second, the
revised questionnaire was sent to 15 firms from the database (these were not included in the final sample) to test protocol and survey design. No changes were made at this stage.

The survey was mailed to a named respondent in early November 2003. Each respondent received a letter explaining the purpose of the research, a survey and a business reply envelope. The non-respondent problem was addressed in two ways (Forza, 2002). First, the response rate was improved by two further mailings; a reminder postcard after two weeks and a letter and replacement survey after five weeks. 102 useable responses were received, yielding a response rate of 20.4% (see table 1). Second, non-response bias was assessed by comparing early and late respondents (Armstrong and Overton, 1977; Lambert and Harrington, 1990). For the purposes of this research early respondents were classified as responses received before the reminder postcards were sent. The two groups were compared for each of the variables under study; the data indicate no significant differences (for example: degree of customisation $t = 0.61, P = 0.54$).

![Please insert table 1 about here]

3.2 Customisation measurement

The independent variable ‘degree of customisation’ was based on Mintzberg (1988) and Duray et al (2000). Here, the point of customer involvement in the production process differentiates the level of customisation. Three levels of customisation were identified:

1. Full customisation (customer input into product design or fabrication)
2. Partial customisation (customer input into product assembly or delivery)
3. Standard (no customer input)
Respondents were asked to indicate the level of customisation for their plant’s primary product (measured in terms of turnover).

3.3 Performance measurement

The study measures the impact of customisation on four competitive priorities: cost, quality, delivery and flexibility. Respondents were asked to indicate the performance of their primary product compared to that of their major competitors. The performance scale was a five-point likert scale with anchors labelled ‘much below’ (=1) and ‘much above’ (=5). Here, subjective measures were preferred for two reasons. First, it was felt that objectives measures might reduce the response rate. Previous studies have noted the reluctance of respondents to divulge sensitive financial information (Boyer et al, 1996), leading to a reduction in responses (Ward and Duray, 2000). Second, it was felt that accounting measures might not tap the concepts at the level of aggregation required. As further support, prior research has shown significant relationships between subjective and objective measures (Boyer et al, 1996; 1997; Ward and Duray, 2000), signifying that subjective measures may be considered reliable. However, objective measures were also obtained for the quality and delivery dimensions. Details of the measures are shown in table 2.

[Please insert table 2 about here]

4.0 Results and discussion

4.1 Hypothesis 1

One-way analyses of variance were performed between the degree of customisation and each of the five cost variables. The results are summarised in table 3. Mixed support is found for hypothesis 1; customisation does not have a significant effect on four of the five dependent
variables. The data suggest that there are no trade-offs between customisation and design \((F = 0.17)\), component \((F = 1.07)\), delivery \((F = 1.17)\) and servicing \((F = 0.50)\) costs for the sample firms.

However, contrary to hypothesis 1 customisation does have a significant effect on manufacturing costs \((F = 3.71, p < 0.05)\). The Scheffé test showed that manufacturing costs differed significantly between fully customised and standard products \((p < 0.10)\), and between fully customised and partially customised products \((p < 0.10)\). These findings support an earlier exploratory study where increased manufacturing costs were found to be one of the key negative outcomes of increased product customisation (Ahlstrom and Westbrook, 1999).

[Please insert table 3 about here]

The results offer mixed support for one of the key tenets of mass customisation; that customised products can be offered at the low cost of standardised products (Pine, 1993; Hart, 1995). Costs beyond the shop floor did not differ significantly between the three levels of customisation, suggesting that these capabilities are cumulative. Importantly, customisation did not significantly impact component costs. Previous studies (Ahlstrom and Westbrook, 1999) have found a positive relationship between product customisation and component costs, the results of this study suggest this trade-off has been overcome. However, despite the advances in flexible manufacturing and product design, manufacturing costs remain higher for full customisation than either partial customisation or standard products.
4.2 Hypothesis 2

One way analyses of variance were performed between the degree of customisation and each of the five quality variables. The results are summarised in table 4. The results fully support hypothesis 2; customisation does not have a significant effect on product durability ($F = 0.78$), product reliability ($F = 0.40$), conformance quality ($F = 0.43$), the percentage of products returned defective ($F = 1.94$), and the percentage of products that pass final inspection ($F = 0.80$).

[Please insert table 4 about here]

Given the almost obsessive focus on quality by many Western manufacturers in the 1980s, the lack of trade-off is to be expected. High levels of quality are currently so universal that quality is no longer sufficient for customer loyalty or sustainable competitive advantage (Vokurka and Fliedner, 1998; Yusuf and Adeleye, 2002). Quality has become what Terry Hill (2000) would call an ‘order qualifier’. In order to win new orders companies must look to sustain competitive levels of quality whilst improving performance for other competitive priorities. The data suggest that the degree of customisation could be improved whilst retaining comparable levels of quality. This finding is consistent with the principles of the sand cone model (Ferdows and De Meyer, 1990), insomuch as capabilities may be built in a cumulative sequence starting with quality as a base.

4.3 Hypothesis 3a

One way analyses of variance were performed between the degree of customisation and both measures of delivery speed. The results are summarised in table 5. The results do not support hypothesis 3a; customisation has a significant effect on the speed of delivery ($F =
3.91, \( p < 0.05 \)) and average lead time (\( F = 7.57, \ p < 0.00 \)). The Scheffé test showed that the speed of delivery differed significantly between fully customised and standard products \( (p < 0.05) \) and fully customised and partially customised products \( (p < 0.10) \). Moreover, average lead time differed significantly between fully customised and standard products \( (p < 0.01) \) and fully customised and partially customised products \( (p < 0.01) \).

[Please insert table 5 about here]

Mass customisation suggests that customised products can be delivered without a concomitant increase in lead time (Pine, 1993). The data suggest this is not the case; both measures indicated delivery speed was significantly slower for fully customised products. However in a trend similar to that of manufacturing costs, the delivery speed of partial customisation was not significantly different from that of standard products.

4.4 Hypothesis 3b

One way analyses of variance were performed between the degree of customisation and both measures of delivery reliability. The results are summarised in table 5. The results support hypothesis 3b; customisation does not have a significant effect on the reliability of delivery times \( (F = 2.05) \) or the percentage of products delivered on time \( (F = 1.57) \).

4.5 Hypothesis 4

One way analyses of variance were performed between the degree of customisation and four flexibility factors. The results are summarised in table 6. The results fully support hypothesis 4; customisation does not have a significant effect on the ability of the sampled firms to operate efficiently at different production levels \( (F = 2.00) \), to operate profitably at
different production levels \((F = 0.17)\), to economically run various batch sizes \((F = 0.37)\), and to vary aggregate output between production periods \((F = 1.03)\).


[Please insert table 6 about here]

The data posit that flexibility and customisation capabilities are cumulative. It is suggested that customisation builds on flexibility, that a level of flexibility is required to produce customised products (Da Silveira et al, 2001). If a strategy of mass customisation is to be successful, plants must be able to handle fluctuating batch sizes and changes to capacity (Holweg and Pil, 2001).

4.6 Controlling for size and industry

To control for the effects of size and industry, one way analyses of covariance were conducted between the degree of customisation and each of the dependent variables applying firm size (number of employees) and industry (dummy coded SIC codes) as the covariates. The results were not significantly different from those of the analyses of variance (results available on request). The fact that no major changes were detected increases the probability that the independent variable (degree of customization) is indeed having an effect on the dependent variables (cost, quality, delivery and flexibility).

5.0 Managerial implications

The findings of the study have several important implications for the business community. First, the current study suggests that product customisation is not free; full customisation represents a trade-off with both manufacturing costs and delivery lead-times. This finding is particularly pertinent given the hype surrounding mass customisation. The advent of mass
customisation was assumed to eliminate trade-offs between customisation and other objectives, companies could ‘have it all’ (Pine et al, 1993). Despite the claimed success of a limited number of case studies, this study shows that in the wider context the introduction of product customisation will lead to a significant decrease in other areas of manufacturing performance. For firms considering a shift to mass customisation it is imperative that they understand what the customer really values. The results suggest that the introduction of full customisation may be successful only where customers are somewhat price and time insensitive.

Second, the results show that partial customisation is a cumulative capability; it does not trade-off with cost, quality, delivery or flexibility. Given that customisation is argued to increase customer value (Tu et al, 2001), a firm that can provide sufficiently meaningful differentiation at the level of assembly or delivery may create competitive advantage. Customer value comprises both benefits and sacrifices (Zeithaml, 1988; Mazumdar, 1993); partial customisation offers a potential method of increasing benefits without a concomitant rise in sacrifices, thus augmenting total value. The customising firm may also benefit; customers may be willing to pay more for a partially customised product. The partially customised product will generate higher gross profit margins as customers pay more for a product that does incur any increases to marginal costs.

Third, the current study adds to the debate surrounding manufacturing trade-offs. It has been suggested that advanced production models, such as mass customisation, overcome traditional notions of manufacturing trade-offs. The study shows that at the level of full customisation, customer input into design or fabrication, significant trade-offs still exist. The existence of trade-offs has important implications for manufacturing strategy. Trade-offs
force choices between strategic positions, firms cannot be all things to all people, but must choose to compete in those areas that offer the highest customer value.

6.0 Limitations and future research directions

One threat to the validity of the findings is the distribution of the sample firms. Although there is no reason to suspect that the results would vary between countries, future research could be extended beyond the UK and may compare differences between countries. Two further concerns are the subjective performance measures and the potential for single respondent bias. The use of subjective measures was a deliberate choice on the part of the research team, however, future research may use objective measures to ensure the reliability of the findings. Single respondent bias is a concern, especially given the use of subjective measures; future research may either seek multiple respondents for the survey data or use a form of triangulation between quantitative and qualitative data (Forza, 2002). Furthermore, we would greatly encourage the use of longitudinal work in this area; studies may assess the impact of the introduction of mass customisation on the four competitive priorities. This would greatly help establish causality between the measures of performance.

Acknowledgements

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References


Figure 1: Positioning mass customisation
Table 1: Summary of respondents

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<th>£51-101 million</th>
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Table 2: Summary of dependent variables

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<td>Percentage pass final inspection*</td>
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<td>Speed of delivery</td>
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<td>Reliability of delivery times</td>
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<td>Percentage delivered on time*</td>
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* Objective measure
Table 3: Differences in costs across product types

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<td>Full custom (c)</td>
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<tr>
<td>Manufacturing costs</td>
<td>2.93</td>
<td>3.06</td>
<td>3.56</td>
<td>(a, c) * (b, c) *</td>
</tr>
<tr>
<td>Component costs</td>
<td>2.86</td>
<td>3.02</td>
<td>3.20</td>
<td>NS</td>
</tr>
<tr>
<td>Delivery costs</td>
<td>2.71</td>
<td>2.98</td>
<td>3.07</td>
<td>NS</td>
</tr>
<tr>
<td>Servicing costs</td>
<td>2.86</td>
<td>3.00</td>
<td>3.10</td>
<td>NS</td>
</tr>
</tbody>
</table>

* $P < 0.10$  ** $P < 0.05$  *** $P < 0.01$
Table 4: Differences in quality across product types

<table>
<thead>
<tr>
<th>Quality Factor</th>
<th>Product</th>
<th>Standard (a)</th>
<th>Partial custom (b)</th>
<th>Full custom (c)</th>
<th>F Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product durability</td>
<td></td>
<td>3.71</td>
<td>3.98</td>
<td>3.95</td>
<td>0.78</td>
<td>0.46</td>
</tr>
<tr>
<td>Product reliability</td>
<td></td>
<td>3.86</td>
<td>4.04</td>
<td>3.95</td>
<td>0.40</td>
<td>0.67</td>
</tr>
<tr>
<td>Conformance quality</td>
<td></td>
<td>3.86</td>
<td>4.04</td>
<td>3.98</td>
<td>0.43</td>
<td>0.65</td>
</tr>
<tr>
<td>Percentage returned</td>
<td></td>
<td>1.32</td>
<td>1.44</td>
<td>0.86</td>
<td>1.94</td>
<td>0.15</td>
</tr>
<tr>
<td>Percentage pass final</td>
<td></td>
<td>96.54</td>
<td>94.36</td>
<td>94.51</td>
<td>0.80</td>
<td>0.45</td>
</tr>
<tr>
<td>inspection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 5: Differences in delivery across product types

<table>
<thead>
<tr>
<th>Delivery Factor</th>
<th>Product</th>
<th>Pairwise Differences</th>
<th>F Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard (a)</td>
<td>Partial custom (b)</td>
<td>Full custom (c)</td>
<td></td>
</tr>
<tr>
<td>Speed of delivery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.21</td>
<td>3.68</td>
<td>3.50</td>
<td>(a, c) ** (b, c) * 3.91 0.02</td>
</tr>
<tr>
<td>Average lead time (days)</td>
<td>11.07</td>
<td>35.00</td>
<td>81.44</td>
<td>(a, c) *** (b, c) *** 7.57 0.00</td>
</tr>
<tr>
<td>Reliability of delivery times</td>
<td>4.00</td>
<td>3.83</td>
<td>3.51</td>
<td>NS 2.05 0.13</td>
</tr>
<tr>
<td>Percentage delivered on time</td>
<td>92.00</td>
<td>90.04</td>
<td>86.15</td>
<td>NS 1.57 0.21</td>
</tr>
</tbody>
</table>

* P < 0.10 ** P < 0.05 *** P < 0.01
Table 6: Differences in flexibility across product types

<table>
<thead>
<tr>
<th>Flexibility Factor</th>
<th>Product</th>
<th>Standard (a)</th>
<th>Partial custom (b)</th>
<th>Full custom (c)</th>
<th>F Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate efficiently at different levels</td>
<td></td>
<td>3.14</td>
<td>3.49</td>
<td>3.00</td>
<td>2.00</td>
<td>0.14</td>
</tr>
<tr>
<td>Operate profitably at different levels</td>
<td></td>
<td>2.79</td>
<td>3.15</td>
<td>2.80</td>
<td>0.17</td>
<td>0.32</td>
</tr>
<tr>
<td>Economically run various batch sizes</td>
<td></td>
<td>3.93</td>
<td>3.68</td>
<td>3.65</td>
<td>0.37</td>
<td>0.69</td>
</tr>
<tr>
<td>Vary aggregate output between periods</td>
<td></td>
<td>3.64</td>
<td>3.78</td>
<td>3.49</td>
<td>1.03</td>
<td>0.36</td>
</tr>
</tbody>
</table>