Human Centred Design of 21st Century Automobiles

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Abstract

Reflections upon the meaning of the word “design” are made and a relatively complete definition of the paradigm of human centred design is formulated. Evidence is provided of the economic benefit of human centred design as an innovation model and as a practical set of methodologies for achieving products, systems and services which are physically, perceptually, cognitively and emotionally intuitive for people. Indirect evidence is provided which supports the position that the automotive industry would benefit from a shift away from largely technological objectives and design processes towards instead a more human centred design approach, particularly in five key areas of interaction between people and automobiles.

Design

In the English language the word “design” takes on a variety of noun and verb meanings. In its noun form, standard dictionaries suggest concepts of sketch, drawing, plan, pattern, intention or purpose, or the art of producing them. In its verb form the same dictionaries suggest elements of definition involving representing an artefact, system or society, or the fixing of its look, function or purpose. The word “design” therefore has meanings ranging from the abstract conception of something to the actual plans and processes required to achieve it. The concept of design as a way of making sense of things has been the subject of many studies (Krippendorff 1989) as has the design thinking process itself (Brown 2008 ; Brown 2009).

Since “design” can be used to express intention as opposed to the actual materials, forms, processes and markets, it is often used to describe the driving force of the creative thought itself. In this usage the word “design” assumes a role similar to that of postmodern discourse, as defined by Foucault and others (Butler 2002; Foucault 2010), thus it refers to language which is absorbed and exchanged between people, providing the basic units of meaning. In this usage “design” can signify the shaping power described in philosophical analysis by terms such as “thought processing” (Heim 1993) and “instrumental realism” (Ihde 1991; Ihde 1998).

When attempting to characterise the major movements which operate within the world of design today, three in particular seem to each be characterised by its own specific discourses and values (see figure 1) and to be practiced by large numbers of designers and other professionals. Technology driven design, sustainable design and human centred design are major movements which usually lead to distinguishably different results, despite working within the same legal, regulatory, contextual and economic constraints. The different core discourses based on technical novelty, planetary impact or human meaning lead to notable differences in the resulting product, system or service.

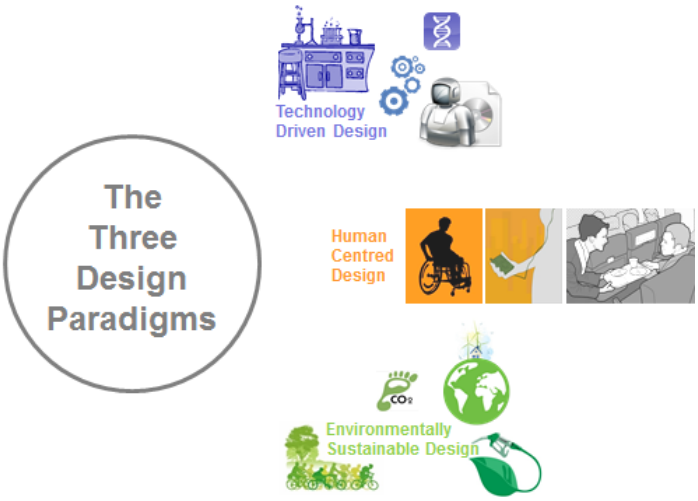

Figure 1) Three major design paradigms.

Human Centred Design

In recent years many businesses have shifted their emphasis away from matters of pure technology and manufacture, moving instead towards a growing preoccupation with how the products, systems or services are perceived and experienced by the consumer (Du Plessis 2011 ; Hill 2010 ; Holt and Cameron 2010 ; Lindstrom 2005 ; Schultz, Antorini and Csaba 2005 ; Shaw, Dibeehi and Walden 2010 ; Verganti 2009 ; Von Hippel 2005). This observation is supported by numerous studies including the work of Eric Von Hippel (2007) of the MIT Business School who has noted that large scale statistical evidence demonstrates that “70% to 80% of new product development that fails does so not for lack of advanced technology, but because of a failure to understand users’ needs.”

A growing abundance of sophisticated and relatively low cost technologies has shifted the focus from the physical aspects of design to the metaphysical aspects. Well-known brands such as Alessi, Armani, Apple, Facebook, Ferrari, Google, IKEA, Nokia, Phillips and Virgin have led the way. Choosing and rescaling technologies to fit people's needs has been the trick in many cases such as Apple, while focusing on emotional engagement has made companies like Alessi a household name.

The shift is evident in the progression of paradigms which have evolved and prospered over the decades starting with ergonomics and moving through human factors, usability, user centred design, inclusivity, interaction design, design for product experience, design for customer experience, design for emotion, emotionally durable design, sensory branding, neurobranding, service design and finally, most recently, the umbrella paradigm of human centred design. What began as the psychological study of human beings on a scientific basis (Meister, 1999) for purposes of machine design has evolved to become the measurement and modelling of how people interact (Moggridge 2007) with the world, what they perceive and experience, and what meanings (Csikszentmihalyi 1981) they create.

Human centred design leads to products, systems and services which are physically, perceptually, cognitively and emotionally intuitive. It is based on the use of techniques which communicate, interact, empathise and stimulate the people involved, obtaining an understanding of their needs, desires and experiences which often transcends that which the people themselves actually realised. The toolbox of human centred design techniques grows continuously, sometimes by borrowing from fields such as psychology or sociology, and sometimes instead by defining new analogies and approaches. Design card decks such as those by IDEO (IDEO 2003) and PLEX (Lucero and Arrasvuori 2010) and design texts such as those of Chapman (2005), Dunne (2008), Jordan (2000), Mulder and Yaar (2006), Norman (2005), and Schifferstein and Hekkert (2007) are routinely deployed by human centred designers.

The human centred designer is a relatively transparent figure who does not impose preferences on a project, but, instead, conveys and translates the will of the people. The tools deployed by the human centred designer include techniques such as ethnographic interviews, questionnaires, day-in-the-life analysis, fly-on-the-wall observation, activity analysis, error analysis, cognitive task analysis, the five whys, conceptual landscape, narration, visual journals, cultural probes, be your customer, customer journey, real fictions, para-functional prototypes, personas, scenarios, extreme users, focus groups and co-design.

Human centred design has its roots in semi-scientific fields such as ergonomics, computer science and artificial intelligence. The echoes of this past can be readily noted in current design practice and in international standards such as ISO 9241-210 “Ergonomics of human-centred system interaction”. ISO 9241-210 defines human centred design as “an approach to systems design and development that aims to make interactive systems more usable by focusing on the use of the system and applying human factors/ergonomics and usability knowledge and techniques” and specifically recommends six principles of human centred design:

- Explicit understanding of users, tasks and environments
- Involvement of users throughout design and development
- User-centred evaluation driven/refined design
- Iterative process
- Consideration of the whole user experience
- The adoption of multidisciplinary skills and perspectives.

Such engineering based approaches address well the needs of the users of tools which have clearly defined functions. The difficulty in the case of consumer products, systems and services is that the customer does not always adopt the point of view of a “user” of a “tool”. As Susan Gasson has highlighted, “user-centred

system development methods fail to promote human interests because of a goal-directed focus on the closure of predetermined, technical, problems". Designing based on human personas and scenarios (Carroll 2000) rather than from pre-defined goals provides more opportunities for facilitating imagination, learning and goal definition. Human centred design approaches have been claimed to lead to greater discourse, motivation and second order understanding (Krippendorff 2004).

As an innovation model, human centred design is a complex form of market-pull business strategy which involves the business proposing innovative new meanings and lifestyles and then responding quickly to the commentary and feedback. As an innovation model it thus involves:

- Greater interaction with the customers (see for example Von Hippel 2005)
- Greater communication between the customers (see for example Cesvet, Babinski and Alper 2009)
- Greater communication within the business (see for example Gray, Brown and Macanufo 2010)
- Better communication of the vision (see for example Temporal and Alder 1998)
- Identification and integration of the ethical challenges (see for example Brown 2005)
- A change of business strategy (see for example Hatch and Schultz 2008)

While not without drawbacks (Steen 2012) such as the risk of pre-conceived stereotypes and meanings entering into the human centred design process by stealth, the paradigm does nevertheless provide a systematic umbrella approach for developing products, systems and services based on matters of perception, interaction, learning and meaning.

Automotive Human Centred Design Challenges

As a business sector characterised by more than 100 years of success from technological innovation the automotive industry is characterised by highly efficient scientific and technological R&D structures and initiatives. Less developed are, instead, the human centred R&D structures and initiatives. General consensus has been achieved in many technological (Braess and Seiffert 2005 ; Robert Bosch GmbH 2007) and ergonomic (Bhise 2012) areas of automotive design, however there is far less agreement regarding the human centred requirements and approaches. No major motor manufacturer currently operates a business model based on the definition of new meanings as occurs with organisations such as Apple Inc. or Alessi S.p.a.. However, data suggests that many industries which have traditionally been considered to be technological in nature have recently been adopting a more human centred approach due to the benefits in terms of sales and revenue (Verganti 2009).

In order to meet the desires and expectations of 21st century customers several human centred automotive design developments would appear highly useful. Pondered consideration of the theoretical constructs involved, and of the empirical evidence from interactions with a large number of automotive sector professionals, has led to the identification of five fundamental 21st century challenges in automotive human centred design which have the potential to greater impact upon the fortunes of automotive sector industries. What follows is a brief description of each of the challenges as perceived by the author.

Co-Design Tools

Figure 2) Co-design tools.

The 21st century is one of personal freedom, democracy and human empowerment. New interactive tools for internet, mobile telephony and virtual worlds are distributing and democratising the design process in many business sectors. Crowd sourcing, crowd funding, co-design (Sanders and Stappers 2008), the open

source software movement (Von Hippel 2005) and numerous other new business practices are demonstrating how the consumer now considers himself or herself to be a major stakeholder in design, development and innovation. Whereas in the 20th century the majority of consumers were happy to evaluate and judge a new product or service before purchase, today's better informed, better educated and more highly empowered consumers expect to take an active part in the actual design and development. In many business sectors there has been a major shift from consuming to co-designing.

As a sector which has evolved along mainly technological lines, the automotive industry has not traditionally deployed co-design tools to the same degree as the current internet and mobile telephony sectors. While the marketing and branding departments of the major motor manufacturers have worked closely with the styling, design and engineering teams for many years now, the internal company arrangements have not usually been reflected in parallel external arrangements with auto clubs, brand connoisseurs and the general public. Numerous issues related to technological intellectual property rights, quality control and brand communication have made such initiatives difficult.

Nevertheless, great opportunities exist for developing and deploying co-design tools which involve customer stakeholders in early concept evaluations, in engineering target setting and in the branding and marketing activities. The establishment of appropriate company software, internet websites and social networking platforms will permit a wider and more diverse relationship between the professional stakeholders and the people for whom they endeavour. Appropriate software, websites and networking platforms which are designed with human centred principles in mind will guarantee that the needs, desires and meanings of the target customers are addressed immediately at the start of the design process, and maintained continuously in-the-loop throughout the product gestation, launch and beyond.

Iconic Touchpoints

Figure 3) Iconic touchpoints.

The 21st century is characterised by rapid progress towards a full understanding of the functioning of the human mind. We now know much about how sensory stimuli enter the mind, become stored in memory and, when the conditions are appropriate, become iconic. The neural connections between the sensory and the motor areas of the cortex have been identified, the functioning of consciousness has been better understood, the role of emotion in matters such as memory storage and decision making has been established and, most recently, the existence of mirror neurons has helped to explain the source of many aspects of human social behaviour.

As a sector which has evolved along mainly technological lines the automotive industry has not usually deployed design tools which fully integrate the data and laws governing human perceptual, cognitive and emotional behaviour. In addition, the fundamental role of the automobile in the construction of the personal identity and social reality has often been underestimated. A review of the branding guidelines of several automotive sector companies suggests a lack specification regarding the exact physical and informational automobile touchpoints convey the brand's characteristics, narrative, lifestyle and meaning.

A more highly focused definition of the consumer touchpoints for a given automotive sector organisation must necessarily consider the human mental, psychological and social requirements for achieving "iconicity". The word "iconicity" refers to that condition in which a word, object, concept or value constitutes a self-referential and self-defining category in people's minds. An iconic design is one which is deeply lodged in human memory and in social construction, thus it is one which forms part of the social fabric and linguistic

discourse which people use to structure their thinking and lives. An iconic design acts as a self-referential and self-defining category, i.e. a taxonomy consisting of only itself.

Anecdotal evidence from research studies (Abbott et al. 2009) suggests that words such as “Ferrari” or “Rolls Royce” act as categories of their own, i.e. that they are fully iconic. The same anecdotal evidence suggests that other well-known automotive brands are members of the wider cognitive construct of “automobile”. Iconicity is achieved through a set of conditions which include, but are not limited to, the following: rarity, cost, unique sensory characteristics, unique selling points, consistent branding and repeated communication. While the success of the most iconic brands may not be easy to emulate, there is nevertheless a strong case for the development and introduction of “iconicity toolkits” which guide designers towards the identification to the key touchpoints (starting with the styling and interior design) which can be designed so as to achieve mental icons in people’s memory and social fabric. Since an iconic design is one which adds new vocabulary and meanings to everyday human experience, significant commercial advantages are to be expected from the achievement of automobile touchpoints which have greater potential to become iconic. Research (Verganti 2009) demonstrates that new categories and new meanings facilitate the generation of substantial and longer lasting revenue streams.

Perception Enhancement

Figure 4) Perception enhancement.

In the 21st century digital signal processing has made it possible to decode the natural languages of many animals (Krause 2012) and environments (Augoyard and Torgue 2005). Signal processing techniques such as Fourier Analysis and Time-Frequency Analysis (Burrus, Gopinath and Guo 1997) have been used to decode the sounds and vibrations of the natural world, revealing structures and meanings which were not previously known to exist. The combined use of advanced signal processing routines to analyse the structural and statistical properties of the stimuli involved, and the careful deployment of observational, ethnographic or experimental protocols, permits the deciphering of even the most complex forms of communication.

As a sector which has evolved along mainly technological lines the automotive industry has not always analysed stimuli from the point of view of their uniqueness, ecological characteristics and information carrying potential. The natural vibration, sound and other stimuli which are produced by the automobile as part of its normal operation are usually simply optimised in terms of comfort or pleasantness. While detailed comparative studies of automobile stimuli are now part of routine Noise, Vibration and Harshness (NVH) testing, the efforts are usually focused on matters of comfort, pleasantness or sensory branding. There are, however, great additional opportunities for designing the language of communication between the automobile and people.

Preliminary efforts at decoding the vibration languages of automobiles have already been made (Giacomin 2005) and simple guidelines for enhancing the communication between the steering system and the driver (Berber-Solano, Ajovalasit and Giacomin 2010) have already been developed. There is still great need, however, for contextual and cognitive decoding of the other automotive stimuli such as the steering torque, the chassis acceleration and the sounds which occur during the various operating conditions. Perception enhancement methodologies lead to automobiles which “speak” to drivers and passengers in a clearer and more easily understood manner.

At the current point in time one particularly critical area of automotive perception enhancement is that of the tailored emissions of hybrid and electrical vehicles. These new traction technologies have no historical precedents regarding their natural stimuli, thus no obvious perceptual, cognitive or emotional design

specifications. The great freedom of design offered by these flexible technologies on the one hand, coupled with the lack of existing mental models and stereotypes on the other, leaves a logical and metaphysical gap in the sensory design specifications of current automobiles. Detailed analysis of the information carrying features of the sound, vibration and other emissions of thermal engined, electrical and hybrid automobiles appears necessary in order to combine the main information carrying features of each into a single language.

Gamification

Figure 5) Gamification.

In the 21st century video and other games have repeatedly demonstrated the addictive potential of well-designed sensory stimuli and cognitive tasks (Koster 2004 ; Thompson, Berbank-Green and Cusworth 2007). Design strategies based on game criteria have been shown to sharpen flow experiences (Csikszentmihalyi 1990) and to enhance brand satisfaction (Reeves and Read 2009 ; Zichermann and Linder 2010). The practice has become so prevalent as to lead to a specific term for its use. Gamification is generally taken to mean the use of game thinking, game mechanics and game design techniques to enhance non-game contexts. Typical game design criteria which have been successfully applied to products, systems and services include a high degree of interaction, clear rules, increasing levels of difficulty, occasional serendipity and surprise, clear feedback of failure and strong use of narrative and storytelling.

As a sector which has evolved along mainly technological lines the automotive industry has not usually described driving or in-car activity using game-like terminology. Fundamental and justified concerns about the physics of the vehicle such as road safety and comfort have tended to dominate the discourse, and thus the consequent design activity. Nevertheless, terms such as “driving feel”, “driving enjoyment”, “driving pleasure” and other phenomenological (Macann 1993) descriptions have frequently been used in conjunction with driving. As with all human endeavour, there is a large amount of game-like activity associated with automobiles including road positioning, route planning, way finding, eco-driving, in-car entertainment and others. Like any other human activity driving involves a complex mixture of sensory stimuli and cognitive goals which must be identified and decided upon rapidly, in the manner of a video or other game. As such, design strategies based on the achievement of driving flow (Csikszentmihalyi 1990) and on the deployment of game criteria (Koster 2004) hold the potential to greatly sharpen the driving experience while simultaneously enhancing the brand satisfaction.

The Emotional Automobile

Figure 6) The emotional automobile.

In the 21st century the complexity and computational power of computers continues to expand exponentially in line with Moore's Law predictions (Kurzweil 1999). Further, the increasing embedding of computational power within products, systems and services has often led to a breakdown in the traditional design bedrocks of "material", "form" and "function" (Thackara 2005). New design paradigms are thus urgently required in order to fill the gap between the traditional modernist ethos and the new information based reality.

Futurologists such a Ray Kurzweil (1999) have speculated in detail regarding the nature of future human-machine interactions. A few thought provoking predictions of automotive interest for the year 2019 include the following:

- A $1,000 personal computer will have as much computational power as the human brain.

- The total computational power of all available computers will be comparable to the total combined brainpower of all members of the human species.

- Computers will be embedded within most objects including jewellery, clothing and furniture.

- Computers will perform most of automobile driving for reasons of road safety.

- Robots will be reliable, ubiquitous and characterised by human-like personalities.

- Most information inquiries and business transactions will involve a simulated human agent.

All future predictions from all sources suggest that automobile on-board systems will in the near future transcend the human ability to monitor and control them.

As a sector which has evolved along mainly technological lines the automotive industry has produced a wealth of on-board systems which provide a large amount of information to drivers (Cellario 2001). Perceptual and cognitive overload now regularly occur during the use of several systems including the anti-collision, navigation and telephone communication systems. New systems pose challenges for the driver in terms interpretation and interaction, not just because of the large amount of data being displayed, but also, and most significantly, because of the problematic "asymmetries" which exist between people and machines when interacting together in a situated context (Suchman 2007).

Given the growing problem it appears that human centred design approaches are needed to simplify the currently complex interaction which is occurring between the driver and the automobile. In particular, one approach which appears unavoidable is to emulate natural biological evolution by equipping automobiles with basic emotional responses which simplify and centrally modulate (Kamvar and Harris 2009) the functioning of the individual on-board systems. The six basic human emotions (Oatley, Keltner and Jenkins 2006 ; Cohan and Allen 2007) provided to us by nature produce integrated and holistic responses to environmental stressors. The centralised priming of our body systems in preparation for action provides numerous evolutionary advantages including the shortening of reaction times, the physical communication of intention and the signalling of social relations. While "sport" and "economy" modes are now common in many automobiles, these fixed plans do not provide the flexibility and immediacy of fully integrated emotional responses to driver requests and road conditions. No current production automobile has a fully integrated control system which coordinates all matters (suspension stiffness, engine mapping, gearbox ratio, steering feedback, throttle feedback, etc.) in such a manner as to provide a unified and easily identifiable emotional response. An easily identifiable emotional response would, however, provide a deeper and more natural relationship between the driver and the automobile than what is achievable by means of only stimulus and response.

Conclusions

Evidence has been provided of the economic benefit of human centred design as an innovation model and as a practical set of methodologies for the design of products, systems and services which are physically, perceptually, cognitively and emotionally intuitive for people. Indirect evidence has been provided which supports the position that the automotive industry would benefit from a shift away from largely technological objectives and design processes towards instead a more human centred design approach. Consideration of value system involved in human centred design, and of the typical methodologies which are deployed, has led to the identification of five key areas of interaction between people and automobiles which would benefit substantially from an approach which is less technological and more human centred.

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