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Most Advanced yet Acceptable: A case of referential form-driven meaning innovation

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Abstract: Adopting a research-through-design approach we report a study to examine how radical departures from archetypal product form influence product meaning. We then consider implications for product acceptability. To achieve this we employ form theory to drive the design of three conceptual products. The three concepts were then prototyped and used as stimuli to gather participant responses to radical departures in product form from a dominant archetype. Results indicated the necessity of balance between typicality and novelty of form to achieve more acceptable meaning innovations. Specifically, results showed a requirement for maintaining inherent archetypal form characteristics and qualities, while at the same time providing opportunities for meaning change through radically novel form compositions, axis and balance. This approach to form-driven meaning change we tentatively term Referential Form-driven Meaning Innovation (RFMI). Implications for the application of the RFMI approach both in practice and as conceptual departure point for further studies are finally discussed.

Keywords: Meaning Innovation, Form Aesthetic, Product Characteristics

1 Introduction

The Oxford English dictionary defines innovation as, ‘something new or different’ and ‘the act of innovating; introduction of new things or methods’ (OED: Oxford English Dictionary, 2015). Innovation is concerned with newness and the yet to be seen or known. As such the process of innovating new ideas and concepts is of particular importance to design. This is because the aim of design can be described as the transformation of existing products and services into preferred products and services (Simon, 1996). Although a definition of design is often debated with the resulting difficulty in reaching consensus, for the purposes of our investigation of radical form innovation and implications for acceptability, the Simon (ibid) definition is a useful starting point in understanding the role and importance of design-

driven innovation. This is because taking the Simon (op cit) definition in hand we can then understand the role of innovation as providing a means to reach the preferred state described in the definition. This also relates to Nelson and Stolterman's (2012) notion of an ultimate particular. As design problems are ill-defined and open ended (Rittel & Webber, 1973), the designer's goal is not to reach a single correct solution or truth, as is the case in the natural sciences for example (see also Archer (1995; 1979)). Instead the designer must draw towards an ultimate particular; a best solution given a developing understanding of the design problem.

Thus, a definition of innovation as centred upon the new or different has clear parallels to the Simon (1996) definition of design. Both design and innovation are concerned with change, with change being more or less radical in its approach to the new. Implicit in both is the desire for a positive change (innovation) or preferred difference (design). In the current paper we focus upon how radical form innovation, defined as a conspicuous form-driven departure from the product archetype, may influence product acceptability. That is, how do radical departures from a product's archetypical form influence its meaning and what implications does this have for its ability to be accepted, so standing a greater chance of being seen as both new and preferred?

2 Design Innovation

Design innovation appears to entail some kind of synthesis between the new and a desirable preferred. This then brings to mind Loewy's ("Raymond loewy Biography," 2015) MAYA (Most Advanced Yet Acceptable) dictum. This simplification of innovation in design, although indicative of a tension between the advanced and acceptable, is also problematic in its inability to clearly explain both constructs as they relate to the overarching aim of design: transforming the existing into the preferred; acceptable for whom, in which context and at what time? To answer these questions it is thus important to contextualise design innovation as existing within and driven by user needs and satisfaction (Rampino, 2011), rather than advanced technical solutions alone. While we do not deny the role of technology as driver for innovation, the current study focused upon the former to consider how radical form innovation may implicate product meaning and acceptability. Although form and technical function can be seen as inseparable sides of the same coin (Crilly, 2010), we see form aesthetic as particularly critical to meaning change, and so focus upon an analysis of form as driver of change, with potential implications for acceptability. As such we interpret the MAYA principles as most advanced in meaning yet acceptable.

Building upon the Simon (1996) definition of design, and considering our focus upon user acceptability, the current study's examination of product form innovation also takes inspiration from Krippendoff's (2008) definition of industrial design as the creative activity that lends form and meaning to industrially manufactured objects. Thus, the relationship between form and meaning is well expressed within this definition. We extend this to innovation in meaning driven by radical form departures from the product archetype. Taking

this approach to the analysis of product form innovation we subscribe to Verganti's (2008; 2009) notion of *Design-driven Innovation* as innovating the meaning of a product. The product's meaning, as experienced by the user, becomes a driver for innovation. As an example the Italian company Alessi radically changed the meaning of a kitchen utensil, through radical departures in form aesthetic, from pure functional tool to a playful product, leveraging the users' affective response (Figure 1).

Figure 1 Meaning-driven innovation from Alessi

As a result of innovating the meaning of their products Alessi were able to achieve rapid market success. We do not however deny the importance of technology or market driven innovation. Indeed, as Verganti (ibid) proclaims, innovation in meaning must necessarily live alongside forces of market-pull and technology push. However, given the scope of our current investigation as concerned with the relationship between radical form innovation and acceptability, we see the construct of meaning change as providing potential for underpinning an investigation of the influence of product form departures from archetypical design. This is because form aesthetic is a critical driver of emotional response. That is, form is often subjective, relying upon interpretation of design aesthetic. As such it is important to the user's interpretation of both meaning and acceptability.

Thus, if we define innovation as concerned with the new and design aimed at transformation to a preferred state, form appears critical to the user's assessment of product meaning and acceptance. This then returns us to the central thesis of design-driven innovation in meaning (Verganti op cit); its relation to and dependence upon issues of diffusion and adoption within a user group when labelling anything as *innovative* (Erlhoff & Marshall, 2008).

The current study's examination of acceptability of radical form innovation explores how radical form-driven departures from an archetypal design influence product meaning. We define radical form innovation as an attempt to innovate the meaning of a product through departures from the product archetype. We then examine the implications of these departures for acceptability. We conclude by providing insights into how form may best be leveraged to provide opportunities for the synthesis of the often contradictory requirements of meaning innovation and acceptability.

3 Product Form Innovation

Taking a definition of design innovation as transformation to a preferred or more appropriate state, the current study focuses upon the relationship between form innovation and meaning change to explore implications for transformation to a acceptable preferred.

To help define the space within which form locates as influence on innovative design, we adopt Rampino's (2011) notion of a form-lever as driver for innovation. Contrasting the form lever with mode of use (function) and technology, and taking a definition of innovation as radical changes in meaning (R Verganti, 2008), Rampino (ibid) defines form driven innovation as, 'considering the product's morphological attributes in order to define a new form (figurative level) and a new language (meaning level)' (Rampino, 2011, p8). This approach may then result in aesthetic innovation, which is related to both the appearance of external form and the form's recognition as differentiated from existing products of the same category.

Rampino's (ibid) description of both form-driven innovation and the potential for its influence upon meaning change are particularly useful to the current study for two reasons. First, it clearly defines a category of innovation apart from the technical or functional. Second, as with the current investigation, Rampino (op cit) is interested in the potential for radical form innovations to implicate meaning change, with a particular emphasis on the implications of form innovation that departs from the product archetype. However, before we appropriate form-driven innovation as construct for examining acceptability it is worth pausing to explore the notion of form and how form may relate to acceptability in the context of design innovation.

Form, as posited by Erlhoff and Marshall (2008), is the visual shape of content. That is, form has physical material properties, but also is experienced as such; the context of form. This is discussed in terms of the Platonic concepts of the *World of Being* and the *World of Becoming*. The former describes the material properties of the natural world; fixed and constant truths in the best interests of the scientific tradition. In contrast the *World of Becoming* involves interpretation of these material entities. This separation of the material and its connotation has also been defined as, for example, expression and impression (Hallnas, 2011), which draws upon semiotic theory in notions of sign and signifier; denotation and connotation (Chandler, 2002). What all this has in common however, is a separation of entity (and its material properties as existing outside) and the critical role interpretation plays in constructing an understanding of form (the self). If we adopt a definition of innovation as acceptable newness and the goal of design as appropriate transformation (of products, systems and services) this later aspect of form as constructed expression and interpretation is of particular interest to our aims here.

Thus, form as purveyor of meaning in its ability to evoke aesthetic response is fundamental to design practice in its potential for innovative meaning change. If design is described as concerned with the ways in which users understand and project meanings onto the products

they appropriate and use (R Verganti, 2008), then understanding form's role in meaning innovation is fundamental to product success. This is because the potential of form as driver for interpretation can also influence assessment of technical or objective design characteristics, resulting in, for example, reduced acceptability (Hoegg & Alba, 2011). As such care is required in a form-driven approach to meaning innovation. Too radical a form may result in the unacceptable. Likewise, too moderate a change may also be perceived as less stimulating in terms of the projection of new meaning. This is because the user may both value novelty and stimulation, but at the same time require reassurance expressed through familiarity (Celhay and Trinquecoste, 2015). Interestingly, Hung and Chen's (2012) study of novelty as driver for aesthetic preference in product design indicated the way in which typicality and novelty appeared as two distinctly separate constructs, each inhibiting the influence of the other.

This then brings us neatly back to a discussion of the typical and novel in relation to form and meaning; most advanced yet acceptable. Verganti (2008) discusses the constructs of both product archetype and dominant design, with the former indicative of an established typical form language as related to a product category (i.e. a chair's four legs, seat and back). In contrast, dominant design is described as closer to design icon (Hung and Chen op cit); a design that wins acclaim and attracts imitation from competitors due to its established authority (i.e. the iPhone from Apple Inc).

Related to this, Hekkert et al's (2003) analysis of the MAYA principle also indicated how a combination of novelty and typicality was best placed to provide opportunities for acceptability. Likewise, the current study indicates the interactive effect of novel form with reference to the form archetype as best placed to satisfy the stimulation of novelty grounded by sufficient reference to the familiar.

The relationship between typical and novel is also taken up by Celhay and Trinquecoste (2015) in their analysis of user response to atypical designs. Results indicated a relationship between radical innovation and typical design. In the case of radical innovations and new product categories, users appeared to prefer more typical or archetypal designs. In contrast, novel or atypical designs were preferred in more incremental innovation. This then also suggests acceptability depended upon product category, with more established products providing greater opportunities for meaning innovation. The current study's choice of product stimuli (tableware) is based upon the assumption that the product's well established category provided greater opportunity for participants to focus upon radical and atypical form departures from the product archetype in pursuit of new meanings, rather than emergent technical aspects.

3 Research Aims

This paper presents a study aimed at examining the influence of form upon meaning innovation. The work presented here explores how product form innovation may influence

product acceptability and implications for design-driven meaning innovation. With these research aims, we address the following two research questions.

- Do radical departures from *archetypal product form influence* product meaning?
- What are the implications of radical form-driven meaning innovation for product acceptability?

4 Research Methods

4.1 Research-through-Design

In order to control and specify the manipulation of form away from the product archetype, the authors adopted a research-through-design approach. This provided opportunities to underpin the design of product stimuli with form theory. We were thus in a position to better examine how differing approaches to radical form design, as defined by specific form manipulation (i.e. axis, form type, proportion) influenced product meaning and acceptability.

For the purposes of our investigation it was decided the choice of product should be based upon our aims of exploring form as influence upon acceptability. As such, tableware was chosen as a product category that both leveraged form as driver for product personality and constituted an establish product type. Within this category, table bowl was chosen as a product that would be familiar to our participants. Familiarity was important in our examination of departures from product archetype as archetypal status is achieved through both past experiences and recognition that a particular form does or does not embody an archetypal design.

As mentioned above, design work made use of form theory as anchor for conceptual design ideation. In particular we drew upon Rowena Kostellow's (Hannah, 2002) universal theory of form aesthetic. Through a series of exercises first undertaken at Pratt Institute, New York, Hannah (ibid) describes a set of fundamental and universal elements and principles of form. Included in these rich descriptions is a repertoire of form types that include both rectilinear and curvilinear forms. The former describes a category of form defined through parallel lines, right angles, mass, plan and line-like forms. The later form compositions are concerned with the integration of geometric primitives including cone, sphere, hemisphere, cylinder and ovoid. Through a combination of two or more of these individual elements, paying attention to position and axis, a designer may create a composition of forms, each with its individual character, but each lending to the other to create a complete whole. Through this process differing form characteristics may be expressed; stable, balanced, dynamic, static etc (Figure 2).

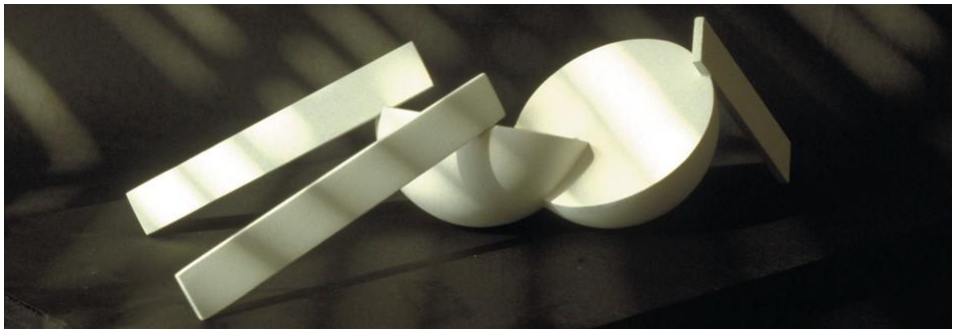


Figure 2 Example curvilinear/rectilinear form composition. From Hannah (2002)

Figure 3 illustrates some of the design ideation work produced during our research-through-design approach. The final three design concepts (A, B and C) were embodied and expressed through three high fidelity prototypes using digital modelling and printing processes. The design prototypes were finished using simulate identical pure white surfaces to limit the effect of material differences and focus participant assessment upon differentiation in form.

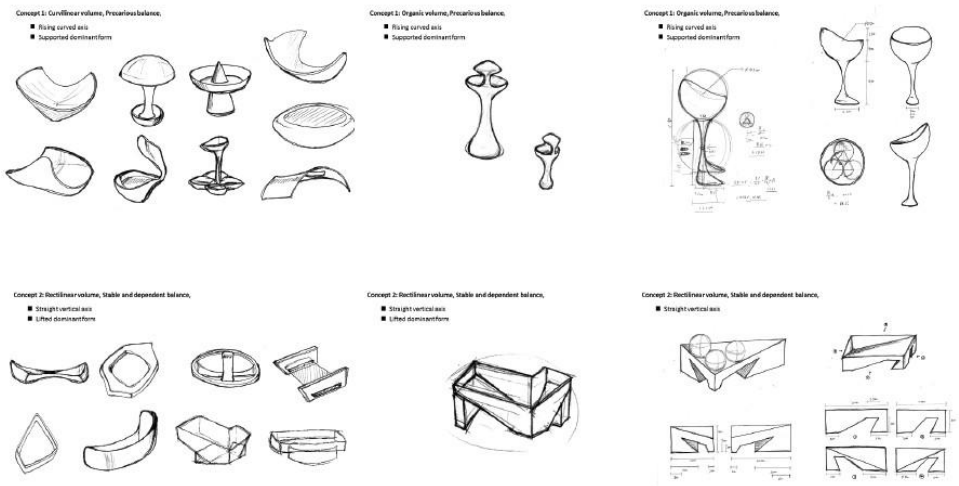


Figure 3 Research-through-design concept ideation sheets

Drawing upon Kostellow's theory of form, we adopted the concepts of rectilinear and curvilinear; stability and balance to drive the development of three product concepts. A first design (Design A) followed the product archetype of a curvilinear form with tapered sides narrower at the base and wider at the top.

A second concept (Design B) aimed to depart from the product archetype (Design A) in terms of its curvilinear design, with strong vertical axis creating an impression of both greater dynamic movement and precarious balance (Figure 4, Design B). A third (Design C) was produced to be entirely rectilinear in design, expressing stability of form while constituting a clear departure from the archetypal design (A).

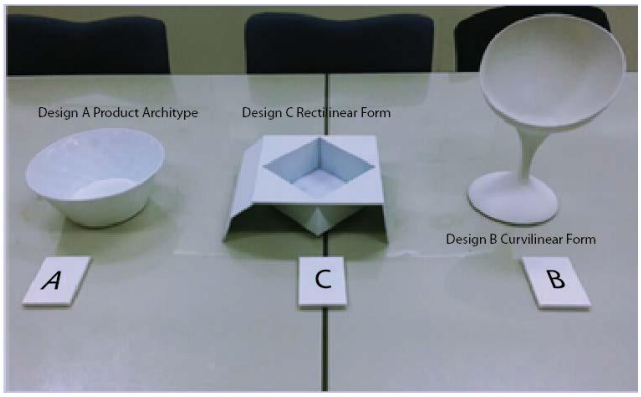


Figure 4 Final three design concepts (A, B and C) as prototype stimuli

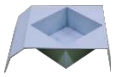
4.2 Participants

A total 50 college students from various majors participated in an experiment to examine the influence of radical form departures from the product archetype upon acceptability (*n=50*). Twenty-eight participants were male, and twenty-two were female, with an age range between 19 to 35 and an average of 23.8 years.

4.3 Design Stimuli & Data Collection

The three prototypes expressing the form designs (Table 1, A, B and C) were used as stimuli to gather data related to acceptability. As such, the three concepts acted as vehicles through which acceptability could be measured and compared between Design A (Archetypal form), Design B (Curvilinear/precarious balance) and Design C (rectilinear stability).

Table 1 Design stimuli code and each description embedded characteristics

Description	Design	Form Characteristics
A Product Archetype		Archetypal design. Bowl form
B Curvilinear Form		Curvilinear design, Precarious balance, Rising curved axis
C Rectilinear Form		Rectilinear design, Dependent balance, Straight vertical axis

The evaluation of each concept was conducted in four phases. Each phase consisted of two sets of semantic differential scales (SDs). In choosing the two sets we drew upon the work of Khalaj and Owen (2014), and the notions of Qualities of Form (QF, Figure 5) and Design Personality Characteristics (DPC, Figure 6). QF was used to evaluate the participants visceral (Norman, 2004) response to form aesthetic. DPC SDs were employed to explore responses to the more figurative personalities of the three concepts; their meanings as expressed through their form.

Responses were then examined to explore any relationships between radical form departures and product acceptability. The advantage of using the two sets of SD scales (SD and DPC) was that they provide two concepts to measure response to the form stimuli rather than one (Khalaj et al, 2014). In the current study acceptability was derived from responses to the two SD scales in terms of where responses fell between the two bipolar of each pair, using Likert-scale questions to record response. However, as not all pairs indicated a clear positive/negative dichotomy, only pairs with dichotomous adjectives were used in the assessment degree of acceptability (F1 Elegant-Inelegant, F4 Innovative-Imitative, H1 Interesting-boring, H2 Attractive-repulsive, H5 Mature-Immature, H8 Friendly-Unfriendly, and H10 Extraordinary-Ordinary).

As a result, it was found that those bipolar pairs without a clear positive/negative dichotomous relationship were less suited in the assessment of the participants' acceptability of the product form stimuli.


Part #-1 Qualities of form of a product

Quality of Form

F1	**Elegant**	_____	_____	_____	_____	_____	**Inelegant**
F2	**Organic**	_____	_____	_____	_____	_____	**Geometric**
F3	**Ornate**	_____	_____	_____	_____	_____	**Plain**
F4	**Innovative**	_____	_____	_____	_____	_____	**Imitative**
F5	**Compact**	_____	_____	_____	_____	_____	**Large**
F6	**Symmetrical**	_____	_____	_____	_____	_____	**Asymmetrical**
F7	**Simple**	_____	_____	_____	_____	_____	**Complex**
F8	**Dynamic**	_____	_____	_____	_____	_____	**Static**
F9	**Soft**	_____	_____	_____	_____	_____	**Hard**

Middle point

* Ornate(화려한), Organic(자연의, 인위적이지 않은)

Figure 5 Survey sheet showing 9 SD scale design quality of form (QF) bipolar. From Khalaj and Pedgley (2014)

Part #-2 Personality characteristics of a product

Personality Characteristic

H1	Interesting	_____	_____	_____	_____	_____	Boring
H2	Attractive	_____	_____	_____	_____	_____	Repulsive
H3	Feminine	_____	_____	_____	_____	_____	Masculine
H4	Quiet	_____	_____	_____	_____	_____	Noisy
H5	Mature	_____	_____	_____	_____	_____	Immature
H6	Exciting	_____	_____	_____	_____	_____	Calm
H7	Aggressive	_____	_____	_____	_____	_____	Submissive
H8	Friendly	_____	_____	_____	_____	_____	Unfriendly
H9	Futuristic	_____	_____	_____	_____	_____	Nostalgic
H10	Extraordinary	_____	_____	_____	_____	_____	Ordinary

* Submissive(순종적인), Nostalgic(향수를 불러 일으키는)

Figure 6 Survey sheet showing 10 SD scale design personality (DPC) bipolar. From Khalaj and Owain (2014)

4.4 Procedure

The experiment was conducted in a dedicated lab space environment at the researchers' institution, with the three design stimuli (A, B, C) arranged on a table in front of the participants (Figure 4). At the start of each session the design concepts were covered to prevent exposure prior to the administration of the 19 SD scale response questions.

First, participants were provided with information on the study's aims and their rights and obligations as research subjects. They were then provided instructions on how to complete the 19 SD scale responses during their assessment of the three design concepts. Each of the three concepts was then revealed in turn and the SD scales presented in Figures 5 and 6 provided to the participants to complete. Participants repeated this process three times (once for each of the concepts A, B and C). The order of participant concept evaluation was randomised to limit order effect. During concept evaluation, participants were free to handle and interact with the prototype designs in any way they wished. There was no time limitation provided; participants were free to take as long or as short a time as they wanted to complete the SD scale response questions. Session times ranged from 15 to 28 minutes. At the end of each session a single open-ended question was provided to the participants: Which form do you think is the most novel and why? SD scale responses to the 19 questions were finally archived for later statistical analysis.

5 Results

5.1 Product Personality & Influence of Radical Form

A One-way ANOVA test was run to examine if there was any significant differences between the participants responses to designs A, B and C in terms of the 19 SD response items. Results showed that the three different designs had a significant effect upon how participants responded to all bar one of the SD scales (*Table 2, F (2, 147), p < .05*).

Table 2 Significant effect of design upon participant responses

Label	F	w	p
Inelegant-elegant (F1)	11.872	0.126604667	.000
Geometric-Organic (F2)	4.064	0.039246648	.019
Plane-Ornate (F3)	10.871	0.116309048	.000
Imitative-Innovative (F4)	11.065	0.118316268	.000
Large-Compact (F5)	3.617	0.033722785	.029
Asymmetrical-Symmetrical (F6)	5.270	0.053871047	.006
Complex-Simple (F7)	10.701	0.072394546	.000
Static-Dynamic (F8)	6.853	0.114534988	.001
Hard-Soft (F9)	24.442	0.238132885	.000
Boring-Interesting (H1)	13.627	0.144095275	.000
Repulsive-Attractive (H2)	3.344	0.030307883	.038
Masculine-Feminine (H3)	14.117	0.148862486	.000
Noisy-Quiet (H4)	9.051	0.09693784	.000
Immature-Mature (H5)	8.670	0.092776368	.000
Calm-Exiting (H6)	2.203	0.015790027	.114
Submissive-Aggressive (H7)	9.538	0.102203332	.000
Unfriendly-friendly (H8)	4.360	0.042874992	.014
Nostalgic-Futuristic (H9)	8.817	0.094385033	.000
Ordinary-Extraordinary (H10)	9.446	0.101217322	.000

These results indicated that the three designs (A Archetype, B Curvilinear, C Rectilinear) were all understood as embodying significantly different form and personality characteristics when presented to the participants for evaluation. That is, the result indicated the radical form departures from the product archetype (B Curvilinear, C Rectilinear) significantly influenced the meaning of the three designs.

4.2 Concept Comparisons

In order to examine how individual differences between the three concept designs may have influenced participant acceptability*, t-tests* were conducted with designs A, B and C as independent variables and the 19 SD responses (9 QF and 10 DPC) as dependent variables.

Table 3 shows comparative results between the three possible comparison combinations (A archetype - B curvilinear; B curvilinear - C rectilinear; A archetype - C rectilinear).

Table 3 Comparative results of t-test

	Design Quality of Form (QF)									Design Personality Characteristics (DPC)									
Compared concepts	Inelegant-Elegant (F1)	Geometric-Organic (F2)	Plane-Ornate (F3)	Imitative-Innovative (F4)	Large-Compact (F5)	Asymmetrical-Symmetrical (F6)	Complex-Simple (F7)	Static-Dynamic (F8)	Hard-Soft (F9)	Boring-Interesting (H1)	Repulsive-Attractive (H2)	Masculine-Feminine (H3)	Noisy-Quite (H4)	Immature-Mature (H5)	Calm-Exiting (H6)	Submissive-Aggressive (H7)	Unfriendly-Friendly (H8)	Nostalgic-Futuristic (H9)	Ordinary-Extraordinary (H10)
A&B	.03	.71	.06	.07	.28	.03	.01	.32	.17	.36	.29	.01	.01	.08	.43	.68	.04	.06	.02
B&C	.00	.06	.08	.10	.83	.23	.33	.00	.01	.02	.07	.01	.01	.04	.68	.71	.02	.09	.48
A&C	.27	.04	.95	.44	.90	.29	.07	.13	.21	.31	.46	.89	.77	.86	.74	.73	.96	.48	.24

4.2.1 ARCHETYPE (A) AND CURVILINEAR (B)

The comparative analysis of the archetypal design (A) and curvilinear design (B) showed significant differences between three of the QF response items and four DPC response items. Significant differences between the three QF questions are further illustrated in Figure 7.

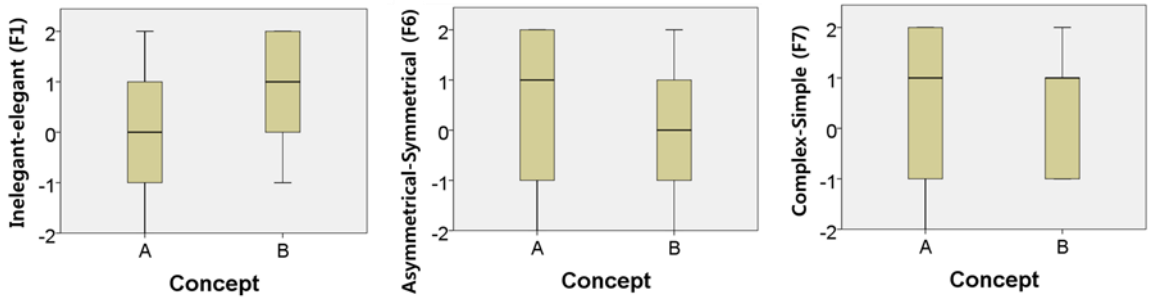


Figure 7 Box charts showing significant differences between Inelegant-Elegant (F1, left), Asymmetrical-Symmetrical (F6, centre) and Complex-Simple (F7, right)

Participants responses showed that the curvilinear design (B) was seen to be significantly more elegant (*M = 1.10, SE = 0.135, t (98) = -4.396*), asymmetrical (*M = .20, SE = .178, t (98) = 1.136*) and simple (*M = .46, SE = .160, t (98) = -.620*) compared to the archetypal design (A). In contrast, the product archetype (A) was seen to be more symmetrical (*M = .52, SE = .218, t (98) = 1.136*), inelegant (*M = .12, SE = .178, t (98) = -4.396*) and complex (*M = .30, SE = .203,*

t (98) = -.620). These results indicated that, in terms of design form, participants may have found the curvilinear design (B) more appealing (elegant) than the product archetype. If so, the results indicate participants' preference for the curvilinear design (B); indicating their acceptability of the product form. However, although significant differences were found between the assessment of the bipolar asymmetry-symmetry (F6) and complex-simple (F7), it is unclear if these significant differences influenced acceptability as neither of the two bipolar pairs (F6, F7) have a clearly negative/positive dichotomy. Table 4 summarises results for the three significantly different QF SD bipolar (response indicating potential acceptability in bold).

Table 4 Differences in quality of form (QF) assessment between designs A and B

Description	Design	Quality of Form	M	SE	t(98)
A Product Archetype		**Inelegant**	**.12**	**.178**	**-4.396**
		Symmetrical	.52	.218	1.136
		Complex	.30	.203	-.620
B Curvilinear Form		**Elegant**	**1.10**	**.135**	**-4.396**
		Asymmetrical	.20	.178	1.136
		Simple	.46	.160	-.620

Of the 10 DPCs, results showed significant differences in four of the 10 response items (Figure 8, Masculine-Feminine (H3), Noisy-Quiet (H4), Unfriendly-Friendly (H8), Ordinary-Extraordinary (H10).

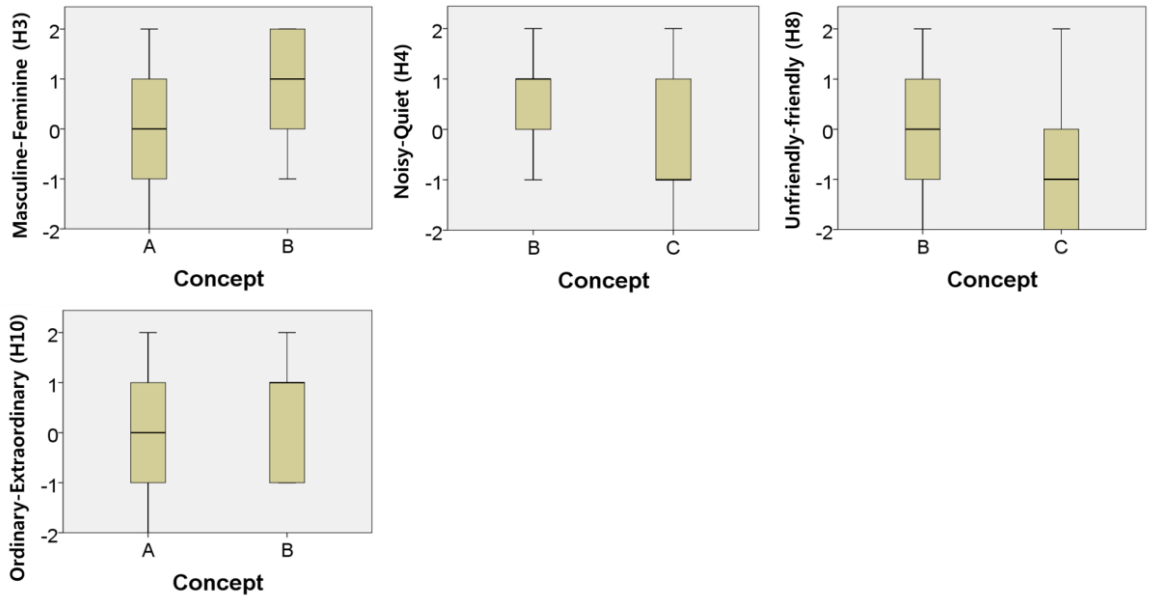


Figure 8 Box charts showing significant differences between Masculine-Feminine (H3), Noisy-Quiet (H4), Unfriendly-Friendly (H8), Ordinary-Extraordinary (H10).

Participants assessed design B (Curvilinear) as significantly more feminine (*M = .90, SE = .135, t(98) = -3.273*) and quiet (*M = .60, SE = .131, t(98) = -.820*), while design A was evaluated as significantly more masculine (*M = .16, SE = .182, t(98) = -3.273*) and noisy (*M = .42, SE = .176, t(98) = -.820*). However, the curvilinear design (B) was seen to be more unfriendly (*M = .08, SE = .148, t(98) = .337*) compared to the product archetype (A). The curvilinear design (B) was also assessed to be significantly more extraordinary (*M = .62, SE = .159, t(98) = -3.191*) as compared with design A. Table 5 summarises the results.

Table 5 Differences in design personality characteristics (DPCs) between designs A and B.

Description	Design	Design Personality Characteristics	M	SE	t(98)
A Product Archetype		Masculine	.16	.182	-3.273
		Noisy	.42	.176	-.820
		Friendly	**.16**	**.186**	**.337**
		Ordinary	**-.20**	**.202**	**-3.191**
B Curvilinear Form		Feminine	.90	.135	-3.273
		Quite	.60	.131	-.820
		Unfriendly	**.08**	**.148**	**.337**
		Extraordinary	**.62**	**.159**	**-3.191**

As indicated in Table 5, the product archetype was seen to be significantly more masculine compared to the femininity of the curvilinear design. However, as these two bipolar adjectives do not provide a clear positive/negative dichotomy, it is unclear if this result may have influenced acceptability. However, as design B was assessed to be significantly quitter compared to the *noise* of the product archetype (A), this result may have indicated comparative preference for the curvilinear design. The extraordinary result, compared to the ordinary archetypal design also indicated a preference for the radical form departure of design B, again indicating its acceptability. Design B was also assessed as being significantly more unfriendly than the product archetype (A). This contradictory result appeared inconclusive as to the acceptability of the radical form departure of design B in terms design personality characteristics. That is, although two of the significant bipolar responses (Noisy-quiet, extraordinary-ordinary) indicated preference for the curvilinear design (B), the pair unfriendly-friendly indicated preference for the product archetype.

4.2.2 CURVILINEAR (B) AND RECTILINEAR (C)

Next we ran *t-tests* to examine significant differences between design concept B (curvilinear) and design C (rectilinear). In terms of differences in response to the 9 QF SD responses, three proved to be statistically significant (Inelegant-Elegant (F1), Static-Dynamic (F8), Hard-Soft (F9)). Figure 9 illustrates the three significant differences in response.

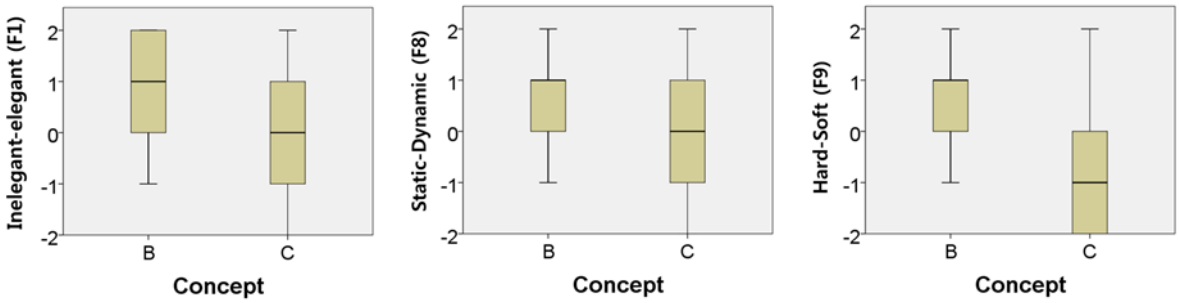
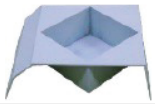


Figure 9 Box charts showing significant differences between Inelegant-Elegant (F1, left), Static-Dynamic (F8, centre) and Hard-Soft (F9, right).

As seen in Figure 9, the curvilinear design (B) was assessed as significantly more elegant compared to the rectilinear concept (C). It was also assessed to be more dynamic and soft compared with the rectilinear concept B. Table 6 summarises these results.

Table 6 Differences in quality of form between B Curvilinear Form and C Rectilinear Form

Description		Quality of Form	M	SE	t(98)
B Curvilinear Form		**Elegant**	**1.10**	**.135**	**4.460**
		Dynamic	**.58**	**.143**	**2.078**
		Soft	.64	.136	6.377
C Rectilinear		**Inelegant**	**.04**	**.196**	**4.460**
		Static	**.08**	**.193**	**2.078**
		Hard	-.86	.192	6.377

The curvilinear form departure from product archetype was assessed more positively than the rectilinear design in terms of QF characteristics. This thus indicated the curvilinear form was more acceptable than the rectilinear design. That is, a curvilinear departure from the product archetype was seen to be more appropriate compared to the rectilinear design.

Comparing design personality characteristics (DPCs) between the curvilinear concept (B) and rectilinear design (C) five of the 10 differences in SD scale responses were found to be statistically significant (Figure 10, Boring-Interesting (H1), Masculine-Feminine (H3), Noisy-Quiet (H4), Immature-Mature (H5), Unfriendly-Friendly (H8))(Figure 10).

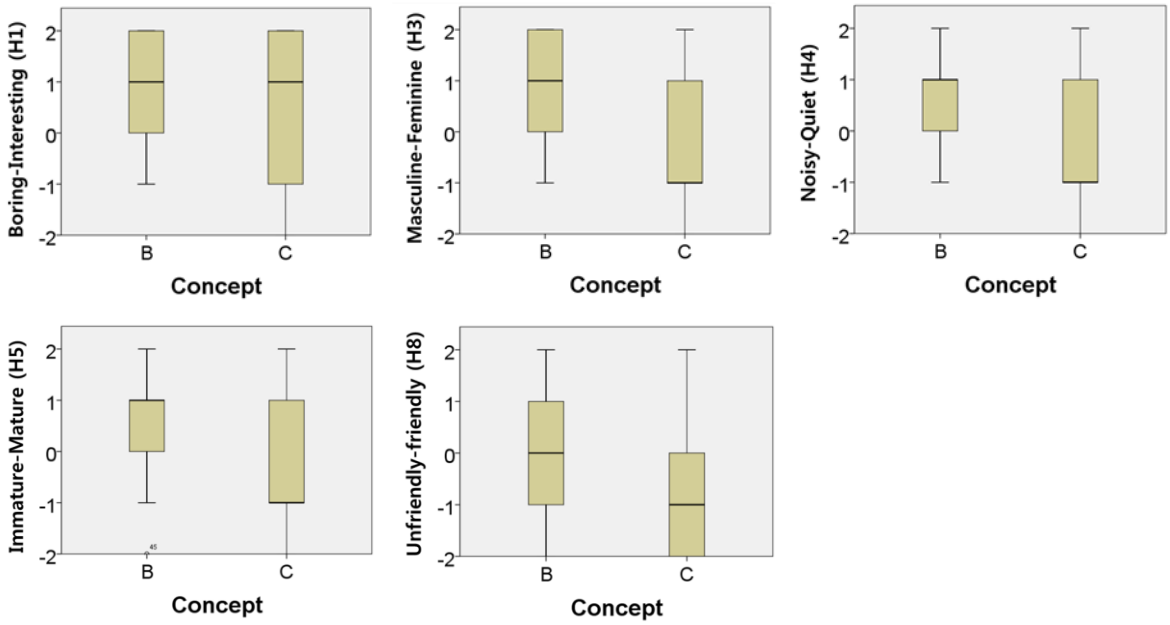
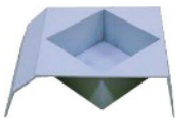


Figure 10 Box charts showing significant differences between Boring-Interesting (H1), Masculine-Feminine (H3), Noisy-Quiet (H4), Immature-Mature (H5), Unfriendly-Friendly (H8).

The curvilinear design B was assessed as significantly more interesting (*M = .92, SE = .159, t(98) = 1.535*), compared with design C, which was assessed as being significantly more boring (*M = .54, SE = .190, t(98) = 1.535*). Results also indicated the participants assessed the curvilinear design B as significantly more feminine (*M = .90, SE = .135, t(98) = 5.512*), quiet (*M = .60, SE = .131, t(98) = 4.212*) and mature (*M = .54, SE = .143, t(98) = 3.878*) compared to the rectilinear concept C. Finally, design B was also assessed as significantly more friendly (*M = .08, SE = .148, t(98) = 2.440*) compared to the rectilinear design C. Table 7 summarises these results.

Table 7 Differences in personality characteristics between B Curvilinear Form and C Rectilinear Form

Description	Design	Design Per onality Characteristics	M	SE	t(98)
B Curvilinear Form		**Interesting**	**.92**	**.159**	**1.535**
		Feminine	.90	.135	5.512
		Quite	.60	.131	4.212
		Mature	**.54**	**.143**	**3.878**
		Friendly	**.08**	**.148**	**2.440**
C Rectilinear Fo		**Boring**	**.54**	**.190**	**1.535**
		Masculine	-.36	.185	5.512
		Noisy	-.32	.175	4.212
		Immature	**-.36**	**.182**	**3.878**
		Unfriendly	**-.52**	**.196**	**2.440**

As indicated in Table 7, the curvilinear form departure appeared to be significantly more interesting, mature and friendly compared to the rectilinear form design C. This indicated participants assessed the design personality characteristics of design B more positively against design C. This may again have indicated the curvilinear form departure of design B was more acceptable than the rectilinear approach taken in the design of concept C. In terms of the two further personality characteristic bipolar pairs identified as significantly different between designs B and C (Masculine-Feminine (H3), Noisy-Quiet (H4), it is less clear if these may indicate differences in acceptability as neither has a clearly positive/negative dichotomy.

4.2.3 ARCHETYPE (A) AND RECTILINEAR (C)

From the 9 QF and 10 DPC SDs, only the personality characteristic Geometric-Organic (F2) was found to be significantly different between the product archetype (A) and rectilinear form departure (C). Figure 11 illustrates this result as a box-plot.

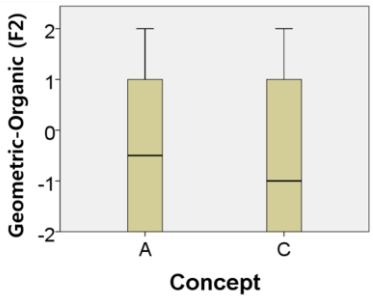


Figure 11 Box chart showing significant differences between Geometric-Organic (F2)

The statistical analysis showed that the participants assessed the archetypal design (A) as significantly more organic (*M = -.36, SE = .193, t(98) = .335*), compared to the rectilinear concept (C), which was rated as significantly more geometric (*M = -.46, SE = .227, t(98) = .335*). However, due to the SD bipolar inability to express a clearly positive/negative dichotomy (Geometric-Organic (F2)), the result could not be inferred to suggest differences in the perceived acceptability of the rectilinear design C compared to the product archetype A.

6. Discussion & Conclusions

The study reported in this paper aimed to examine if radical departures from archetypal product form influence product acceptability and to reflect upon the potential implications for form-driven meaning innovation.

In our research-through-design approach, three product stimuli (design A product archetype, design B curvilinear form, design C rectilinear form) were assessed by a sample of 50 participants through 19 bipolar five-item SD (Semantic Differential) scales. The 19 SD scale questions gathered data to indicate participant response to the form and personality of the three design stimuli. A One-way ANOVA test was run to examine if differences in

participant responses gathered through the 19 SDs were statistically significant. Results showed that the three designs had a significant effect upon how participants responded to 18 of the 19 SD scale questions. This result indicated the two radical form departures from the product archetype (Design B curvilinear and C rectilinear form) significantly influenced how participants assessed both the form and product personality of the three designs, indicating their influence upon meaning change.

In order to further examine if comparative differences between the three designs (A, B and C) influenced acceptability, *t-tests* were conducted for each of the 19 SD scale responses (9 Design Quality of Form and 10 Design Personality Characteristics). Results were then compared between three comparative combinations: design A product archetype and design B curvilinear form; design B curvilinear form and design C rectilinear form; design A product archetype and design C rectilinear Form.

In terms of comparative differences between the product archetype (design A) and the curvilinear design (B), three design quality of form (Inelegant-Elegant (F1), Asymmetrical-Symmetrical (F6), Complex-Simple (F7)) and four product personality characteristics (Masculine-Feminine (H3), Noisy-Quiet (H4), Unfriendly-Friendly (H8), Ordinary-Extraordinary (H10)) were found to be significantly different. Of the three significantly different design form attribute results, the more clearly dichotomous result of inelegant (design A, product archetype) and elegant (design B curvilinear form) suggested how the form of the radically curvilinear design departure may have influenced form acceptability. For the participants it appeared the strongly vertical, precariously balanced form of the curvilinear design was seen as more elegant than the product archetype, indicating increased acceptability. As the product archetype is also a curvilinear form, this result suggested a similar approach (in terms basic geometric primitives), but with strong departures in terms axis and balance, may have provided a radical yet more acceptable form aesthetic. Supporting this observation, further results comparing design B curvilinear form and design C rectilinear form also indicated significant differences between the participants' assessment of product form elegance; the curvilinear form B being assessed as significantly more elegant than the rectilinear form C. There was no significant difference in the participants' response to the elegance of the product archetype (A) compared to the rectilinear form design (C).

In the comparative analysis of design B (curvilinear form) and design C (rectilinear form) SD scale responses Static-Dynamic (F8) and Hard-Soft (F9) were found to be significantly different. This may again indicate how the two approaches to radical form departures from the product archetype may have influenced design acceptability, with the curvilinear form seen as more dynamic and softer. In contrast the rectilinear design (C) was assessed to be significantly more static and harder. These results appeared to indicate the participants' acceptability of the curvilinear design's (B) approach to radical form departure from product archetype. It appears the axis of the curvilinear form (B) were interpreted as more dynamic compared to the rectilinear design's more austere approach to radical form change. That is,

the curvilinear design's approach to form departure: radical axis and balance, but similarity in inherent qualities of curvilinear forms, was seen as more acceptable through reference to the curvilinear form of the product archetype (A).

In terms assessment of product personality characteristics between the three designs, all significant differences were found between design A product archetype and design B curvilinear form, and design B curvilinear form and design C rectilinear Form. The result for the SD Noisy-Quiet (H4) showed participants assessed the curvilinear design (B) as significantly quieter than both the product archetype (design A) and the rectilinear design (C). However, while results for the SD Unfriendly-Friendly (H8) showed participants assessed the curvilinear design (B) as friendlier than the rectilinear form (C), results also indicated how the participants also saw the archetypal design (A) as significantly more friendly compared to the curvilinear form. These results may indicate the acceptability of the curvilinear departure from product archetype, but only when compared to a rectilinear departure. In contrast, when compared to the archetypal product acceptability appears to have been compromised. Further evidence of this phenomenon was found in the result that when the curvilinear design (B) was examined against the product characteristics of the rectilinear design (C) two further significant results were identified (Boring-Interesting (H1) and Immature-Mature (H5)), with the curvilinear design (B) assessed as significantly more interesting and mature compared to the rectilinear form departure (C).

Finally, only the curvilinear design (B) was seen as significantly more extraordinary (Ordinary-Extraordinary (H10)) compared to the product archetype (A). In fact, only a single, unsurprisingly significant result was found between the rectilinear design (C) and the product archetype (A); Geometric-Organic (F2). This may have indicated the acceptability of the rectilinear form, in that no significant difference was found between the rectilinear approach and product archetype (A). However, considering the eight significant differences across product form attributes and product characteristics between the curvilinear design (B) and rectilinear approach (C), we discount this interpretation of findings. Instead we suggest these results indicated how the rectilinear design (C) lacked the ability to stimuli participant response compared to the curvilinear design (B). That is, with reference to the MAYA dictum, the rectilinear form departure may not have been 'advanced' enough in its departure from the product archetype, where advanced is defined as much by user interaction and assessment as by the product's inherent form characteristics alone. In contrast, the curvilinear approach appeared to attract more positive response, both in terms product form and characteristics, when compared with both the rectilinear design (C) and product archetype (A).

What implications do these results have for form as leverage for meaning innovation and acceptability? As discussed in the paper's introduction, a definition of innovation is founded upon the concept of newness. Paralleling this requirement, design can be described as appropriate transformations into preferred states (Simon, 1996). As such innovation provides the potential for design to be valued as new and innovative only if the solution is

seen to also be appropriate to the product, its use, function and context. Due to this last, but critical context specific requirement for innovative appropriateness, understanding what is or is not appropriate relies heavily upon subjective interpretation; or the product's meaning (Norman, 2004; R Verganti, 2008). Within this we have shown how radical, but specifically defined (employing a research-through-design approach and underpinned by form theory), departures from the typological product form have influenced how different form departures are assessed.

In terms of meaning innovation driven by radical departures from the form archetype, the results presented in this study have indicated the potential for form to provide opportunities for both acceptability (or appropriate transformation into the preferred) and meaning change (innovative newness). Participant responses have indicated that an approach which references the fundamental form elements of the product archetype (curvilinear design) may provide opportunities to satisfy the user's requirement for typicality as a kind of reassurance. However, an ability to at the same time provide novelty and newness (as seen in the curvilinear approach in terms dynamic axis and balance) in a departure from the archetype has potential to provide opportunities for novel meaning change, but at the same time be acceptably so in terms the assessment of appropriate transformation. These findings thus agree with Hung and Chen's (2012) study of novelty as driver for aesthetic preference in product design, indicating how typicality and novelty must co-exist in a tension to provide the most opportune foundations for form-driven innovation. Results are also in line with Hekket et al (2003) who indicate a necessary interaction between novelty and typicality as providing the greatest opportunity for innovative acceptability.

As such our study's contribution comes from the insightful observation that, in order for designers to leverage form as driver for meaning innovation, references to archetypical design provide opportunities to increase product acceptability when the essential qualities of the archetypal form are in some way expressed in the form departure. This approach to bridging the typicality/novelty divide we thus tentatively term Referential Form-driven Meaning Innovation (RFMI).

However, this initial explorative study does not provide a clear link between RFMI and successful form-driven meaning innovation. This is because, as mentioned above, meaning and its relationship to both form and design innovation is highly context specific, relying greatly on individual interpretation, which in itself is founded upon cultural and social frames of reference. Moreover, although results are interpreted as acceptability of form-driven innovation, it is unclear how or in what ways these findings relate to actual aesthetic preference or pleasure derived from interaction with the product form stimuli.

More work is now required to understand how RFMI may be appropriated and applied to the design of various products, experiences and services across different contexts, cultures and social environments. For example, how does RFMI relate to different product types and categories (i.e. interaction design, technology-driven, HCI) and differing contexts and experiences (domestic, public, private)? How does the RFMI approach relate to use and

product function? We believe answers to these questions have the potential to provide designers new tools and methods to assist in pursuit of form-driven meaning innovation. Continued work in this area will also help to develop a rich corpus of knowledge and understanding related to the critical importance form continues to play as driver for both appropriate transformation and innovative new meanings and experiences.

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