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An Exploration of the Roles Values Play in Design Decision-Making

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Abstract

The paper presents the findings of a study into design decision-making and specifically the use of values during design decision-making. It briefly describes the development of a taxonomy of values used in design decision-making developed from a series of pilot interviews, protocol analysis and focus groups. This was necessary because although the values agenda is not new, previous studies were found to have gaps, or did not reflect the current state of play. From this more in-depth case studies were carried out to explore the influence of values in design decision-making. Eight designers were asked to design a lectern out of sustainable materials. They were given one day to complete the project. For one hour during the day they were asked to 'talk aloud' while being videoed, also known as concurrent verbalisation and protocol analysis. They also took part in a 40 minute retrospective interview about their design work, at the end of the day. One designer was asked to complete a ten day design project in order to verify the results against a longitudinal project. They also took part in a 40 minute retrospective interview at the end of the project. The paper presents some of the rich data collected during the study. And illustrates the ability to research the role of values in design decision-making. The data generated shows values driving many of the decisions designers make including the way in which they cognitively organise their design activity and through which they can reduce avenues of enquiry.

Keywords

Design Decision-Making, Knowledge, Skills, Values, Empirical Evidence, Research Methods

Research regarding decision-making is not new. The concern of this paper is design decision-making, and particularly in the context of industrial design, of which there is little prior art. In 1982 Hicks *et al* came up with a document concerning Understanding Design and Technology (1982). This was an important document that categorised the factors involved in design decision-making under three headings: knowledge, skills and values. In the 1990s Norman published a paper entitled 'The nature of technology for design' (1998). It described the idea that technology for the purpose of those engaged in designing could also be thought of as the summation of knowledge, skills and values (see Figure 1).

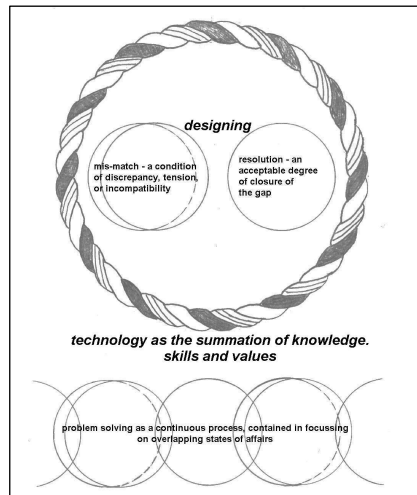


Figure 1. Technology as the summation of knowledge, skills and values (Norman, 2000, p.129).

The 1990s saw many contributions to the debate surrounding the use of knowledge (see de Vries 2003; Dasgupta 1996; Norman 1998; Vincenti 1990) including a PhD completed in 1999 by Pedgley. This thesis explored design decision-making and focused on design epistemology, or the use of knowledge and information during the creation of new artefacts and systems. The case study explored as a key aspect of the research was the design of a polymer acoustic guitar. Pedgley found that even when the guitar had not been seen or heard, there was an opinion that it could never be as good as wooden ones and would always be perceived as a low value artefact. (Norman, Pedgley and Coles, 2004, p.3). This kind of response was one of the drivers to research the role of values as it suggested that people's responses are governed by emotional factors, or values, as much as by rationality.

Exploring the use of values in design decision-making

A literature review found that the role of values within design decision-making had been largely unexplored (see Coles and Norman, 2005). The aim of the research was to develop a complete classification system for values influencing design decision-making. The prior art showed the influence of *personal values*, *societal values* and *values embedded in design*. New understandings were provided by the pilot studies. There was evidence that the influence of stakeholder values differed from those of society; that designers used internal perceptions of external values; and that designers were influenced by meta-values. From the literature and the findings from the initial phase of data collection, the new taxonomy presented in Table 1 was developed.

Table 1 The new values taxonomy

EXTERNAL VALUES	Summary description	INTERNAL VALUES	Summary description
Societal values (SV)	Values from the designer's own or another society that have been readily sought by the designer. There must be evidence that these values have been sought through research, for example the designer has questioned members of the society where the interest lies.	Perceived societal values (PSV)	Values from the designer's own or another society that have not been sought but are instead perceived by the designer.
Identified stakeholder values (ISV)	Values that are sought from those identified as having greater influence or importance to the designer	Perceived identified stakeholder values (PISV)	Values perceived by the designer regarding those identified as having greater influence or importance to the designer
Economic system values (ESV)	Values sought by the designer regarding the economics affecting the product or system	Perceived economic system values (PESV)	Values perceived by the designer regarding the economics affecting the product or system
Values embedded in design (VED)	Values found in existing products and, or values the designer wishes to embed within their own product or system	Designer's personal values (DPV)	The designers own values
		Meta-values (MV)	Values used as principles for evaluation, organising activity and determining potential consequences

The pilot studies (Trimingham, 2007) showed that it was most appropriate to use two data collection methods, these are retrospective interviews; and concurrent verbalisation and protocol analysis.

One-to-one retrospective interviews are a qualitative method of gaining in-depth responses to questions asked. The outcome is a wealth of information on case studies. The interviewer is empowered with the ability to probe and explore responses that other research techniques would not allow. One of the main disadvantages of retrospective analysis is that it is not a reflection of true design activity and may therefore be unreliable. Participants are required to discuss processes and activities, both internal and external, after they have occurred. Lee and Radcliffe (1990) state, "The major weakness of this method

is the difficulty of tracing how the time was spent during the actual design period". It must also be factored in that the participant's account of their processes and activities may not be wholly accurate due to the impregnable arena of tacit knowledge (Ryle, 1948). Another disadvantage of discussing design work retrospectively was discovered during the pilot studies. The drawing folios presented by both the A-level and undergraduate participants were presentation folios, in which many pages had been 're-done' to look more 'designerly', and some had been disposed of if the student felt they would not contribute to their marks. This has the effect that the interview reflected the design work that was presented to the interviewer, and did not completely reflect the design activity that occurred. This disadvantage was overcome during the main study, as participants were asked to complete the design activity within an allotted time, and all work produced in that time was collected. Had a third stage of studies occurred participants would have been asked to number drawings as they are produced.

Concurrent verbalisation and protocol analysis allows the researcher to document parallel activities in order to analyse different influences and interactions that are required at each stage of decision-making. There has been much discussion regarding the inadequacy of protocol analysis, experiments showing limitations such as: *The set-up*: Its obtrusive nature may change the subject's behaviour and their cognitive performances; *Concurrent verbalisation*: Akin and Lin have reservations that although verbalisation aids the researcher to "access the mental processes of the designer" (1996, p.36) the effect of verbalisation on the designer and the design activities has not yet been determined. Dörner believes that any attempt to verbalise cognitive processes is detrimental, stating "Germinal processes exist in human thought, in which casting ideas into verbal form is premature because it would destroy the dynamics of thought" (1999, p.38); *The limitation of the data being captured*: "People do not necessarily know what is going on inside their own heads, let alone have the ability to verbalise it" (Cross et al, 1996, p.2). Indeed one participant made two comments to the researcher at the end of the pilot study. That he often found himself 'thinking one thing and saying another', this suggest he was reporting parallel but independent thoughts to those being employed in the task. And, that in periods of deep thought he would find he had not said anything at all.

All current research techniques are limited to collecting information on audio, visual or tangible data and that with all these methods it is impossible to do anything but make inferences about internal tacit processes. The use of both retrospective interviews and concurrent verbalisation and protocol analysis during the main study was advantageous in that it allowed a deeper understanding of the complex nature of values and the difficulties in their analysis. It also allowed suspended judgement on certain results (such as the frequency of the use of certain values) due to conflicting data.

Analysis was carried out by hand. 'Coding and clustering' is a common procedure for analysing qualitative data and was chosen for the analysis within this project as it allows the researcher to derive meaning from words and build theory from data (Strauss and Corbin, 1990; Robson, 1993; Miles and Huberman, 1994). During this process the coding allows the researcher to cluster together "...instances of a particular kind" (Robson, 1993).

The data was grouped into clusters developed from the research questions so that, for example, all data referring to the 'feasibility of the scheme of work' was grouped together. The researcher did not rely on more than one person recognising a phenomenon for it to be considered important, which was considered to be beneficial during a pilot study with such a small number of participants.

The data for the main study was collected from two events: a one day event and a longitudinal study. Eight participants worked separately but on the same brief for the one day events to enable cross-case comparisons to be made. An overview of the participants and research methods is shown in Table 2.

Table 2. Research methods and participants used for the main study.

Expertise / method	Protocol analysis	Retrospective
A-level	AL and KC	AL and KC
Undergraduate	MLC and SP	MLC and SP
Postgraduate	CA and JM	CA and JM
Professional	AD and DL	AD and DL

The brief was developed in conjunction with Smile Plastics Ltd (www.smile-plastics.co.uk) and Recoup (www.recoup.org). The participants were required to propose a new lectern design made from recycled plastics for Recoup to use at conferences and trade shows. Each participant was given one day to complete the project.

Results

External values - Societal values

Although no evidence was collected regarding *societal values* during the one-day events, the literature provides many examples (See Table 3).

Table 3. Summary of societal values referred to in the prior art.

Author	Summary
Concise Oxford Dictionary, 1992	How the outcome effects the user
Hicks <i>et al</i> ,	Responsibilities to mankind's future survival Inter-relationship between the man-made world and religious social and philosophies The needs of individuals in society and ways of meeting them The importance of ethical values in carrying out design activity and evaluating the effects

	of technology.
Elhamdi <i>et al</i> , 2003	Level of effect that people personally expect from products and services
Baynes, 2005	Designers addressing socially important problems. Social worth of products.
Layton, 1992a	Technology bears social imprints. Technology shapes society. Design preserving social hierarchies. Design reflects cultures Societal values allow technological adoption or technological obsolescence.
Goonatilake, 1984	Technology as a social gene Social values drive design decisions Technology carries the scars of the socio-economic system that gave birth to them
O'Brien and Guerrier, 1995	Values are embedded in a social context
Green, 2003a	Design must be socially and culturally acceptable
Boztepe 2003	Needs are experienced within cultures Social values determining how we view products. Classification of consumer values

External values - Identified Stakeholder values

All apart from one occasion of identified stakeholder values influencing design decisions was from the brief, for example one participants states:

I suppose one point is I decided to ditch the adjustability because there was already a set height in the brief.

Many other values are also present here in that they are making numerous value judgments regarding what to consider from the brief and what to reject and assigning hierarchies to what they find in the brief.

Economic system values

The traditional view of value relating to economics is well reflected in the prior art (See Table 4).

Table 4. Summary of prior art regarding economic values.

Author	Summary
Concise Oxford Dictionary, 1992	The amount of money or goods for which a thing can be exchanged in the open market
Baynes, 2005	Turning products into wealth Contributing to profits Seeking a fit between profit and needs and wants Economic constraints of the market place Relationship between economics and the political and environmental power of consumption Solving problems within the imperatives of the market economy Consideration of the project budget, cost of materials and processes.

	Acceptable levels of performance in relation to cost Understanding of economic competition
Ashby and Johnson, 2003	Relationship between cost and the market place
Boztepe, 2003	Use value Exchange value
Hicks et al,	Use value Intrinsic value Value in exchange Marginal value of one product over another Supply and demand vs. availability and price

Attention to economic system values was only reported by three participants. One participant mentioned that lots of forming of the flat sheet would be expensive, he also mentioned the conflict between this and the need for some form in order to increase the strength of the product. Another participant acknowledges that cost issues are not mentioned in the brief but still believes the difference in cost between different materials is an important question to ask. His decision to try and use the same component for all fixings is also influenced by the desire to minimise the cost of manufacture. The third participant explains how cost was one of the many things she thought about during the project, although she does not go into detail and does not mention cost when explaining the basis of any subsequent decisions.

External values - Values embedded in design

Initially the evidence provided by the literature (See Table 5) review and the pilot studies was used to build one external category.

Table 5. Summary of the prior art regarding values embedded in design.

Author	Summary
Goonatilake, 1984	Products carry embedded value
Layton, 1992a	Value in products highlighted by how they're used Technology cannot be value free Portraying a sense within a design Conveying messages through design Embedding other values within design Values embedded in design affect their success
Cross, 1982	Existing products as a great source of inspiration Designers can both read and write in material culture
Middleton, 2003	Designers work from existing products to create new ones Designers use products as inspiration
Jordan and Macdonald, 2002	Designers have an understanding of the additional values a product holds including physio-pleasure, socio-pleasure, psycho-pleasure and ideopleasure Designers have an understanding of

	product semantics
Feils and Overbeeke, 2003	How an artefact can be interpreted Creating meaningful products
Boztepe 2003	People value products for what they signify
Martin, 1999	Products reflecting other values (societal etc)
Eckert and Martin, 2000	Previous designs furnish a vocabulary for new designs, processes and interpretations Products are used in the following ways; precedent; reuse; pattern and primary generator
Sassatelli, 2000	Value is inherent to the product Value is enhanced by subjective judgement
Boztepe, 2003	Value comes from a persuasiveness from design
Ashby and Johnson, 2003	Materials have embedded personalities and characters Selection by similarity Some objects have a meaningful relationship to the to-be-invented object
Ryle, 1948	Dispositional concepts
Rompay <i>et al</i> , 2004	Values embedded in design are connected to image schemas

The main study, however, showed a clear distinction within this category. Evidence was collected regarding the influence of values *embedded in existing design, existing products and materials*, but evidence was also collected regarding participants making decisions to *embed value in their designs*, a more internal value judgement based activity. Having made this observation the initial literature review regarding values embedded in design was re-visited. It was clear that the literature related to both categories with the distinction being most eloquently put by Cross who describes the difference being a designer's desire and ability to 'read or write in material culture' (1982).

Values embedded in existing design

There were a great number of instances where participants discussed the use of existing products and materials as a source of inspiration. Existing products and materials were also used to inform about design much as Middleton (2003) and Eckert and Stacey (2000) suggest. For example one participant discussed the use of a laptop to inform them about the size of the working platform of the lectern and a balsawood jigsaw to suggest how the product could be manufactured and assembled. Existing products and materials were also used to reject ideas or to reduce avenues of enquiry. One participant decides to reject all ideas that look similar to the existing lecterns seen in the inspirational poster displayed in the room. The existing lectern was also used by one participant as a starting point, or 'anchor', in the words of Eckert and Martin

(2000). The existing products and materials used by each participant are shown in Table 6.

Table 6. Products and materials used by participants in the one day event.

Participant	Products and materials used in the one-day event
ADI	Material samples (in room) Pictures of lecterns (in room) Old lectern picture (in room)
SPI	Old lectern picture (in room)
ALI	Tripod (in room) Material samples (in room) Old lectern picture (in room)
CAI	Pictures of lecterns (in room) Material samples (in room) Fish tank tubes Ellula Sounds speakers
DLI	Folding chairs 3D balsawood dinosaur jigsaw Drawing board Tripod (in room) Material Samples (in the room) Laptop
JMI	Pictures of lecterns (in room) Original lectern (in room) Material samples (in room) Periscope Architecture Parasol bases Bicycles
KCI	Material samples (in room) Flat pack boxes Bottle tops Corkscrew Display board Drawing board Spiral staircase Drawers
MLCI	Seat in a magazine Lectern pictures (in room)

There was also evidence that designers associate values with materials before they are made into products. This echoes Ashby and Johnson's observation (2003) that materials have embedded personalities. One participant discusses different plastics:

But really the values are so different for all of them that I'm not sure that you'd find it worked very well like that. Maybe if you had a progression.

New materials (in this case the recycled plastics) are also associated with materials of similar value, and this association is used to help drive decisions about, for example manufacturing processes. This selection by similarity is also observed by Ashby and Johnson (*ibid*).

I made assumptions and based them on how that material is like other

plastic sheet material except that it comes apart rather more easily ...

Many of the participants discussed using plastic in ways that wood cannot be manipulated to highlight this embedded value. Layton (1992a) also explains how designers work to highlight the value in products by how those products are used.

You could do that with any material really and that's a shame. If you've got a material with flex in it you might as well use it.

Different materials hold different values to the different participants, this provides evidence of the connection between the values embedded in design and a designer's personal values. This reflects Sassatelli's view that value is enhanced by subjective judgement (2000,). To one participant, materials that look obviously recycled hold more value but another participant believes the materials that don't look recycled hold more value. These are two examples of how internal values influence how designers respond to a materials embedded value.

Achieving values embedded in design

The idea of achieving values embedded in design is reflected in much of the prior art. Layton (1992a) explains that designers work to portray a sense in design. This can be seen in the following example:

At the same time I was trying to make this look like it floats, it's light, it's got...it's forward looking, it's moving. So some curves, and direction, and cantilevers

Table 7 shows some of the words used to convey the 'sense' the participants were trying to achieve (or trying to avoid) within their product.

Table 7. Words used by participants to describe the sense they were trying to portray, or avoid in their designs.

Participant	Sense	Participant	Sense
ADI	Forward thinking Light Cool Floating Bland (negative) Striking	DLI	Recoup's ethos Broadening awareness Novel Stereotypical (negative) Wobbly (negative) Creaky (negative) Flex (positive or negative depending on the intention) Challenging preconceptions Innovative Inspiring Refined Obvious (negative) Blocky (negative) Unimaginative (negative) Curvy Distracting (negative) Subdued High quality Corporate
JMI	Garish (negative) Subtle Elegance Camping (as a sense – negative) Home salesman (negative) Dell boy on a stall (negative) Shield Flimsy (negative) Unity	CAI	Modern Professional Smooth
ALI	Slick Simple Modern Blocky (negative) Streamlined Fast Dramatic Floating	KCI	Simple but attractive Different Intrigue Normal (negative) Undoing a bottle
MLCI	Cool	SPI	Alive Elegant Active Dynamic Blocky (negative) Chunky (negative) Oscars (sense)

There was also a lot of evidence of the participants choosing to incorporate the functions of other plastic, or those functions that cannot be achieved with other materials, to show the material either holds the same, or superior value.

So I was thinking about those big over-centring folds like you get with plastic stuff, So you're incorporating a function you get with plastic mouldings and devices you see around you, but your doing it to show this material does exactly the same as that..

Layton (1992a) explains how values within a product can be highlighted by how that product is used. Participants were observed trying to embed value into their products by highlighting the embedded value of the material through how it is used. One participant comments about using steel:

But I felt there was a bit of a contradiction in that, in that what we're saying is that this material isn't able to stand up on its own therefore it needs steel structures

There was evidence of participants associating shapes and styles with values they wished to embed in their new lectern designs, also referred to as selection by synthesis (Ashby and Johnson, 2003). Evidence of designs being rejected because the design had embedded values that were not desired was also evident in the retrospective interviews.

But I just thought it lacks elegance. It's too camping...it's too...it just lacks...

it's just too home salesman sort of ish. You know it's sort of dell boy on a stall!

The decisions designers make that are influenced by the wish to embed value in their designs are also connected to other value categories, again reflecting Martin (1999) who explains that products reflect other values. The influence of other value categories also guides the designer to embed *appropriate* value. One participant explains it was important that the lectern did not detract from the person speaking behind it. The perception of appropriate value is, however, subject to many internal value judgements based on the designer's personal values. For example, as stated above, one participant believes the lectern should not detract attention away from the speaker. However another feels that the lectern should also have the added value of acting as a shield for the user, as he associates his own nervousness of presenting with the value he wishes to embed in the product.

...so it was 'well ok then' appropriate styling in this sort of arena is something that doesn't detract from the person who's speaker, so it needs to be fairly refined

I then went onto thinking of a lectern and I know when I've stood at a lectern at a conference it's...it's almost your little point of safety, it's almost your little shield from the audience.

Although it is clear that the values embedded in existing design are external values, it is also clear that a designer's decisions to embed values in their

design are influenced by internal values, and an internal understanding of values embedded in design, therefore this category of values must be both internal and external.

Combination

There were occasions when these two sub-sections of values (values embedded in design and embedding values in design) combine. Existing products and materials were selected to be combined with new designs in order to associate their value with the new artefact. New designs are also developed to resemble an existing item in order to take on similar values. Table 8 below shows materials that were used either to accompany the recycled plastic or from which the recycled plastic was chosen for its resemblance. It also presents products and concepts used in the new design in order for it to take on the same value.

Table 8. Existing materials and design used to combine with new designs to transfer embedded value.

Bar chairs	Steel (3 people)	Surfboard (negative)	Kite	Flower petals
Swan	Glass (4 people)	Bird tables (negative)	Snake	Virgin plastic
Dyson vacuum cleaner	Marble (3 people)	Tree (negative)	Martini glass (negative)	Polyprop integral hinges
Coke bottle (in room) (4 people, 1 negative)	Slate	Sharks fin (2 people)	Other bottles (3 people)	Holly leaf chair (previous project)
Modern art	Leatherette	Clear tubing (previous project)	Exhibition stands	Carpet

A previous example showed that stainless steel was selected to be incorporated with the recycled plastic sheet for its ability to disappear (an embedded value of the material). It was also selected by a number of participants because it was believed to be of high value, and may therefore associate high value to the new lectern.

People can look at it and say 'gosh is that really recycled material', cos they all have the same value as stainless steel ...

There is also evidence of designers wishing to change what they presume to be a material or an object's embedded value.

...it needs to be obvious that it's recycled plastic, but used in maybe a novel way, rather than in the stereotypical well it's a plastic recycled material so let's make it three times thicker because it's weak

Internal values - Perceived societal values

The designer's perception of societal values was observed to be a driver of many decisions during the main study. Some of these decisions considered what they believed the audience response would be to the aesthetics of the

product. For example one participant based some aesthetic considerations, and particularly rejected certain materials, on how the lectern would look from a distance, as this is how a member of the audience might view it.

So that's why I moved away from some of these materials (which) were...

um sort of garish and bright and colourful because I thought actually from

a distance it would just look, it would look horrible...

These aesthetic considerations were also used to conceptually organise aesthetic priorities (meta-values, see later). For example one participant pays more attention to the upper half of the lectern, observing that the lower half will not be seen by many members of the audience. Perceived societal values are also seen to influence aesthetics through the participants desire to draw attention to the lectern. It was also clear that the participants were aware of appropriate aesthetics for the particular social context in which the lectern would be used. CA comments that the lectern must 'fit in' within the surroundings of a conference facility or a trade show. Participant's perceptions of societal values were made with three distinct drivers (see Table 9).

Table 9. Perception of societal values made with three distinct drivers.

Driver	Examples
Assuming a society's values were congruent with their own	<p>One participant explains that a decision was 'largely a personal point of view but then I'm imposing my perceptions.'</p> <p>One participant assumes that because she doesn't understand other people wouldn't get it.</p> <p>One participant wants to challenge negative preconceptions about recycled plastic, assuming that they are the same as his.</p>
Acknowledging that different groups of people will hold different values.	<p>One participant selects different materials for different audiences.</p> <p>One participant explains that different people will like different things.</p> <p>One participant uses of lots of colours to attract different people.</p>
Perceiving the values of society through their perceived value understanding of identified stakeholders.	<p>Two participants believe it to be important that the audience does not see the user shuffling papers.</p> <p>One participant integrates a light to keep people focussed on the speaker.</p>

Internal values - Perceived Identified stakeholder values

Decisions based on the perceived values of the user included how they would use the lectern. CA listed what she believed would be the lectern's primary and secondary uses. Other participants also highlighted what they believed the user would need in order to use the lectern effectively, including where they would lean on it and what size the top surface would need to be.

We have already seen that participants perceived differently how the stakeholder sees the lectern (with one participant seeing the lectern as a shield and another believing that the user should not hide behind it). This demonstrates that perceived identified stakeholder values are internal values, and therefore subject to many other internal value judgements including those based on the designer's personal values and prior experiences.

Considerations were also made regarding how the user was observed by others. One participant ensured her lectern obscured any possible fiddling with papers that the user may do in the course of the presentation. Another participant made decisions based on her desire to ensure the user looked professional while interacting with the lectern.

Perceived economic system values

There was only one example of PESV during the retrospective interviews. Here one participant is discussing how the cost of the product will have a result on how it is then perceived.

Yeah, and although cost isn't the sort of be all and end all it was . It should be something that is simple to produce. Otherwise people will think well yeah it looks like it does but, its really complicated to make...

This echoes Ashby and Johnson's perception that economic value is dependent on the market industry to which the product is aimed (2003). The participant understands this connection between economic values and the perceptions and internal values of the market for which he is designing, and makes decisions accordingly.

Internal values - Designer's personal values

The idea of a designer's decision-making being influenced by their *personal values* is not new. For a summary of the prior art regarding designer's personal values please see table 10.

Table 10. Summary of the prior art regarding designer's personal values.

Author	Summary
Dorst, 2003	The designer can design according to his own taste, style and abilities.
Kumar and Bjorn-Anderson, 1990	Choices are determined, to a large extent, by the designer's personal values
Pedgley, 1999	Designer's make decisions based on, for example, their preferences, priorities, opinions, passions, convictions and emotions,
Rokeach, 1973	Terminal values and instrumental values

Daley, 1984	Perception and personal experiences
Dorner, 1999	Use of personal analogies Ballistic thinking Heuristics
Gregory and Commander, 1979	Models of design behaviour Heuristics
Kaldate <i>et al</i> , 2003	Decision traps Heuristics

The designer's personal preferences and tastes as well as their personal wishes were observed to have a strong influence over decisions regarding the aesthetics of the lectern, and the selection of materials.

I had already chosen those two cos they look nice.

Personal rules of thumb, or heuristics that the designer has built up, either through previous design projects or from other personal experiences appear to have a high level of influence over decisions. For example one participant has a personal rule of thumb to avoid symmetry in his product design outcomes. Another participant explains that he always follows a set project strategy by first organising a framework on which to work, then addressing 'tricky' issues first.

Past experiences also appear to drive many decisions, as suggested by Daley (1984), Dorner (1999), Gregory and Commander (1979) and Kaldate *et al* (2003). For example CA chooses to use clear tubing for the supporting mechanism of the lectern, this is based on a previous successful project in which she also used clear tubing. An example of Kaldate *et al*'s (2003) anchoring was also observed when AL uses the existing Recoup lectern as an 'anchor' on which he makes truncations to develop a new lectern concept.

It is observed that *all* internal value judgements can be considered as a designer's personal values. As distinctions can be made within a designer's internal value judgements, they have been divided further into categories in order to further our understanding, and for clarity.

Internal values - Meta-values

These could be considered as a designer's personal values, however they are slightly different and worth separating. Meta-values describe value judgements at a more abstract level of judgement about the art of decision-making as a whole. It is not only decisions regarding the physical form, manufacture and intended use (to name a few) that must be considered by the designer, but also to what extent each step towards the conclusion satisfies the overall need. As well as personal values designers also appear to have an internal, value based organisational system. Essentially the thinking behind designers' actions does not just look backwards, as suggested by Schön's reflective practice but also looks forward to plan ahead. This is hinted at by Layton who suggests the use of organisation values when he mentions 'judgements about how intentions are realised shape the activity' (1992, p.36). Daley (1982) commented on a designer's use of values as an ordering mechanism. It is also clear that designers must make value judgements as to what extent an idea satisfies the overall need or whether alternatives should be sought. This is apparent in the following pilot study extracts.

"Realised the need to discover the properties of materials" A value judgment of what needs to happen next based on an earlier decision that there would be great benefit from the design requiring only simple changes to the original material.

"Today I also decided to make some small models of some of the ideas ..." A decision about later activity based on not knowing exactly how the design will be assembled.

Designers also appear to have an internal hierarchy of values. One participant places more importance on certain value judgments than others. She basis her decisions on personal values of aesthetics before she decides on the most appropriate material for the design:

We kind of design the ideas of how we want it to look, then take a range of materials, try to analyse them – which one is best

This group of values was initially referred to as 'organisational values'. However these early observations suggest a concept that is an abstraction from values, used to analyse and determine their use. In epistemology the prefix 'meta' is used to mean 'about', so here it is used as 'about values' as a more appropriate descriptor of this subset. There is little prior art regarding meta-values, a summary is shown below (Table 11).

Table 11. A summary of the prior art regarding meta-values.

Author	Summary
Layton, 1992	Judgements about how intentions are realised shape the activity
Daley 1982	Designers use of values as an ordering mechanism Designer's employment of values for ordering conceptual priorities
Keeney	Values as principles used for evaluation and to determine potential consequences

There was a great deal of evidence of Meta-values working to, in a sense, manage the project, much as Daley (1984, 1982) and Keeney (1992) suggest. Many of the evidence reflects what Layton was suggesting in his 1992 keynote, that we also make judgements to guide activity and decide what steps to take next. Initially we can see all participants taking key points from the brief which they wish to address. This 'wish list' they produce is also influenced by many other values and immediately reduces the avenues of enquiry. This internal 'project manager' continues during the project, with time-keeping and controlling conceptual priorities that can be addressed within the time allocated. For example one participant describes how he made the conscious decision to stay within his 'safe zone' as a designer and to keep things standard due to the constricted time limits. This suggests designers are

able to change their conceptual priorities according to a number of variables, one of which is time. There was also evidence of Meta-values through participants evaluating their ideas (much of which was done through other values). For example one participant explains how she put all of her ideas onto one sheet in order to analyse them effectively.

Meta-values also appear to organise future work. Participants described mentally noting questions that needed addressing, and elements that needed consideration as the project progressed. Many of the participants explained that they had many occasions where they stopped to reflect on what they had done, in order to consider where to go next. There was also evidence of assumptions being made in order for the project to continue. This links to Dörner's ballistic thinking, as some participants were observed to avoid asking questions to which they depend on a positive answer.

...what's it got to display? Um...I wasn't sure about that but I thought ok,

well maybe you need some way of connecting bits and pieces to it.

It became clear that although the use of Meta-values were made explicit at certain times during the retrospective interviews, their use was continuous. Every decision requires guidance to look in one direction rather than another, to consider economic values at a particular stage rather than the values of an identified stakeholder. Even the decision to base a decision on the result from a mathematical equation rather than from some other judgment must involve some internal value influenced judgement. It could also be said then that meta-values influence the process by which a hierarchy of values is prescribed, those being deemed more important being considered by the designer and others remaining with the tacit processes of the designer's internal thinking.

Conclusions

It is clear that the role of values in industrial design decision-making can be described using the new values taxonomy. As a result a new values taxonomy was developed (see Figure 2).

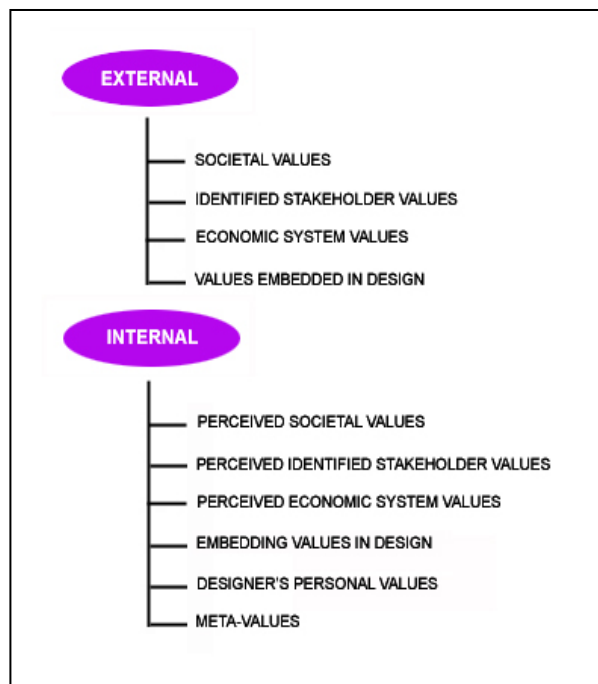


Figure 2. The values involved in an industrial designer's decision-making.

It is clear that values influence design decision-making in many ways, for instance they are used to reduce avenues of enquiry, to direct activity, to analyse ideas, to inform about sizes, properties, functions and manufacture, among many other. Values are used to drive all sorts of decisions from manufacturing to aesthetics. It is clear that data can be collected and analysed regarding values in industrial design decision-making.

Designers are free to be influenced by few, or all values at different stages of a design project. They are also free to be influenced by values to a lesser or greater degree. For some design projects, the values influencing the designer's decisions can be simple and straightforward. For other projects decisions may be based on complex interactions and trade-offs between a number of different values. The purposeful avoidance of certain values may well simplify the decisions a designer must make in order to complete a task, but, ultimately, this approach may not lead to an appropriate outcome.

This research expands on the value-based explorations done by Hicks *et al* in the 1980s and includes the contributions made by key authors in the field as well as evidence collected during the course of the study. A taxonomy of the values influencing design decision-making has been added to a model of design decision-making as a summation of knowledge skills and values (see Figure 3).

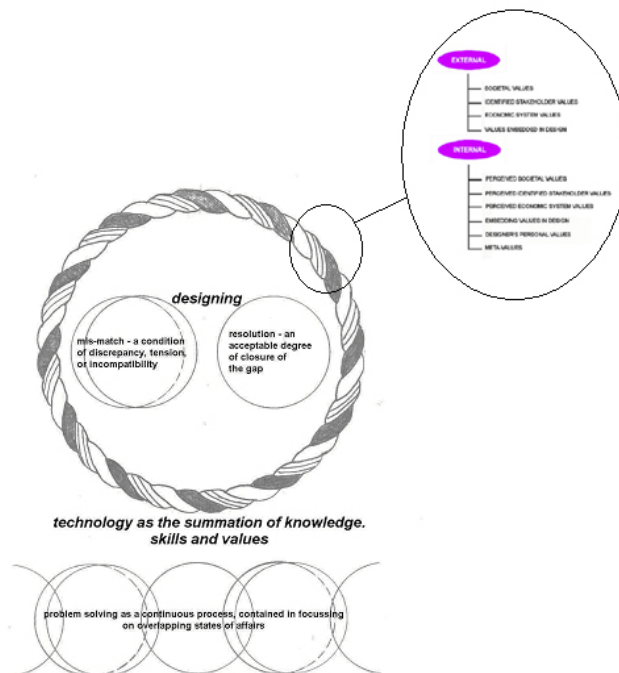


Figure 3. Values as integrated into Norman's model of designing.

By furthering our understanding of design decision-making it is possible to develop more effective teaching practices and resources. This enables students to improve their design capability and essentially become better designers. An understanding of values can increase awareness of what constitutes design decision-making, therefore allowing them to apply effective and more informed strategies to their activities. Many of the findings could be transferred into a resource for designers. Finally the development of educational courses and resources for both students and professionals needs to involve the understanding of how the role of values can influence design decision-making.

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