DESIGNER AS INTEGRATOR: REALITY OR RHETORIC?

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The literature suggests that internal and external product integration are key elements that facilitate a successful product development outcome. It also suggests that the industrial designer is well placed to be an integrating force within organizations. However, do organizations use industrial designers as integrators of various functions or do they use industrial designers for other reasons? The results from a survey conducted with Australian manufacturing organizations indicate that these organizations perceive the role as 'an integrator of various functions' as being the least important role performed by industrial designers. This suggests that the necessity of industrial designers to perform

organizational reality.

INTRODUCTION

Harrison and Lemonis (1996) discuss changes in the Australian manufacturing industry's competitiveness over time and have suggested that quality issues provided competitive advantage in 1980s. While organizations still need to consider price and quality as part of their continuous improvement strategy, Harrison and Lemonis (1996) highlight the move by manufacturers toward an emphasis on design and product mix changes. This view is supported by various researchers who have commented on similar changes taking place in Australia and other parts of the world (e.g. Bartezzaghi, Corso and Verganty, 1997, p.117; Foong, 1993, pp11-15; Knapp, 2001; Lee-Mortimer, 1994a; Murmann, 1994, p.236; Port, 1992; Prasad, 1998; Schilling and Hill, 1998; Spring, McQuater, Swift, Dale and Booker, 1998, p.45; Whitney and Shimelfarb, 1994, p.58). For example, Cusumano (1994) reported that during the 1980s, 'the nine major Japanese automakers gradually took advantage of their manufacturing capabilities to shift the primary competitive domain to product development' (p.27). This shift, according to Cusumano (1994), has resulted in shorter 'development times...expansion of product lines...as well as adoption of full model changes every four years' (p.27). (According to Cusumano, 1994, 'U.S. and European automakers' replacement cycle ranges from 'six to eight years and more', p.27.)

In addition, Gobé (1993) has stated that 'superior design is now perceived as essential, because it impacts both businesses for whom it is created and the public at large', he adds that 'there can be no doubt that design is among

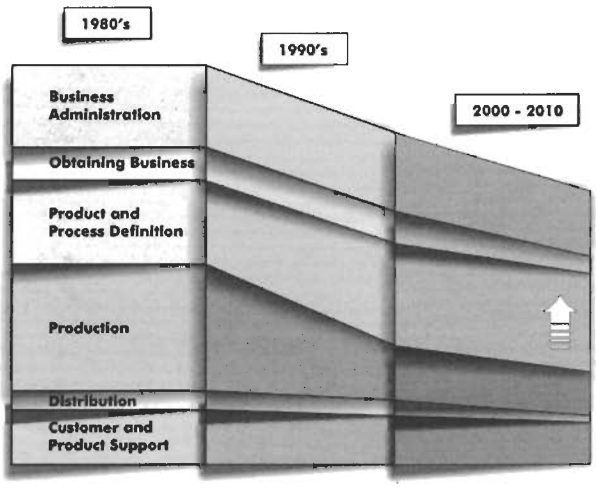

Figure 1: Anticipated change in the relative size of the manufacturing organization. Source: Duncan (1994, p.151).

the most significant ways to pursue competitive advantage' (p.22). This shift is also supported by Duncan's (1994) prediction that the relative size of product and process definition function(s) will increase in the future within organizations, reflecting a greater emphasis placed on the product development process (pp.150-152).

Schilling and Hill (1998) argued that this shift is the outcome of globalization, which has increased the market competition and as a result it is harder for organizations 'to differentiate their products offerings on the basis of cost and quality' (p.68). Therefore, they reason, 'new product development has become central to achieving meaningful differentiation' (p.68). For example, it is argued that this differentiation, especially in mature products (e.g. automobiles), can be accomplished 'by appealing to consumers' emotional response' (Smyth and Wallace, 2000, p.1).

Yamamoto and Lambert (1994) compared aesthetics, price and physical product attributes and their relative influence on evaluation and selection of industrial products (such as motors, solenoids, multimeters and pumps) by potential buyers. They concluded 'in spite of the fact that industrial product appearance does not bear upon performance,' it 'may have (a positive) impact upon product evaluation' (p.315). Therefore, 'attention paid to product aesthetics may have a payoff in terms of sales performance', and thus 'industrial design can be a competitive weapon' (p.317).

Lee-Mortimer (1994b) reported that in Japan design is indeed used as a strategic tool (p.33). A similar trend appears to be occurring in Australia where manufacturers using more advanced strategies are moving beyond a focus on quality and incorporating design as a 'manufacturing' strategy (see Bohemia, 2000).

The above suggests that as lean manufacturers focus more on design aspects than other manufacturing groups, they will view industrial design as providing competitive advantage, and therefore will use design differently from the other two identified manufacturing groups. For example, Owen (1993, p.12) has proposed that design in the future will be used differently, not in its traditional 'styling' role 'at the back end of design process', but rather 'at the front end' in a capacity to generate new concept designs. Krolopp (1994) supports this by arguing that 'designers are much more than stylist' as they are 'problem-solvers' involved in all facets of research, development, marketing and manufacturing (p.38), and they also provide a vision for the company (p.37).

Stefano Marzano, Senior Design Director at Philips, has articulated (cited by Beckwith, 1994, p.15) that responsible design should be concerned with, amongst others things, design for assembly and disassembly and design for durability. This is supported by literature, which suggests that design should play an important role in the early stages of the product development process as decisions made during the design process impact on nearly all aspect of the product (e.g. Houliham, 1993, p.26; The Warren Centre for

Advanced Engineering *et al*, 1987). The reason is that even though the design stage might account for only 5 to 20 per cent of the overall development budget, it determines up to 70 to 80 per cent of the product cost (e.g. Bhat, 1993, p.26; Chapman, Bahill and Wymore, 1992, p.10; Whitney, 1988, cited by Corbett, Dooner, Meleka and Pym, 1991, p.97; Crawford, 1994, p.226; Hills, 1995, p.492; Port, 1992, p.180; Römer, Pache, Weißhahn, Lindemann and Hacker, 2001, p.475; Rutter, Becka and Jenkins, 1997, p.41), see Figure 2. This means 'in a design process, the cost of changes early is exceptionally low, whereas the cost of late changes is very high' (Reinertsen, 1997, p.14).

The literature also suggests that 'designers should be an integral part of the project team right from the start' (Beardsley, 1994, p.54). Beardsley argues that designers' experience and their ability to visualize and to relate abstracts to everyday life can often facilitate common understanding during the design process among team members which 'ensures the successful coordination of many important aspects of a product' (1994, pp53-54). In addition, Beardsley has proposed that designers are also 'responsible for overall perception of quality in the product'

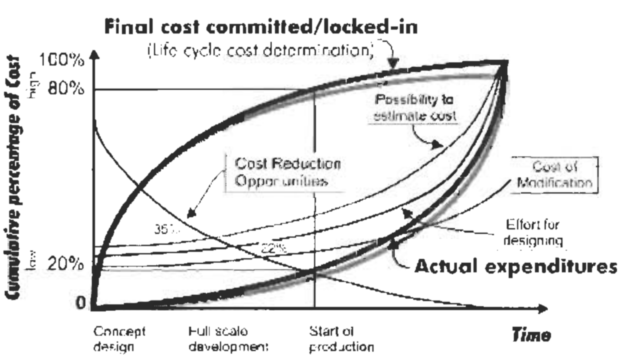

Figure 2: Cost as a function of time for a typical system design process. Based on Chapman et al (1992, p.10), Karbhari et al (1994, p.73), The Design Council et al (1994, p.6) and Ehrienspiel, Kiewert and Lindemann (cited by Römer et al., 2001, p.476).

as they are able to see both 'the total concept and each separate detail' (p.54). Therefore, she has concluded that they are the 'ideal bridge-builders between technology and its real users' (1994, p.54). It is also proposed that the design integration across engineering, marketing and finance often results in award-winning designs (Whitney and Shimelfarb, 1994, p.59). Clark and Fujimoto (1990) stated that integration is what gives companies the competitive edge (p.107). Shida (1994) has reported that integration values of design were seen by surveyed participants as the key elements in managing cross-programme and business issues for the corporation (p.33). Owen (1993, p.10) supports this view and has stated that customers are now concerned with the general level of quality as they 'equate quality with craftsmanship', in other words, how well the product is integrated (1993, p.10); and according to Clark and Fujimoto this product integration 'is achieved mainly through cross-functional coordination within the company and with suppliers' (1990, p.108). Literature in Australia has suggested that there was a recognition, as early as in the late 1950s, that industrial design could be used in other areas than just for styling purposes (Riley, 1958, p.32).

BACKGROUND TO THIS PAPER

The findings presented in this paper are part of a broader study which investigated the impact of lean manufacturing on the role of the industrial designer in Australian manufacturing organizations.

Part of the results from this broader study have already been reported in the article titled 'Suitability of Industrial Designers to Manage a Product Development Group: Australian Perspective' (Bohemia, 2000), which was featured in the 'Academic Review 2000' issue of the *Design Management Journal*. This article provided a description of the lean manufacturing paradigm and the research method used in the large study. It has also reported on the following issues:

- The manufacturing paradigm being used by various Australian manufacturers
- If these manufacturers incorporate designers in their product development process
- Whether they have a product development group and if so,
- What functional areas are represented in this group during different stages of the product development, and
- Who is responsible for the management of the product development group, and lastly,
- Whether senior management consider industrial designers as suitable managers of product development groups.

The most critical conclusions concerning industrial design were that the surveyed organizations perceived the industrial designer's importance as *the source of new product ideas* as very low and that only one fifth of the organizations have felt that industrial designers would be *suitable to manage the product development group* (Bohemia, 2000, p.48). However, a higher percentage of lean manufacturers (lean manufacturers are defined as using lean manufacturing strategies) (37 per cent) perceived industrial designers to be suitable to manage the product development group than both emergers (emergers are defined as using some lean manufacturing strategies) (25 per cent) and non-lean manufacturers (14 per cent). The lean manufacturers also had a higher perception of industrial designers as being the source of new product ideas ($\overline{X}$=3.7) than emergers ($\overline{X}$=3.3) and non-lean manufacturers (non-lean manufacturers are defined as using strategies associated with mass production) ($\overline{X}$=2.5).

The current paper will outline additional findings from the broader study, focusing on the question 'Why is industrial design used by Australian manufacturers?' The results will be presented for all surveyed organizations. The data will then be grouped to contrast the results from organizations that only employ industrial designers with those that contract. Finally, the use of industrial design by various manufacturing groups, that is, lean, emergers and non-lean manufacturers, will be analysed. It was hypothesised in the original study that as organizations move towards lean manufacturing, the reasons for using industrial designers would change.

OBJECTIVES

The aim of the current research was to establish the reasons why Australian manufacturers use industrial design.

METHOD

The survey was designed to gather data on organizational demographics; use of production, design and management techniques; as well as the role and use of industrial design by these organizations. The survey questionnaire was posted to 220 manufacturing organizations located throughout Australia. The number of returned questionnaires was 134, representing a nearly 61 per cent response rate. The main industries were: furniture (25.4 per cent), transport (12.7 per cent), electrical (12.7 per cent) and plastics (11.9 per cent). These four industries accounted for 62.7 per cent of respondents.

The key reasons why organizations use industrial design have been measured using 14 indicators that incorporate the variety of benefits that the industrial designer may deliver to an organization. These indicators were:

- to increase perceived value, product durability, product safety, appearance of the product, efficiency in production, market share, product quality, manufacturing flexibility, and product differentiation, and

- to reduce number of parts, development time, operating costs and product cost, and
- to integrate the various functions in the organization.

The above were measured on a six-point scale where the lowest score was zero for 'not applicable' and highest was five for 'extremely important'.

ANALYSIS AND RESULTS

Why are organizations using industrial design?

Mean scores were calculated for the reasons that industrial design is used by organizations (see Figure 3). Respondents perceived the three most important reasons for using industrial design to be: *increase in appearance of the product* ($\bar{X}$=4.43, s=1.00), *increase in product quality* ($\bar{X}$=3.86, s=1.21), and *reduction in the product costs* ($\bar{X}$=3.83, s=1.30).

The three least important reasons for using industrial design were considered to be: *reduction in operating cost* ($\bar{X}$= 3.11, s=1.58), *reduction in number of parts* ($\bar{X}$=2.91, s=1.58), and as an *integrator of various functions* ($\bar{X}$=2.36, s=1.87).

Employed vs contracted industrial designers

It has been found that overall the importance of various roles performed by industrial designers were perceived to be higher for employed industrial designers compared with contracted industrial designers; except for the roles of *improving appearance* and *reduction of development time* (see Figure 4). It is not surprising that the role of *integrating other various functions* was scored substantially higher (but still perceived to be the least important of all the roles) for employed industrial designers ($\bar{X}$=2.90, s=1.93), than for contracted industrial designers ($\bar{X}$=1.62, s=1.52).

Reasons for use of industrial designers by the manufacturing groups

Why non-lean manufacturers use industrial design. Non-lean manufacturers perceived the top three reasons for using industrial design to be: *increase appearance of the product* ($\bar{X}$=4.39, s=0.92), *increase product quality* ($\bar{X}$=3.87, s=1.23), and to *increase efficiency in production* ($\bar{X}$=3.71, s=1.23).

The three least important reasons for these organizations using industrial design were: *reduction in development time* ($\bar{X}$=2.90, s=1.76), *reduction in number of parts* ($\bar{X}$=2.47,

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	To increase:		To reduce:
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8i4	appearance of the product	8r13	product cost
8i5	efficiency in production		
8i6	market share	8q14	as integrator of various functions
8i7	product quality		
8i8	manufacturing flexibility		
8i9	product differentiation		

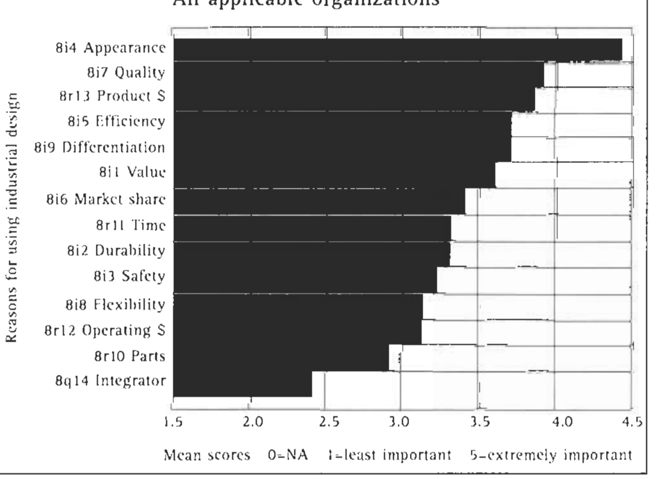

Figure 3: The reasons for using industrial design for all applicable organizations, in order from highest to the lowest mean score.

s=1.55), and as an '*integrator of various functions*' ($\bar{X}$=2.00, s=1.72) (see Figure 5).

Why emergers use industrial design. Emergers use industrial design for these top three reasons: *to increase appearance of the product* ($\bar{X}$=4.50, s=0.96), *to reduce product cost* ($\bar{X}$=4.18, s=0.98), and *to increase product quality* ($\bar{X}$=4.07, s=1.05).

The three least important reasons for emergers for using industrial design were considered to be: *increasing product safety* ($\bar{X}$=3.56, s=1.42), *increasing manufacturing flexibility* ($\bar{X}$=3.52, s=1.35), and *as an integrator of various functions* ($\bar{X}$=2.85, s=1.94) (see Figure 6).

Why lean manufacturers use industrial design. Lean manufacturers perceived the most important reason for using industrial design to be: *increase appearance of the product* ($\bar{X}$=4.41, s=1.23). The following three reasons were considered next important and of equal importance: *reduce product cost* ($\bar{X}$=3.59, s=1.46), *increase market share* ($\bar{X}$=3.59, s=1.54), and *to increase perceived value* ($\bar{X}$=3.59, s=1.77).

The three least important reasons for lean manufacturers

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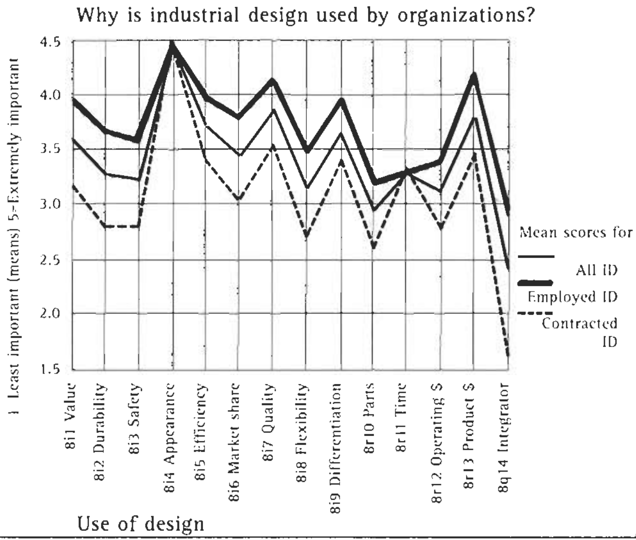

Figure 4: Reasons organizations (that employ or contract industrial designers) use industrial design.

Code	Figure Key:		
	To increase:		To reduce:
8i1	perceived value	8r10	number of parts
8i2	product durability	8r11	development time
8i3	product safety	8r12	operating costs
8i4	appearance of the product	8r13	product cost
8i5	efficiency in production		
8i6	market share	8q14	as integrator of various functions
8i7	product quality		
8i8	manufacturing flexibility		
8i9	product differentiation		

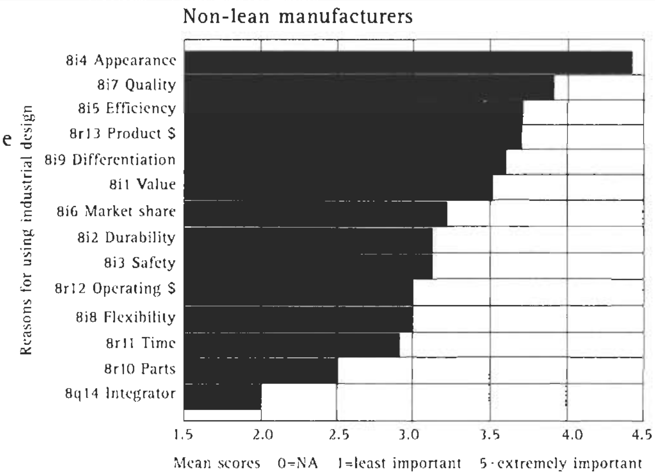

Figure 5: Reasons for non-lean manufacturers to use industrial design, in order from highest to the lowest mean score.

using industrial design were: *reducing number of parts* ($\overline{X}$=2.53, s=1.50), *reducing operating costs* ($\overline{X}$=2.29, s=1.76), and *as an integrator of various functions* ($\overline{X}$=2.13, s=1.93), which was again the lowest score out of all items in this question (see Figure 7).

There are similarities and differences in the way lean manufacturers, emergers and non-lean manufacturers use industrial design. '*Improving the appearance*' of the product is a primary reason for using industrial design across all manufacturing groups. This could be interpreted as the '*core*' reason for using industrial design and one would expect that this '*core*' reason would be included across all groups. '*Reducing product cost*' is an important reason for using industrial design for lean manufacturers and emergers. '*Increasing product quality*' is an important reason for emergers and non-lean manufacturers.

Lean manufacturers differ from emergers and non-lean manufacturers in considering '*to increase perceived value*' and '*to increase market share*' as important reasons for using industrial design.

It was hypothesised that as organizations move towards lean manufacturing, the reasons for using industrial

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8i8	manufacturing flexibility		
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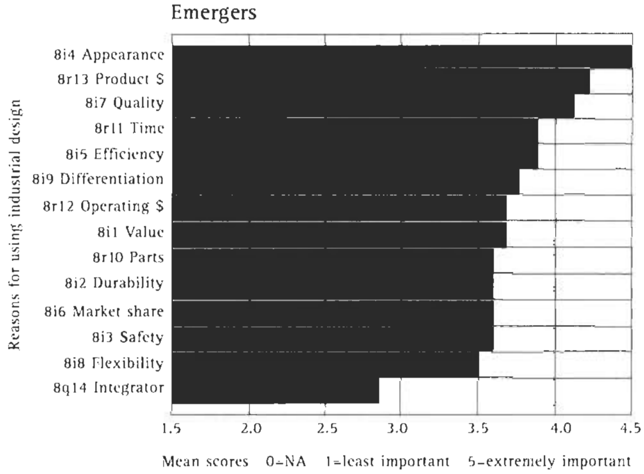

Figure 6: Reasons why emergers use industrial design, in order from highest to the lowest mean score.

Code	Figure Key: To increase:		To reduce:
8i1	perceived value	8r10	number of parts
8i2	product durability	8r11	development time
8i3	product safety	8r12	operating costs
8i4	appearance of the product	8r13	product cost
8i5	efficiency in production		
8i6	market share	8q14	As integrator of various functions
8i7	product quality		
8i8	manufacturing flexibility		
8i9	product differentiation		

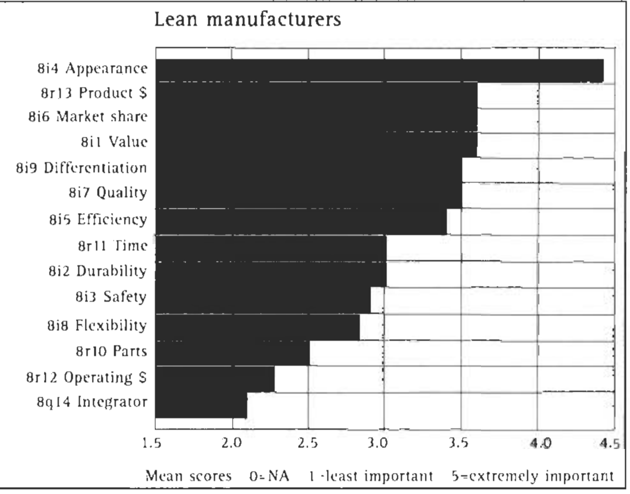

Figure 7: Reasons for lean manufacturers to use industrial design, in order from highest to the lowest mean score.

Rank	Lean manufacturers	Rank	Emergers	Rank	Non-lean manufacturers
1	Increase appearance of the product	1	Increase appearance of the product	1	Increase appearance of the product
2	Increase perceived value	2	Reduce product costs	2	Increase product quality
	Increase market share Reduce	3	Increase product quality	3	Increase efficiency in products
	product costs	4	Reduce development time	4	Reduce product costs

Table 1: Ranked top four scores for each group.

designers would change. Therefore, an analysis of variance was performed to test if there was a significant difference in the way industrial design is used by lean manufacturers, emergers and non-lean manufacturers.

Significant differences between the manufacturing groups

An analysis of variance was performed to test if there was a significant difference in the way industrial design is used by lean manufacturers, emergers and non-lean manufacturers (see Figure 8).

Results were obtained for the following uses:

- '*To reduce number of parts*', F (2,72)=4.8699, p=.0104. A post-hoc (Tukey's HDS) showed a significant difference between emergers ($\bar{X}$=3.61, s=1.45, n=28) and non-lean manufacturers ($\bar{X}$=2.47, s=1.55, n=30). Emergers considered 'to reduce number of parts', as being a more important reason for using industrial design than non-lean manufacturers
- '*To reduce development time*', F (2,73)=3.3050, p=.0423., A post-hoc (Tukey's HDS) showed a significant difference between emergers ($\bar{X}$=3.89, s=1.27, n=28) and non-lean manufacturers ($\bar{X}$=2.90, s=1.76, n=31). Emergers perceived 'to reduce development time', as being a more important use of industrial design than non-lean manufacturers
- '*To reduce operating cost*', F (2,72)=4.8302, p=.0108. A post-hoc (Tukey's HDS) showed a significant difference between lean manufacturers ($\bar{X}$=2.29, s=1.76, n=17) and emergers ($\bar{X}$=3.71, s=1.36, n=28).

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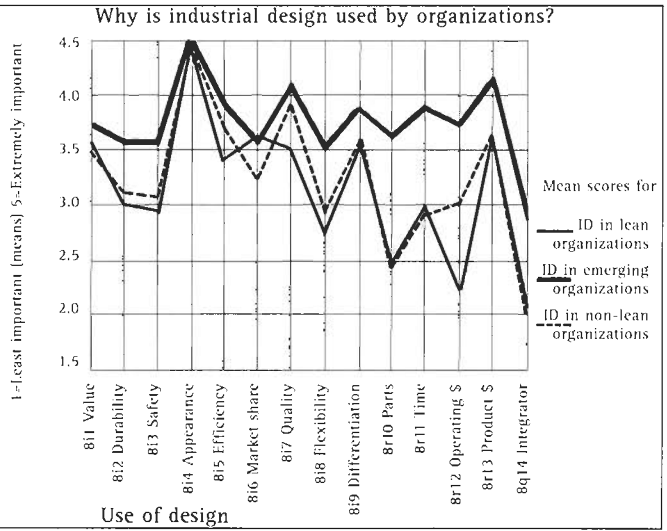

Figure 8: Mean scores for use of industrial design in lean manufacturing, emergers and non-lean manufacturing.

Emergers perceived 'to reduce operating cost', as being a more important use of industrial design than lean manufacturers.

The direction of the significant differences between lean manufacturers, emergers and non-lean manufacturers confirms the trends discussed in the literature, i.e. that manufacturers using more advanced strategies would focus on using less parts, reducing development time and would be relatively less concerned with efficiency issues such as reducing operating costs as these would have been already achieved.

DISCUSSION

At first glance, the data seems to be in the opposite direction to that suggested by the literature (see Figure 8). It would be expected that lean manufacturers would have a higher score than emergers on some of the reasons for using industrial design during the development process, particularly the roles of *integrator, increasing manufacturing flexibility, increasing efficiency in production, reducing operating cost, reducing number of parts* and *reducing development time.* The fact that emergers have scored higher than lean manufacturers on all reasons for using industrial design may indicate that as emergers are in a transition stage, and moving toward lean manufacturing, that they are placing more emphasis on a variety of design strategies that will move them in this direction; e.g. lean manufacturers may have already achieved substantial improvements in many of these areas.

However, the within groups analysis of the data (see Table 1) suggests that while emergers and non-lean manufacturers use industrial design to focus on quality, lean manufacturers seem to recognize that industrial design can be used to provide competitive advantage in other areas and focus on increasing market share and increasing the perceived product value.

The finding that the role of '*integrator of various functions*' was perceived to be the least important role performed by industrial designers conflicts with the literature. The literature claims that in general designers are well suited to be project integrators because of their educational background, which provides them with a cross-disciplinary knowledge (Basta and Vaggione, 1999; Ellis, 1994; Hertenstein and Platt, 1997, p.307). The literature also claims that industrial design is more and more perceived by industry as having 'the all-round role of coordination and integration' (Lorenz, 1986, p.7), and that it should be actively playing that role in organizations (Blaich and Blaich, 1993). Walsh and Roy (1985) have stated that amongst other things, a 'designer also acts as an integrating focus for the interaction between staff in other departments' (p.127). The findings from the current study present a very different picture of what is actually happening within Australian industry to the claims being made in the literature. The key role for industrial designers identified in the current study is still product appearance. While this may not be a particularly surprising finding, the ordering of some of the other roles is unexpected.

The finding that lean manufacturing organizations in Australia considered the role of *integrator* to be of little importance for industrial designers was particularly surprising as the literature suggests that this would be an important role for designers in these organizations (e.g. Clark and Fujimoto, 1990, 1991; Womack, Jones and Roos, 1990). This suggests an interesting area for further research. Can the difference be explained by a time lag between what has been predicted in the literature and organizational reality? Or are other dynamics influencing the results?

The role of *integrator* was perceived as being the least important across all the manufacturing groups (i.e. lean, emergers, and non-lean manufacturers), for both employed and contracted industrial designers. However, the results indicate that when an organization employs industrial designer(s), they perceive this role to be significantly more important than those organizations that contract industrial designers. This suggests that organizations that employ industrial designers involve them in more integrative activities within the organization. This has implications for the role of the designer, particularly if there is an increased trend towards contracting industrial design (Bruce and Morris, 1998).

In summary, the findings in relation to the importance of roles performed by industrial designers in contemporary Australian manufacturing organizations suggest that:

i. A time lag exists between organizational reality and what has been predicted by the literature
ii. The necessity of industrial designers to perform in the role of integrator is overrated, or
iii. The roles of industrial designers performed in Australian organizations are very different from the roles performed by industrial designers in the UK and the US organizations.

The above data interpretations have exposed a fruitful area of possible cross-cultural research into the role of the industrial designers.

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