CULTURE AND CONCEPT DESIGN: A STUDY OF INTERNATIONAL TEAMS

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ABSTRACT
This paper explores the relationship between culture and performance in concept design. Economic globalisation has meant that the management of global teams has become of strategic importance in product development. Cultural diversity is a key factor in such teams, and this work seeks to better understand the effect this can have on two key aspects of the concept design process: concept generation and concept selection. To this end, a group of 32 students from 17 countries all over the world were divided into culturally diverse teams and asked to perform a short design exercise. A version of the Gallery Method allowed two kinds of activity to be monitored – the individual development of concepts and the collective filtering and selection of them. The effect of culture on these processes was the focus of the work. Using Hofstede's cultural dimensions, the output from the sessions were reviewed according to national boundaries. The results indicate that individualism and masculinity had the most discernable effect on concept generation and concept selection respectively. While the work sets out a methodology for applying cultural dimensions to concept design work, limitations and future work that more carefully consider the role of personality and individual variations are also described.

Keywords: Concept design, culture, national characteristics, teamwork, creativity

1 INTRODUCTION
While there are many forms of globalisation, including political, cultural and social, it is economic factors which are driving continued integration and inter-connectedness across geographical boundaries [1]. The implications of this have become a major topic of discussion [2-4]. In the context of product development, the management of global teams has become of strategic importance [5]. The benefits of cultural diversity include: increased ability to respond to local markets, organisational flexibility to changing environments, and enhanced creativity through a diversity of perspectives [6].

When looking for culture differences, people often fall back on national stereotypes. These are problematic in that they conjure an image that is applied indiscriminately to a populace. The bell curves shown in Figure 1 illustrate how in actuality a population may be spread around a particular characteristic: a Swede might be more expressive than an Italian despite the "average" Swede being more reserved. Depending on the homogeneity of a particular culture, the bell curve may be flatter or steeper. For example, Japan (a relatively collectivist nation) when compared with the United States (a relatively individualistic nation) would be likely have a steeper curve.

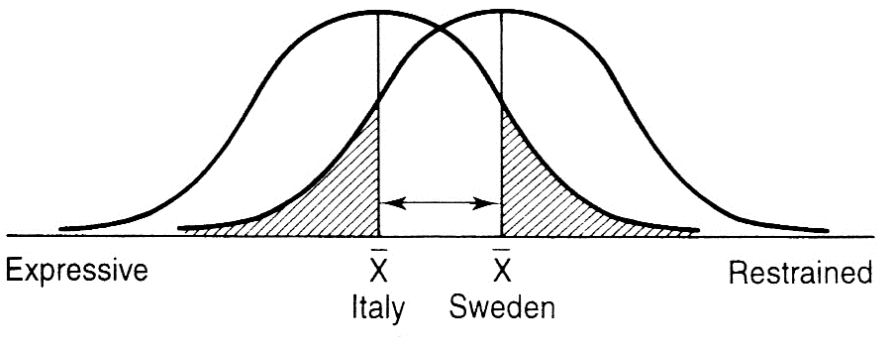

Figure 1: Bell curve representing national stereotypes for Italy and Sweden [6]

The overarching aim of this research is to better understand how the variation in national characteristics can affect individual and team performance in the conceptual design phase of the product development process.

2 HOFSTEDE'S CULTURAL DIMENSIONS

Geert Hofstede, a Dutch researcher, analysed national culture differences across subsidiaries of a multinational corporation (IBM) in 64 countries. He describes culture as one of three elements that affect behaviour: personality, culture and human nature [7]. Human nature describes the innate traits that all human beings have in common – the ability to feel, physical needs and so on. Personality is something unique to each individual and is a complex combination of learned and inherited traits – the "nature vs. nurture" debate. Culture is something learned and develops in localised groups and can be positioned between human nature and personality, as shown in Figure 2.

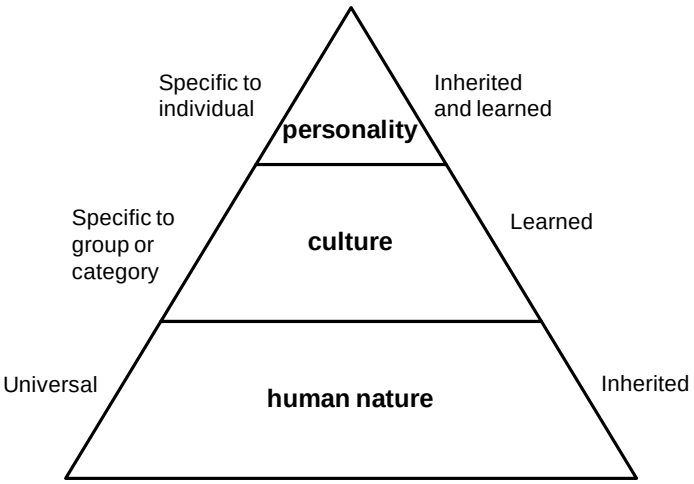

Figure 2: Design team context

Hofstede's studies identified and validated four independent dimensions of national culture differences, with a fifth dimension added later. These include:

- Power distance index (PDI): the extent to which less powerful members of an organisation expect and accept that power is distributed unequally.
- Individualism (IDV): the strength of ties between individuals in a society. In countries with a high index, everyone is expected to look after himself or herself and his or her immediate family.
- Masculinity (MAS): relates to the distinction of gender roles (i.e., men are supposed to be assertive, tough, and focused on material success whereas women are supposed to be more modest, tender, and concerned with the quality of life).
- Uncertainty avoidance (UAI): the extent to which the members of a culture feel threatened by uncertain or unknown situations. This is often expressed through nervous stress and a desire for written and unwritten rules.

A number of studies have explored the implications of Hofstede's work in relation to new product development [8]. Horii et al. [9] explored the different practices and values between Japanese and American organisational styles, concluding that culturally driven behaviour patterns have less impact on project outcomes than organisation styles. In their work on the effects of national culture on new product development, Sivakumar and Nakata [10] used a number of statistical optimisation models to develop a decision framework for global new product team design.

This work focuses on the importance of creativity in the early stages of the design process when ideas are being generated and selected, seeking to explore the effect that national cultures can have in this critical phase of product development. When exploring ethnic diversity in small teams, McLeod et al. [11] report that ethnically diverse teams were more creative than homogenous ones, although the homogenous teams were marginally more "attracted" to their teams. This assertion is further supported by a previous study by Van Boeijen and Badke-Schaub [12] on culturally diverse student design teams

concluding that "diversity creates creativity" and that "cooperation between team members with different cultural profiles leads to global solutions". While Van Boeijen and Badke-Schaub consider the design output generated from the activity to conclude that global solutions are produced, this work provides a quantitative analysis of design output in relation to the cultural composition of the design team.

While it is recognised that Hofstede's dimensions are intended for aggregate analysis and that several other sets of cultural dimensions exist [13], the aim of this paper is to set out an initial methodology for the application of cultural measures to concept design practice in a more tangible way than has previously been the case. The associated limitations of this initial study and intended future work are therefore reviewed in Section 6.

3 CONCEPT DESIGN

The image of the lone inventor fighting to realise an inspired and revolutionary idea is persistent, but rarely reflects the actuality of new product development. Today's technological products are typically so large and complex undertakings that it is beyond the scope of one person to accomplish this alone. The challenge is to harness the creativity of the range of individuals within the group by effectively coordinating their contribution. Indeed, one of the paradoxes facing the engineering industry is that large organisations must by their nature be run according to strict procedural and managerial processes to ensure maximise efficiency, and yet if they are to be innovative they must still be able to accommodate "imaginative non-conformists not readily amenable to formal discipline" [14]. Both Pugh [15] and Ulrich and Eppinger [16] suggest that it is important for designers to undertake a period of concept generation individually as well as in the group setting, with Pugh stating that the concepts are often better generated by individuals.

3.1 Brainstorming

Despite the development of various approaches to concept generation, brainstorming in its various forms [17] remains by far the most common technique used by companies in industry today. Brainstorming consists of a group of people working together in a non-critical environment to generate a high number of ideas. Although there are many variations, there is generally a facilitator, fixed timescale and whiteboard or appropriate writing implements. Organisations such as IDEO [18] have made this approach central to their corporate culture, and such is its popularity brainstorming is often used as shorthand for any meeting where groups try to develop some ideas. Given its verbal and informal nature, however, brainstorming did not provide a suitable format for identifying and understanding the role of each participant in the generation of concepts.

3.2 Gallery Method

Developed by Hellfritz [19], and described by Pahl and Beitz [20] as a tool in their systematic approach, the Gallery Method uses both individual and group modes of working. After being briefed on the design problem, participants are required to sketch their ideas individually and intuitively. These are then pinned on the wall for the group to debate and discuss the merits of each. Ideas and insights from the group discussion are then used by individuals, again working alone. This approach combines the productivity and insight of an individual working alone with the power of group discussion to spark new ideas and directions. It was decided to utilise a variation of the Gallery Method where the second iteration of idea development was omitted. In the study, this allowed two kinds of activity to be monitored – the individual development of ideas and the collective filtering and selection of them. The effect of culture on these processes was the focus of the research.

4 EXPERIMENTATION

The teams were asked to undertake a product design concept generation activity using a variant of the Gallery Method and to reflect on it from a cultural perspective. This follows a process simulating the combination of individual and team working often required in global working. The experimental methodology and set-up is described below.

4.1 Pilot study

An initial exercise was carried out during a workshop at the Institution of Engineering and Technology's 2010 European Young Engineers conference. Although the activity generated an interesting debate between 17 participants from 6 different countries, it was found to be too demanding for the allocated timeframe: participants were expected to develop a specification, generate ideas through brainstorming, and then rank them. As a result, the activity was revised using the more structured approach offered by the Gallery method and a project brief provided to participants in advance.

4.2 Main Study

The participants in this exercise were Masters students undertaking a module entitled Global Design. Its purpose was to introduce students to the issues associated with working in global product development teams. There were a total of 32 students from 17 countries all over the world. As a larger and more diverse group than the pilot study, this afforded an excellent opportunity to examine how they worked together in a design exercise. The students were divided into 10 teams of 3 or 4 that were culturally diverse. The list of teams, their countries and Hofstede's associated cultural dimensions are shown in Table 1.

Table 1: List of teams, countries and cultural dimensions

Participant	Team	Country	PDI	IDV	MAS	UAI
1	A	Mexico	81	30	69	82
2	A	Sweden	31	71	5	29
3	A	UK	35	89	66	35
4	A	Pakistan	55	14	50	70
5	B	UK	35	89	66	35
6	B	Bangladesh*	77	48	56	40
7	B	Spain	57	51	42	86
8	C	UK	35	89	66	35
9	C	Indonesia	78	14	46	48
10	C	Spain	57	51	42	86
11	C	UK	35	89	66	35
12	D	Mexico	81	30	69	82
13	D	Estonia*	33	63	26	59
14	D	UK	35	89	66	35
15	D	Mexico	81	30	69	82
16	E	UK	35	89	66	35
17	E	Indonesia	78	14	46	48
18	E	Germany	35	67	66	65
19	F	China	80	20	66	40
20	F	Poland	68	60	64	93
21	F	Sweden	31	71	5	29
22	G	Turkey	66	37	45	85
23	G	UK	35	89	66	35
24	H	India	77	48	56	40
25	H	UK	35	89	66	35
26	H	Brazil	69	38	49	76
27	I	UK	35	89	66	35
28	I	India	77	48	56	40
29	I	Lithuania*	68	60	64	93
30	J	Ukraine*	68	60	64	93

31	J	Bulgaria*	31	71	5	29
32	J	UK	35	89	66	35

*Cultural dimensions for these countries were not available – participants selected what they felt was the best alternative.

4.3.1 Brief

Teams were asked to design a product to assist urban supermarket shoppers in the transportation of a weekly shopping load without the aid of a car. Three basic requirements were set out for the product:

- Allow a person to transport a weekly shop across an urban environment
- Be desirable for a range of users (unlike the traditional "wheely trolley")
- Incorporate dual function/collapsibility/compactness that allows it to be carried through a working day or when empty

The exercise was then broken down into two phases: firstly, to individually generate as many ideas as possible (15 mins); secondly, as a team to review all of the ideas generated and decide on the five strongest (25 mins). The teams were then given the opportunity to have a general discussion to develop a better understanding of each other's cultures.

5 RESULTS

The work produced in the sessions was analysed. For each individual, work was reviewed for the number of distinct ideas (a single idea was judged as a representation having at least one distinctly different feature than all others developed by that person), the number of sketches (irrespective of whether they were multiple sketches of the same idea), and word count (including both annotation of sketches and verbal description of ideas). The five ideas chosen by the group were then reviewed for the participant/s who generated the idea and its ranking. A sample of output for Team A is shown in Figure 3. The results were then analysed using Hofstede's dimensions as described below.

Figure 3: Sample of output for Team A

5.1 Correlation matrix

In order to provide an overview of the relationships between the experimental variables and the cultural dimensions, a correlation matrix was constructed. The Pearson Product Moment Correlation (or Pearson's correlation for short) is used to reflect the degree of linear relationship between two variables. It ranges from +1 for a perfect positive relationship and -1 for a perfect negative relationship. The correlation coefficient is often designated by the letter "r". The r values for the session outputs against the cultural dimensions are set out in Table 2. These results suggest that individualism has the biggest effect on the number of ideas, with uncertainty avoidance also forming a significant relationship. The effect on selection of ideas is less clear, but individualism and power distance are the two most significant factor. Masculinity is shown to have the weakest influence on all aspects of the session.

Table 2: Pearson's correlation coefficient for session outputs against cultural dimensions

Output	PDI	IDV	MAS	UAI
Number of ideas	-0.46	0.58	-0.09	-0.52
Number of sketches	-0.33	0.43	0.06	-0.23
Word count	-0.24	0.32	0.14	-0.16
Weighted idea selection score	-0.44	0.51	0.12	-0.25

5.1.2 Idea generation

Individualism suggests freedom to think for oneself. Therefore, it was anticipated that it would play a major role in the participants' generation of ideas. The correlation matrix indicates that individualism does, indeed, form the strongest relationship with the number of ideas generated during the 15 minute idea generation phase. Generally speaking, participants from more individualistic countries produced more ideas. Uncertainty avoidance was also found to form a significant negative correlation, which is perhaps unsurprising – individuals from countries with a lower uncertainty avoidance rely less on written rules and conventions. Therefore, it could be speculated that they are more open to generating new ideas. Masculinity was shown to have the weakest correlation, indicating that gender stereotypes have little influence on the constitution or number of ideas generated.

Hofstede uses several examples of dimensions plotted together to reveal cultural groupings. One of these is an individualism and uncertainty avoidance graph (Figure 4). The groupings highlight that some countries can be more homogenous than others. In the upper-right, strong uncertainty avoidance (a resistance to variation) is combined with strong collectivism (identification with ingroups). This would tend to suggest groups that are less open to new ideas and deviations from the norm. Countries in the bottom left are more individualistic and have weaker uncertainty avoidance – this may provide a better platform for the unpredictable and open-ended approach that is utilised in brainstorming. This was framed as a "tendency to innovate" drawn from the top right to the bottom left of Figure 4. Hofstede's graph has been overlaid by the number of sketches produced by each participant during the session, and is indicated by the size of the bubble. The results show that while uncertainty avoidance has a moderate effect on the number of sketches produced, it is individualism which seems to play the most important role.

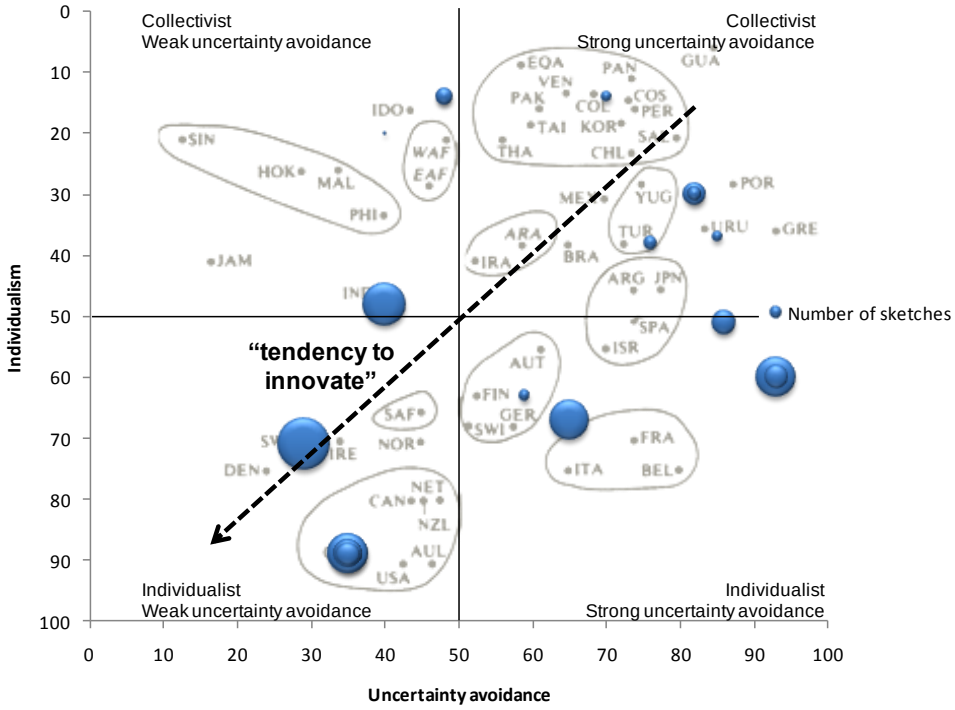

Figure 4: Position of participants on the uncertainty avoidance and individualism dimensions, after Hofstede [7]

5.1.3 Idea selection

Idea selection, the second phase of the concept design session, was then examined. The scored weighting was calculated using a reverse of the ranking, i.e. concepts ranked 1 scored 5, concepts ranked 2 scored 4 etc. These were then added to give an overall score for each participant. It was initially speculated that masculinity would play a significant role in the selection of ideas but Table 2 shows that this was not the case. This could be attributed to suppression of this characteristic given the relatively affluent and well-educated social grouping of participants, the fairly even gender mix, or the fact that the session took place in a culture where equality is generally taken for granted. Another explanation may be that evaluation was executed in a highly rational manner – those with high masculinity scores could still have been leading decision making but not pushing their own ideas for selection. These diverse factors serve to highlight the complexity of cultural analysis.

There was, however, a correlation again to be found with the individualism dimension. This may be due to the tendency for participants from more individualist cultures to speak their mind more freely without worrying about offending other members of the group. The second strongest link was with the power distance index – a negative relationship between these indicated that those with a higher power distance, i.e. the cultures that were more accepting hierarchy and differences in equality, had fewer ideas selected in the review process. Given that this was a free discussion for 25 minutes when teams had the opportunity to rank the best ideas from the individual idea generation phase, it can be speculated that participants from these cultures were more willing to accede to their colleagues or less willing to impose their will on others.

Hofstede uses this plot of power distance against individualism to indicate that in cultures where people are dependent on ingroups (collectivist) they are usually also dependent on power figures (high power distance), as shown in Figure 5. Again, this graph was overlaid with data from the session: in this case the bubbles on the graph indicate the weighted score for each entry. A "tendency to influence" has been identified to indicate that countries in the bottom left have a propensity to be more forceful in defending ideas that they have produced. This is a combination of being individualistic – not as concerned about others outside their social group – and a low power distance index – less concerned with hierarchies. This perhaps means that people from cultures in the bottom left are more likely to state what their opinion is and have less concern about hurting others. People from cultures in the bottom right see group harmony as the main priority and maybe more willing to go along with what is suggested.

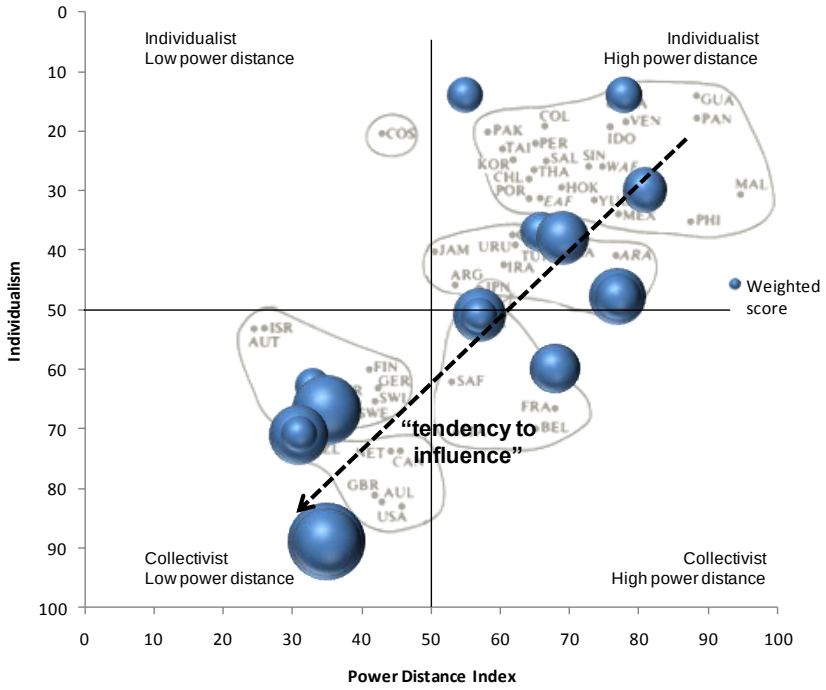

Figure 5: Position of participants on the power distance and individualism dimensions, after Hofstede [7]

6 LIMITATIONS AND FUTURE WORK

A recognised limitation of this work is the use of aggregate data with a relatively small group. Hofstede [21] has clearly stated that the data collected from the IBM study cannot be reliably assigned as absolute values to any individual, non-IBM group, or IBM group that may hold cultural values modified from those held at the time of the initial study. Other large-scale cultural studies such as the GLOBE project [22] are similarly clear that their findings do not scale to comparisons of individuals. While the authors are aware of these limitations, part of the purpose of this work was to develop a methodology for optimising creativity in multicultural team based design practice, and the activity and analysis described outline how this can begin to be achieved.

Although there are a limited number of proprietary approaches for exploring the impact of cultural values on individual or small group relationships and creative performance (such as ITAP International's [23] Hofstede-endorsed online survey tool), access to these is limited and the role of personality in small sample sizes remains the dominant factor, as described by Figure 2 above. Indeed, Hofstede and McRae[24] highlight significant positive correlations between several personality and cultural index pairs (extraversion and individualism; neuroticism and uncertainty avoidance and conscientiousness with power distance). Hofstede states in the manual for his Value Survey Module (VSM) [25] that if researchers are insistent on using the instrument to explore the effect of differing cultural background on individual relationships, then comparison of individuals' responses to questions in the survey would be more relevant than assuming index values for individuals.

As a means to initiate further work in this area, and to provide a cross-reference for the aggregate cultural dimensions, the authors have therefore distributed Donallan's 20-item mini-IPIP [26] personality test to the participants of the study. As demonstrated by Migliore's [27] initial explorations, this provides a relatively unobtrusive means of measuring an individual's personality traits and carries out an initial exploration of linkages to Hofstede's cultural measures. This has been augmented by comparison with participants' responses to the individual items in Hoftstede's VSM questionnaire [28]. These responses are currently being analysed to identify any significant correlation between group creativity, personality and cultural values.

7 CONCLUSIONS

This paper has explored the relationship between culture and performance in idea generation and selection by teams composed of internationally diverse individuals. The teams were set an exercise to design a product to assist urban supermarket shoppers in the transportation of a weekly shopping load without the aid of a car. This required teams to utilise the Gallery Method, allowing individual idea generation and collective filtering and selection to be reviewed. In reviewing the output, Hofstede's cultural dimensions were utilised. There were a number of limitations to the study, the most important being the effect of personalities and cultural balance in each team. However, when distilled to scores for each individual participant, the results indicate that the individualism and uncertainty avoidance dimensions had a discernable effect on idea generation, while individualism and power distance were the most relevant to idea selection. Masculinity was shown to have the weakest influence on both aspects of the session. It is anticipated that this work will provide the basis for further exploration of cultural influences in concept design, including team formation and management techniques.

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