

New product development “according to Hoyle”: part 1 – the analogy

E. A. APPLETON and T. D. SHORT*

Durham University, South Road, Durham DH1 3LE, UK

This paper, Part 1 of 2, introduces an analogy between the New Product Design process and a pack/game of cards. After introducing the analogy, it goes on to demonstrate that, just as Hoyle suggested rules for card games, similar analogous rules can be derived for product design, and the companies involved in such endeavours. It provides a “team-based” methodology for learning the analogy, and suggests a number of developments of the analogy that can be used for furthering the understanding of the New Product Design process. Part 2 of the paper will go on to provide some examples of the use of the analogy in practice.

Keywords: New Product Development; Analogy; Hoyle; Card Game

1. Introduction

This paper stems from an original idea that arose when one of the authors, Professor Appleton, was preparing teaching material for a lecture on Engineering Design. The lecture was to describe the use of idea generation processes and the organisation of those ideas by combining them to give a product concept. Initially, it was envisaged that a jigsaw puzzle analogy would be useful; that is, each individual idea was like a piece of a jigsaw puzzle and the first part of the embodiment phase of design was like selecting puzzle pieces and fitting them together to complete one of several possible puzzle solutions. In this analogy, the puzzle pieces can be combined to complete several different solutions and individual pieces can be duplicated so they can be used in more than one solution. Although the analogy was attractive from several points of view, the nature of a jigsaw puzzle is essentially amorphous and hence was not obviously analogous to the more structured, matrix-based methods of organising design ideas, such as morphology charts. In addition, it had been hoped that the analogy could be extended to cover the quasi-quantitative methods of idea selection, such as Quality Function Deployment (QFD) and Value Analysis/Engineering (VE). Jigsaw puzzle pieces are also essentially binary, they fit or do not fit; there is no degree or graduation of fit, whereas an individual idea in the concept of a product may be a strong idea or a weak idea; there are degrees of fit within the product concept, measured against the design specification. At this point, playing cards were discovered as an analogy for

*Corresponding author. Email: t.d.short@durham.ac.uk

design ideas and playing a card game as analogous to the early stages of the design process.

The use of analogous thinking is not new to the area of creativity, nor to the Engineering Design process. The seminal book “The Act of Creation” by A Koestler (1964), describes and substantiates a tripartite view of creativity using comic, scientific and artistic paradigms. This paper follows that lead using card game playing and New Product Development (NPD) paradigms.

Hoyle is famous as the original author of the rules for card games in 1746, since when his name has been used for any number of books relating to card games, such as “Hoyle’s Modern Encyclopedia of Card Games” (Gibson, 1993) or “Play According to Hoyle: Hoyle’s Rules of Games with Cards” (United States Playing Card Company, 2002). The inclusion of his name in the title of this paper is meant to signify that, just as Hoyle laid down the rules for playing card games, this paper proposes “rules” for undertaking the first stages of the design process. There will be those who believe that “rules” are not applicable to such a “creative” process but this paper is intended to illustrate, by argument and demonstration, how a degree of structure can support and stimulate creative techniques.

This paper presents the results of the research into the card game analogy itself, whilst Part 2 of the paper (Short and Appleton) gives examples of the analogy in practice. In describing the analogy, it presents a methodology for understanding the design process and the importance of providing a structure to that process. The paper begins by describing the two component parts of the analogy, cards and card games, their correspondence to ideas, and their combination to form product concepts. It goes on to describe a practical way of learning the approach, in a manner used very successfully by the authors with local companies. The paper ends by discussing and drawing conclusions on the effectiveness of the analogy, and the methodology proposed.

2 Design Methodologies and Teams

At the present time product designers are faced with an array of tools and techniques to aid their design work, many of which come under the “Design for X” or “DFX” heading (see, for example, Boothroyd, Dewhurst et al. (1994) and the authors’ work: Appleton and Garside (2000a; 2000b); Short, Garside et al (2002)). However, there is far less published material on the integration of these techniques, with most methods being selected individually on an ad-hoc basis to solve particular concerns and issues. Approaches such as QFD (Kogure and Akao, 1983), VE (Miles, 1961), and Pahl and Beitz’s systematic approach (Pahl, Beitz et al., 2007) seek to integrate individual techniques into a coherent whole but numerous surveys indicate that these processes are longwinded, complex and hence expensive and time consuming. The very process of seeking to quantify the process, such as through QFD or VE, causes further complications. If a number of quantitative methods are combined an explosion of data is generated, which is why designers rarely use QFD or VE in full but prefer to use these techniques in the earlier, less data intensive stages. Although rigorous, the systematic approach by Pahl and Beitz is often described as unnecessarily demanding for designs other than the most technically demanding and correspondingly expensive products. Pahl and Beitz themselves recognise that making “the solution field ... as wide as possible ... constitutes the strength and also the weakness of the approach” (Pahl, Beitz et al., 2007: 106). This matches the authors’ experience in working with numerous local

companies, from very small SMEs, through to multinationals: for example, the authors have failed to find a single company that uses all three Houses of Quality in QFD – despite its theoretical validity. In many cases, the stumbling block has proved to be the practicality of using the methodology. QFD is perceived to be complex and time consuming; DFA (using Boothroyd’s software) is extremely expensive and again time consuming. It is rare to find hard pressed SMEs using these standard – and potentially very financially rewarding – methodologies. Instead, the authors have found it far more successful to use team-based methods that are theoretically valid, but can be taught and practiced within half a day from their first introduction.

The approach described in this paper is targeted at “everyday products” produced by relatively small companies, employing correspondingly small design teams in the region of 5-30. Very small design teams of less than five may find the approach useful but the teamwork basis of many of the techniques may cause difficulties. However, small and large design teams may be able to boost team numbers and effectiveness by recruiting participants from their marketing, production and field service functions.

The approach is also aimed at those who may be struggling with the design process – this may be undergraduates with no experience of “real” company-based design (although some knowledge of the design process is assumed), new graduates who are beginning to find their feet, or even experienced designers who are looking for a new approach. Just as analogies can provide new insights into a product’s functions, so they can also provide fresh insight in to the design process, helping those who find themselves in a rut to break free. Thus, the method proposed here is radical, team based and allows for the full flow of subjective judgement.

3. The “Card Game” Analogy

In describing any analogy it is necessary to describe the characteristics of the analogy, the corresponding real world situation and their inter-relationship. This section will build up the analogy step by step, starting with the physical elements of the analogy, cards and ideas, and progressing through to playing a competitive game which is analogous to deciding a product concept.

3.1 *Playing Cards and Ideas*

The primary components of card games are the playing cards themselves. In this analogy the cards correspond to design ideas. Such design ideas can be materialised by expressing the idea in the form of a diagram, sketch or words drawn or written on cards or individual slips of paper.

3.2 *Suits*

When first dealt a hand of cards, it is a natural reaction to sort the cards into suits. Individual suits can be used to represent design features or functions. For example, the power source for a machine could be represented by Clubs and the actuation of the device could be Spades.

In the card game, Bridge, the suits have an order of importance; Spades, Hearts, Diamonds and Clubs in descending order. Similarly, in design some product features will be considered more important than others. Equally, in Bridge and other games the

order of importance of suits changes during a game, just as the importance of a particular feature may change as the design process progresses.

3.3 Card Values

Playing cards can be arranged in ascending order from two to ten followed by the Jack, Queen, King, Ace. Similarly, it is argued that one can “score” each of the design ideas in a design search space. The ace playing card has the highest value just as an ace design idea will have outstanding value. For example, if electricity is an excellent power source because it is inexpensive, flexible and convenient, it would be equivalent to, say the King of Clubs. If actuation was via a solenoid, which was inadequate because of load, speed and reliability then it might be equivalent to a three of Spades.

3.4 Dealing the Cards

At the start of any game of cards, the cards are dealt to each player. Similarly, at the start of any NPD process, a number of ideas are generated about the product, its functions and styles and so on. In companies with a well developed and well managed design process, these ideas may be generated using a formal idea generation methodology, such as brainstorming. This is equivalent to dealing out a large number of cards, before selecting a preferred hand from amongst them. For many SMEs with limited resources, or sometime even larger companies, the process is unplanned and unmanaged, leading to a random selection of ideas being produced, in a similar manner to the normal dealing of cards in a game. This dealing process is further considered in section 4.2.

3.5 A Hand

The dealt selection of cards together make up a “hand” – once the dealing and selection process is over, this hand contains the final cards with which one will play the game. In the design process, a number of ideas are generated for each product function. These are then combined – through luck or through judgement – into the final product.

3.6 A Game

Once each player has his or her final hand, the game can begin between all the players. In the NPD process, once the final product has been developed, it enters the market place in competition with all the other manufacturers in the product sector.

3.7 Summary

There are six key points to the analogy:

1. A single playing card is considered to be analogous to a single design idea, to do with any part of the “new product” under development;
2. Each card has a value, analogous to the “value” of a design idea;
3. Each card has a suit, analogous to the various functions of the product being designed;
4. Dealing the cards is analogous to generating ideas for functions within the product design;

5. A complete hand of cards is analogous to a selection of ideas, brought together, to form a coherent new product;
6. The game of cards, using the hand that has been dealt, is analogous to competition within the market place.

4. Advancing the analogy

The paper up until this point has suggested and explained methods whereby a “hand of cards” can be compared to a New Product with functional strengths and weakness that can be compared to the cards within the hand. However, a hand of cards is clearly of no use until it is played within a game of cards – and the pros and cons of any specific hand will be dependent on the game that is being played. This section will therefore investigate the analogy between the “game of cards” and the design process, to see how this helps in understanding the part that the design process plays in the market place. It will place the analogy in the context of Pahl and Beitz (2007) to underline its theoretical background.

In keeping with the theme of a card game, the best way to learn and to appreciate the strength of this analogy is to play with cards – playing cards, collectors cards and design cards. The approach detailed below has been used numerous times by the authors as an introduction to an industrial case study, with impressive results.

4.1 Know the game you are playing

The session should start by splitting into small groups of four, five or six participants, each group seated around a card table and provided with a pack of regular playing cards. The participants are then asked an initial question “What game do you want to play?”. When answering this question each group-member should be asked to make notes on the reasons for their choice. The groups should discuss their choice and reasons and try to identify parallel choices in the NPD strategy process. Bearing in mind that each player in the game is analogous to a NPD team, an example could be, “I chose to play poker because I have experience of playing poker and I think I can win” which is parallel to the NPD team saying “We specialise in the development of products for the automotive industry because that is where we have our core competence”. Alternatively “I do not play cards very often so I had better stick to something simple, how about Snap?” which is like “We do not have great skills in this area so we will not develop anything new, we will just follow the market leaders”. However, given that each player in the card game is a NPD team, representing competing companies in the marketplace, the game played will be a compromise. An aggressive and experienced team may decide to play poker, a less experienced team may decide upon a simpler, non-gambling game, such as Snap. An inexperienced player is likely to lose if the other players are experienced and they choose to play a complex game such as poker. Similarly a skilled player will be at little advantage if they join a game played by novices if the game requires little skill and is mainly influenced by chance. Certain games such as Bridge can only be played if a set number of players are available – equivalent to the conditions having to be right before any company can join enter the market. In both a card game and in NPD it is important that all participants understand what game is being played and how to play it to their advantage. This is summarised by Pahl and Beitz under their headings “Identifying Strategic Opportunities”, “Identifying Needs and Trends” and “Considering Company Aims” (Pahl, Beitz et al., 2007: 71, 72, 73)

A further aspect of choosing the “game” might well depend on the type of product that is going to be designed. If the product is a “stranger” (a term often used to describe a completely new product) or a “repeater” (an upgraded version of an existing product). In the case of a stranger, companies may aim to be first-to-market – the equivalent of a “first past the post” card game, such as snap or Gin Rummy, where a winning hand is played as soon as possible. Where the product is a repeater, the company is more likely to choose a strategic time to bring the new product to the market place – analogous to games such as bridge or poker, where a hand is fully dealt before playing the game. This selection of a game to play is equivalent to adopting a design management strategy. In the NPD paradigm a design team can adopt a strategy that matches experience, team size, competitive stance etc. In terms of design management strategy there is no “best method”, but a choice between a number of approaches. A company should choose the game it will play with the resources it is willing to invest and the skill and technology available.

4.2 Dealing a Hand

Having established which game is being played, each group then starts their game by “electing” a Dealer. In NPD somebody has to take an initiative; that person is often called the Product Manager or Product Champion. The Dealer opens the pack, shuffles the cards and deals the cards to each player. The manner of dealing the cards and the number of cards dealt will depend upon the game to be played: in poker a set number of cards are dealt to each player; in Bridge there are four players and all the cards are dealt. In NPD the Product Manager may suggest a mechanism for generating ideas – brainstorming generates lots of ideas, whereas the 6-3-5 method (Wright, 1998; Pahl, Beitz et al., 2007) generates a set number of ideas from each participant. In practice such a collection of ideas can be generated in several ways:-

1. From the imagination of the designer.
2. From creative techniques used by a design team
3. From a previous product or competitor product.
4. From research activities
5. From discussion with competitors

It is useful to discuss these methods and their correspondence to a card game.

4.2.1 The imagination of the designer

This is the route to a concept used by many individual designers or inventors. In such circumstances the concept is often seen as the only solution because there is no significant challenge from the analysis of other solutions. Even design teams can fall into this trap, particularly if the team contains a dominant member and there is (believed to be) little time or opportunity to challenge that person’s concept.

In many ways this approach is closely equivalent to the normal method of dealing cards. The somewhat arbitrarily generated hand may be strong or weak. It may be a winning hand with little need for further development, however, it may also be a weak hand that will never win even though it is skilfully and extensively developed. The characteristic of such a method is that the concept is generated with little or no exploration of the design space.

4.2.2 Creative techniques used by the design team

Creative techniques in product concept generation are widely used in formal and informal structures. Most designers are familiar with the method of Brainstorming (Pahl, Beitz et al., 2007: 83) using a combination of words and sketches. Similarly, many design teams display and discuss ideas in a manner that could fall under the title of the Gallery Method (Wright, 1998; Pahl, Beitz et al., 2007: 86). In other cases, designers work together to share and improve ideas, which in a formal procedure could be the 6-3-5 method (Pahl, Beitz et al., 2007: 85). In essence, the continued stream of ideas from a brainstorming session is analogous to a steady stream of cards to a player. The player has no control over which card will be dealt – whether it will be an ace or a two.

4.2.3 Previous or competitors' products: "stealing" ideas

In this instance the word "stealing" is not used in a pejorative sense of an illegal action, more in the sense of using or building upon ideas that already exist in the market place, in an existing product of the company or one of its competitors. It is obvious that IPR protection through patents and copyright needs to be taken into account but many ideas will not be subject to such restrictions. Many companies already use such methods in what is known as competitor product strip-down. In-depth study of competitor products can be a very useful and practical strategy (Pahl, Beitz et al., 2007: 81). Within the analogy, the design of a competitor product represents a further "hand of cards", that is, an integrated collection of ideas. Knowing and studying an opponent's hand within a card game can give a player a considerable advantage, albeit typically an illegal advantage. However, in games such as bridge or whist, it is quite normal to note what cards have already been played during a game – following the trend of previous hands can give an indication of what cards are remaining in each competitor's hand. In the same way, following design trends in competitors' products can lead to an indication of what their future products or development might be.

Alternatively, one could view previous and competitor products as being equivalent to hands of cards lying face upward on the table. As these concepts represent products that are already in the marketplace the game to be played cannot be on the basis of "first past the post". In such circumstances the game to be played is one of developing a winning hand based upon some concept of strength of the cards and their combination in, say, a game of Poker. This directly corresponds to the development of a winning product which is a winning combination of strong design ideas. Once again the assessment of the hands on the table, that is, the assessment of products in the market place, is an important skill. Techniques such as QFD and Value Analysis seek to solve this problem.

4.2.4 Research Activity

In a game of cards, it is useless to develop a hand of cards, without first understanding what makes a good hand, what makes an "unbeatable" hand and what makes a poor hand. Similarly, it might be no use playing a game of poker thinking that 4 kings is the best hand that could be held. A little more background work prior to the game would immediately show that 4 aces beats 4 kings and that a Royal Flush beats them all. In NPD, research and understanding the results of the research is equally important, as described by Pahl and Beitz under "Information Gathering" (2007: 78). Whereas creative techniques generate a stream of design ideas, research is much slower and longer term. However, research has the ability to generate and support completely new

ideas, filling in the gaps in ideas or extending concepts with newly generated technology. In some cases, it might be that all competitors are playing thinking kings are the highest available card, until one competitor discovers an ace – either by chanced which is uncontrollable, or following extensive research. The design “ace up the sleeve” can be crucial in overcoming a competitor’s product.

4.2.5 Discussion with customers or potential customers

Many texts, including Pahl and Beitz, recommend preparatory analysis using formal market survey and analysis techniques. Others describe rigorous methods for generating product specifications, using extensive scoring of customer opinions. The problem that arises from these rigorous preparatory methods is that there is a tendency for the proceeding design work to be reactive rather than proactive. The authors suggest that the way to win customers is to give them a product better than they ever dreamed rather than what they think they need.

Using a card game as an analogy for product development appears to be a powerful way of thinking but the concept of a “Customer” is not directly obvious. If a hand of cards is a winning hand and is played to win the game then the act of satisfying the rules to win is analogous to satisfying a customer by producing a winning design. Extending the analogy leads to “discussion with customers or potential customers” having the meaning of learning what the rules say about winning. In a card game there are many routes to arrive at a win, just as in product development there are many ways to arrive at a successful product design. Similarly, there is a variety of winning hands in a card game and there are many different products that satisfy the customer. In playing cards an “obvious” player with a strong hand may lose to a skilful and devious player with a weaker hand. In design an obvious design may not take the market if it is in competition with a more unusual and innovative product. The authors suggest that a customer is no better at predicting how the whole market will react to a product idea than any card player will know what is the order in the deck before the cards are dealt. A customer may have a strong view of what they want but customers do not necessarily have a magic insight into the rest of the market place.

4.3 Producing a Morphology Chart

After the deal, the players look at their own cards. At this stage in the learning activity, each participant should consider how they go about rating their hand. To make this judgement, they need to understand the game and may find it helpful to rearrange the cards in their hand into some sort of helpful order. Arranging the cards in this way can be analogous to Pahl and Beitz’s “Systematic search with the Help of Classification Schemes” which then leads to the production of a morphology chart (Pahl, Beitz et al., 2007: 92, 104). In order to understand this, the players in each group should move away from playing against themselves and should now consider themselves to be a single design team, developing their own New Product. The dealer this time should deal, say, twenty cards, face upward, representing the first collection of ideas produced through any of the methods detailed above. The participants should then arrange the cards in a logical pattern that helps to analyse the cards present and their strengths and weaknesses. Even though the instruction to arrange or sort the cards is vague, most teams will quickly arrange the cards in rows or columns with one row or column for each suit and the cards within a suit arranged in face value order.

At this stage the question to be answered is “Can design ideas be arranged in a similar manner?”. Before moving over to the design paradigm, a transition card based illustration can be used. To do this the participants are provided with a set of collectors cards or even post cards. The cards could show cars or footballers, scenic views or pop stars. The authors use post-cards showing “Leading Ladies” from the theatre or films. Once again deal, say, twenty cards face upward. Ask each team to arrange the cards in a matrix format in a similar way to how they arranged the playing cards. There will be several ways to organise these cards and the team’s ability to arrange the cards usefully will depend upon the information available on the cards and the knowledge of the participants. So, the participants may choose to arrange “footballer” cards in rows devoted to the teams they play for, one row for Manchester United, one row for Newcastle United and one row for Liverpool. Perhaps players for other teams are bunched together in a row titled “Others”. The participants may also arrange the cards in each row in an order that reflects the playing positions starting with the goalkeeper, then the centre backs, midfielders and finally the forwards. Perhaps left side players will be listed lower than right side players. In this way it is easy to spot that the Newcastle left back is missing and there are two players competing for the Manchester United No 9 position.

Now move over to the design paradigm. Deal out a set of previously prepared cards that show design ideas for features of an everyday object, say, a hairdryer. Specific examples for the hairdryer example can be found in Wright (1998). From a pack of about 50 individual ideas, each on an individual card, deal about twenty cards. Ask the participants to arrange the cards in a useful matrix. They will probably move to arrange the cards in rows relating to features such as: General Layout; Handle; Packaging; Accessories; Controls. The length of any row will indicate how many ideas have been generated in each category. Ask the team to discuss rows with a shortage of ideas and any “missing “ rows, that is, necessary features with no design solutions at the present time. The team should search through the remaining cards, filling out the rows and adding further rows if necessary. At the end of this process most of the design ideas cards will have been added to the matrix. Dealing out the cards and searching through them is analogous to brainstorming new ideas, or searching through the ideas generated by an earlier brainstorming activity, and then ordering them. The matrix of design ideas that is produced by the ordering process is known as a Morphology Chart (Pahl, Beitz et al., 2007). A morphology Chart is a very powerful and simple way of organising design ideas and recognising strengths and weaknesses in the range and number of ideas available.

The teams should now be asked to arrange each row of the hair dryer matrix into an order of merit, with poor ideas to the left and good ideas to the right. Care should be taken to try to ensure that the participants are not overly analytical, positioning each card simply by looking at its neighbours, and they should be encouraged to be subjective. If a design idea causes disagreement amongst the participants or differences are “too close to call”, then the idea should be given the benefit of the doubt, pointing out that this is a “first cut” in the idea filtering process. If the participants find the process difficult they should be encouraged to discuss why the process is difficult. Difficulties are usually caused by lack of information, lack of meaningful criteria, conflicting requirements and incompatibility with other features. Where an order of merit is possible, arrange the cards accordingly. Where an order of merit is difficult or impossible to decide, leave the cards in that row in a random order. It should be noted

that different design teams will arrange these ideas in different orders, according to their own preference, experience and background. This is exactly the same as the way the groups organised the footballer cards.

Such a structured approach focuses further creative work towards aspects of design weakness or deficiency; rows with few cards suggest that further work should be undertaken to develop more ideas for that particular function. Rows where the best idea is still not considered to be very good would also require further work to provide “better” solutions – equivalent to hunting amongst a pack for a king of clubs when the dealt cards only include an 8.

4.4 Developing a Hand

The remaining task in forming a hand of cards is the selection of a preferred set of cards from the cards that have been dealt. This is equivalent to selecting a set of ideas from the whole of the ideas available, to form a product concept (Pahl, Beitz et al., 2007: 104). If the original idea generation process has been exhaustive or at least comprehensive it may be possible to select a winning combination of ideas directly. However, from a practical point of view a less than ideal solution may be the best available and so it is necessary to move on to the next phase of the card game, the collection and rejection of cards.

Appraisal of the initial hand dealt is an important skill because this first analysis of the hand sets the strategy for retaining and rejecting cards during the playing of the hand. The strategy is one of risk management, retaining cards that have a good chance of contributing to a winning hand and rejecting cards that are unlikely to make such a contribution. This aspect of the card playing analogy is particularly interesting with respect to the development of a product concept as it suggests that from the very first ideas that are generated, risks are being taken: risks in taking ideas further, beyond the concept phase (holding on to what is believed to be the king of clubs); risks in rejecting ideas immediately (discarding the two of hearts); and risks in hoping that better ideas will appear later in the deal (relying on the appearance of a 7 of diamonds to make a straight flush). With training and practice, players can identify which cards they wish to hold on to and which they wish to discard. In NPD, this is the process whereby good ideas are selected to be taken forward, and poor ideas are rejected.

Many card games require the players to assess their hand in some way and to make an estimate of their ability to win – even to bet on their ability to win the hand or game. This bidding process is particularly important in both Bridge and Poker. If the cards in a hand are equivalent to design ideas in a product concept, a design team or Product Manager has to form a judgement of the strength of the concept in comparison to concepts held by other competitors. In order to turn the ideas into reality, however, the company may need to “bet” on new tooling or new manufacturing processes, in the hope that their product turns out to be a winning product. Investing in an inferior product coming to market is similar to betting on a pair of twos in poker – it may be that no-one else can beat it, but the chances are that there is a better player out there with a significantly better hand. If the investment has been too heavy, the competitor may be forced to fold – to leave the game having run out of money.

The problems inherent in the selection and rejection of design ideas can be demonstrated by returning to the hair-dryer morphology chart. The team should select a set of cards that represent a single new hairdryer concept, leaving the remaining cards behind. The team should be encouraged to make use of a team based approach to ensure

that the design ideas represent the best ideas from the point of view of functionality, aesthetics, manufacturability and so on. This will give an arbitrary collection of ideas that represent a starting point for a new hairdryer. Now the cards that have been left behind in the morphology chart should be combined into a sub-deck, shuffled and stacked onto a table. Keeping the selected cards in view, start the process of developing the arbitrary idea collection. As in card games, take the top card from the deck and add it to the hand. The team should reject one card to the table. Continue this process until all of the cards in the deck have been selected.

Now ask the team to consider the iterative process they have just carried out. The discussion should deal with the following questions:-

- What did they think about the initial collection of ideas?
- Is the final design concept acceptable?
- How did it compare with the first concept selected from the Morphology Chart?
- How many iterative cycles were used?
- Did the direction of the design process change during the iterations?
- Were the choices made arbitrary and, if so, why were they arbitrary?

The subsequent discussion should explore the potential benefits of using a structured methodology for idea generation and sorting, compared to a process of product concept development using reiterative cycles.

The learning exercise can be continued by playing a single hand of a simple game, say Gin Rummy. In Rummy, and many other card games, the game starts by dealing a set number of cards (nine) to each player. The individual players sort out their cards and decide upon their best option for winning. There are several ways to form a winning hand and in simple games like Gin Rummy the aim is to arrive at a winning hand as quickly as possible, before any other player. As it is unlikely that a player will be dealt a winning hand the game involves the development of a winning hand by selecting and rejecting cards.

In this part of the game each player takes a turn to draw one card from the top of the deck or takes the previously rejected card from the previous player. Having assessed the extended hand the player then rejects one card face up to the reject stack (up card). The objective of the game is to collect a hand of cards that matches the requirements of a winning hand. A winning hand usually consists of flushes and runs, a run being three or more cards in the same suit with a consecutive run of face values whereas a flush is three or four cards from different suits but with the same face value. Cards are drawn and rejected until one player has achieved a winning hand in which all of his/her cards form part of a run or a flush (matched set). Reflection again on the selection and rejection process, the aim of developing a “winning hand” – any winning hand – and the likelihood, or otherwise, of gaining that hand before a competitor, can reap rich rewards in the understanding of the design process.

Literature relating to NPD has often drawn attention to the short product development times achieved in Japan. These studies, such as by Sobek and Ward (1996), indicate that Japanese companies carried out more preliminary work and preparation and were not involved in wasteful and time consuming reiterative product development cycles. Claims were made that methods such as concurrent engineering enabled Japanese designers to achieve reductions in product development cycle times and western companies moved to use concurrent engineering approaches such as Team-working, co-location, QFD/VE/FMEA/DFA/DFM techniques, CAD/CAM and Rapid-prototyping. After many faltering starts all of these approaches have made their contribution but the

card playing analogy gives an excellent illustration of the fundamental principle of concurrency.

4.5 Playing a Hand

In a study of product development at Toyota, American researchers (Sobek and Ward, 1996) discovered that Toyota develops more initial concepts for each new product and takes these concepts further into the embodiment stage of the design process than their Western counterparts. In the card playing analogy, Toyota is playing several hands in the same game. This strategy is time consuming and expensive; Toyota has to accept the fact that they will have several losing hands. However, the telling point is that they are substantially increasing the chance of holding the winning hand. This contrasts strongly with Pahl and Beitz's statement "The very great theoretically admissible, but practically unattainable, number of solutions must be reduced at the earliest possible moment" (Pahl, Beitz et al., 2007: 107), albeit "the earliest possible moment" can be defined in many ways.

Imagine Toyota playing "New Product Poker". If Toyota have four hands to play against a single hand from a Western counterpart and all players are of equal skill, the chances are that Toyota will win four times out of five. In addition, the Toyota players are not individual competitors, they collude to produce winning hands by exchanging and sharing their best ideas as the game proceeds. Toyota spends more time (and consequently more money) developing its hand through picking up and discarding incompatible cards (ideas) to those already in the hand. It is clear that not only will this give an increased chance of winning any particular game, but also it is likely to produce a winning hand sooner – before other competitors have had chance to develop fully their own hands. Under such conditions, Toyota can ensure that they are first to market with any new product. The Western attitude, on the other hand, is to reject ideas as soon as possible to avoid the expense of developing ideas that are eventually rejected.

It has to be noted, however, that even if Toyota has four hands to a different company's one hand, it is still possible, albeit unlikely, that Toyota will not have the winning hand; random chance may still allow a competitor to beat them.

4.6 Scoring points

Several card games use point scoring; once again the points scoring method gives an interesting insight into the costs and risks of NPD. Taking Gin Rummy as the analogy, points are used to decide the winner over a number of hands. Gin Rummy is a "first past the post" game in which the first player to assemble a matched set is said to "knock". In NPD terms this is equivalent to being first to get a product to market. However, scoring in Gin Rummy can be a little more complex because players who do not knock are penalised. The penalty is added to the score of the player who knocks and is of a value equal to the sums of the card values held by the other players where the cards are not part of a matched set. In NPD the equivalent of unmatched cards are ideas that have not been fully integrated into a product concept. The penalty represents the wasted effort of developing a product that does not get to the market in time. However, in Gin Rummy it is possible to knock without having a full complement of matched cards, equivalent to moving a concept into the design process without a fully developed concept. This can be a winning strategy provided that all other players are in less well developed positions. If a company moves on to embodiment prematurely, compared with one of its

competitors, there will be a penalty to pay; in Gin Rummy this penalty is 25 points to the competitor(s) with the better hand.

5. Understanding the methodology

In the authors' experience, the best way of understanding and fully appreciating the methodology is, as with many design methods, to use it on a real product. Following the introduction to the overall analogy and method that has been described above, it can be applied directly within a company to a New Product that requires some creativity. Indeed, it can equally be introduced as part of a "creativity day", where a group of designers, more or less experienced, are brought together to revisit standard creativity techniques and to learn new ones. One way of generating interest in these sessions has been to include clips from the television series "Friends – in particular Series 1, Episode 18, "The one with the poker". The ability and rivalry between the group of friends allows for any number of useful revelations about the design process.

6. Discussion and Conclusions

One of the important methods of solving problems is using the problem from a view point that makes the solution more obvious. The mutilated chess board is a classic example, as discussed by Kaufmann (1991). This paper has been concerned with a view of new product development using a perspective based upon playing card games. As such it appears to have been surprisingly fruitful in that it has been able to illustrate developments in NPD methodology and should come as a simple means of guiding designs along the NPD path.

Some arguably obvious conclusions are as follows. Note that in describing these conclusions, the first sentence refers to the NPD process and the remains relate to the card playing paradigm, where appropriate words relate to the alternative paradigm are included in brackets.

1. Be sure that the product development team know what game it is playing. Make sure that resources and "know-how" match the market place. A novice card player should not embark upon a "high roller" poker game. A skilled card player should not waste time on a game of chance where skill is discounted.
2. Japanese companies use and develop large design idea search spaces even though many of the ideas will not be included in a final concept. It is obvious that a card player is more likely to find a winning hand (concept) if he/she finds a method of searching through as many of the cards (search space) in the pack as possible. Similarly, playing (developing) several hands (concepts) at one time means an increased likelihood of winning.
3. An understanding of the market needs, product history and competitor products is invaluable. Card players who are aware of the cards in other players hands, cards that have been rejected and cards in the remains of the deck obviously have an enormous advantage. It would be foolish to play against somebody who could read the back of the cards as they would be able to anticipate and frustrate your moves and benefit their own.
4. It is unlikely that there can only be a single winning concept for a new product. A winning concept is a set of ideas that are compatible and of high value. In some instances getting a viable concept as quickly as possible is more important

than having ideas of outstanding quality. In a fiercely competitive market it is likely that both speed and quality are of the essence. A winning hand of cards will generally be a compatible set of cards in a matched set. In some games it is important to get a matched set as soon as possible, as in Gin Rummy. In other instances (for example Poker) it is the quality of the sets that is important. If a player does not have a viable hand (concept) they are forced to fold. The remaining players then gamble on the strength of their hands.

In presenting the card game analogy, this paper has introduced a new methodology for understanding the design process. In suggesting that creativity activities can be analogous to dealing out cards, the paper has shown how a structured approach to the design process, and the consequent rules, can be understood and contextualised, just as Hoyle suggested clear rules for card games.

The methodology is clearly relevant for students who have had little experience of “real” design issues, particularly in the corporate context. However, the method is equally beneficial to in experienced designers who may “stall” in a manner similar to writers’ block, or more dangerously, may charge off up a “blind alley”. The provision of a card-game structure to the overall design process places existing design tools, such as the morphology chart, into context and allows this inexperienced designer to see the direction, hence removing the block or redirecting from the blind alley. For more experienced practising engineers, the analogy provides a different and fresh viewpoint on the design process, helping to stimulate the designer to new ideas.

The methodology elucidates a number of key issues in the design process and has been shown in practice to benefit particularly those companies where the design process is poorly understood and ill managed, as is often the case in small companies. In doing so, the methodology can be seen to be worthy of consideration for helping design teams to develop their own knowledge and understanding, and for helping companies to learn how to produce their own “winning” products.

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