Design Guideline Gap and 2 Feedback Loop Limitation:

Two issues in Design and Emotion theory, research and practice

Dr. Terence Love

Dept of Design, Curtin University, Western Australia
IEED, Lancaster University, UK
IADE/UNIDCOM, Lisbon, Portugal
t.love@love.com.au

Abstract

This paper identifies and describes two issues, 'Design Guideline Gap' and '2 Feedback Loop Limitation' that expose problems in the Design and Emotion theory and more widely challenge the validity of design theory, research findings and design practices. The paper describes the issues by way of examples, draws out the implications for emotion-related design research, theory and practice and suggests ways of addressing the design and emotion theory problems exposed by the analyses presented in the paper.

Keywords: Design epistemology, systems design, biological limitations to emotion

1. Introduction

The field of study at the conjunction of Design and Emotion predates the current 50 year old field of design research and extends more widely. It can be seen, for example, in the work of Dewey, James, Tonnies, Whiting, Coase, Fielden, O'Doherty, Gregory, Sprott, Eastman, Westcott, Maslow, Forrester and Rapoport [1-15]. . It can also be seen in the origins of Socio-Technical Systems design (STS) in the Tavistock Clinic (from 1914)[16], the studies of computer supported cooperative work (CSCW), community development and youth work program design during the 70s and 80s. Interest in the conjunction of emotional response and design also occurred in other fields such as advertising, film making, literature, history and theology, Recently, interest in Design and Emotion research and design has become focused around organisations such as the Design and Emotion Society[17] and the establishment of Cognition and Affect programs such as that developed by Aaron Sloman[18].

This paper identifies and describes two issues at present unaddressed in the Design and Emotion field. These two issues potentially challenge the validity of broad swathes of emotion-related design theory, research findings and design practices in the Design and Emotion arena. The author has coined the two issues as:

- The 'Design Guideline Gap'
- The '2 Feedback Loop Limitation'

Both issues emerged in the author's research relating to Design and Emotion over the last two decades The first, The 'Design Guideline Gap' emerged from epistemological analysis of design theory focused on validity and coherency of concepts and theory relationships in the design literature[19, 20]. The second issue emerged from research investigating the arbitrage of systems design and research methods into the design research field, especially in areas involving affect and emotionally-based cognition [see, for example, 21, 22-30]. Evidence for

this second issue is found widely in the systems design realm and discussed by researchers including Forrester[31, 32], Sterman[33] and Meadows[34].

The analyses and findings reported in this paper are from drawing out the implications of these two issues for Design and Emotion. In essence this is critical theory analysis that in most fields would be expected to have occurred earlier in the development of the field. The lack of attention to these issues in the Design and Emotion literature has led to conceptual developments that can be viewed as underjustified and potentially false [35, 36].

The structure of the paper is as follows. After this introduction, each of the above two issues will be described in separate sections, each with two short examples that illustrate each problematique. In section four of the paper, the implications of the above two issues for Design and Emotion field are teased out. The concluding section of the paper outlines pathways to address the potential weaknesses in design and emotion theory they reveal.

2. The 'Design Guideline Gap'

Since its origins in the 1960s, the primary role of design research has been to develop theory that in the limit will automate design. This approach has been highly successful. It has led to automation of a large number of design activities including creative activities previously regarded as intuitive and the sole province of human designers. The outcomes of this 40 years of design research work can be seen in the computer software that designers use in Art and Design, engineering design, information systems design, systems design , business process design, design optimisation, chip design, software architectural design etc. By observation over the last three decades, benefits include improvements to the volume of output of designers of an order or more, an improvement in quality of designed outputs and a significant reduction in design failures, especially in fields such as industrial/product design and graphic design. Taking a helicopter view of this situation, design research outcomes have resulted from empirical research that has made explicit tacit design knowledge of designers whilst at the same time deeply analysing design problem contexts and solutions to produce design principles and specific practical **design guidelines** that enable computer software to automatically develop successful design solutions. The specificity of these design guidelines is of the form '*Use this font, with this leading and place the text in this way in this design situation*' or '*display these images, with this kind of pan and zoom at these timings*' or '*the maximum piston speed for these piston and bore material is 30 m/s'* or '*the optimal layout for these chips is the following*'. A crucial aspect is having an explicit process, identified by design research that makes a deterministic link between generic information about design situations, tacit knowledge, design problems etc and **design guidelines** that specify exact design details. This process must take the general information and convert it into specific design instructions such as '*add a red band across the web page in this place*.'

In the Design and Emotion literature, however, this type of design research activity is substantially absent. Instead, in the Design and Emotion field there has been a strong development of research methods to gather generic information about individuals emotional responses to designed outputs and some of these have been developed into generic design principles. What are missing – the Design Guideline Gap – are formal explicit processes that link information about emotional responses to designs to the generation of new emotion-related design guidelines and to existing design guidelines. This issue was raised peripherally in earlier critiques by Love[35, 36] of the Design and Emotion literatures of the last 2 decades.

From observation, the 'Design Guideline Gap' has remained 'hidden in full view' because of two factors both with a self-centred view of designers and researchers roles in design activity:

- Ignoring that the primary output of design research has been in automation via computer design systems (i.e. assuming that design research is primarily about improving how humans design)
- Lack of awareness of a gap between information provided to designers (e.g. findings about users' emotional responses) and decisions about specific design details due to a lack of attention to theory and epistemological issues.

In essence, the core of the problem in Design and Emotion is a misunderstanding, erroneous belief, or faulty claim (depending on where one is standing epistemologically) that the design tools and methods of the field produce direct design guidelines in the same manner as those developed in other design fields that enable automated design outcomes

The following two examples illustrate the widespread nature of the Design Guideline Gap by reviewing Design and Emotion tools and methods from the knowledgebase of the Design and Emotion Society website. In the Design and Emotion Society knowledgebase, the tools and methods are separated into five categories: understand user/market; explore ideas and concepts; design specification; test and evaluate; and market implementation. The two examples are sampled randomly from those catalogued as 'design specification' tools: the area in which the Design Guideline Gap is identified.

2.1. Example 1: Cabinet

1.1. Overview of the tool/method

a) Problem being addressed: Designers collect visual material for inspiration in their design process. In practice they keep two collections, a digital that is used in the actual design process for collages and mood boards and a physical collection that they gather and organize to keep them sensitive to new insights. The two collections do not meet or interact well with each other and computer tools do not provide inspiration.

b) Solution provided: The divide between the physical and digital collections is bridged by on one hand enabling easy capturing of physical material and on the other hand offering a direct physical interaction with the digital collection. No words are needed in the interaction with both collections.

c) Description: Cabinet is a table-sized interaction device that allows designers to collect and organize collections of both physical and digital visual material. Cabinet captures
material by taking a picture from above or digital images can be added with a USB flash drive. Images can be organized spatially in stacks and compositions using the
whole length of the arm. Cabinet blends the physical world and digital world very smoothly through its interaction and smooth transitions from the physical to the digital realm.

d) Limitations:no limitations

e) Theoretical background: theories/models underlying the tool/method

Figure 1: Description of 'Cabinet' tool/method from the Design and Emotion Society website (see http://www.designandemotion.org/society/knowledge_base/template.html?item=120)

As can be seen from the above description, the 'Cabinet' method is a data collection method. It enables a human designer to access digitalised samples of digital and physical samples of ideas, objects, designs and the like.

No part of its functioning, however, includes any means of determining parts of a future or new design for the designer.

There is a 'gap' between the output of the 'Cabinet' tool/method and the specification of individual design features of a new design both in terms of emotion-related issues and other design issues. That is, the cabinet tool does not result in design specification for emotion-related purposes or any other design brief.

The 'Cabinet' tool/method has a 'Design Guideline Gap'.

2.2. Example 2: Vision in Product Design

1.2. Overview of the tool/method

a) Problem being addressed:
1. Designers have difficulties coming up with radical innovations because they are driven by problem solving; companies suffer similar problems because they are
driven by market information. In both cases, (experiences with) existing products dominate venues for future products, thereby limiting what may be possible.

2. Current design methods disregard the designer as a creative, personal, and intuitive mind whose choices and decisions do and should affect the outcome of any design process.

b) Solution provided:
Vision in Product design (ViP) is a 6-stage design method that increases the likelihood of generating innovative ideas by focusing on what is possible instead of what is wrong, and by creating space for the designer to feel and incorporate
values and opinions in the process.

c) Description:
The ViP method places human-product interaction, defined as the way a product is perceived, used, and experienced, at the centre of the design process.

Given a certain design task, the designer first has to 'deconstruct' what she already thinks she knows about the product that comes to mind as an existing solution. In this way he regresses to the context level where we no longer talk about products or interactions with products, but the set of starting points or factors that underlie them. This brings the designer to the first step in the design phase (see model below), building a context on the basis of all sorts of possible, relevant, and interesting starting points. Everything can be a starting point: trends in the behavior of (groups of) people or social, technological, or cultural developments, principles about human needs, their functioning or thinking, and laws of nature. Based on this contextual view, a position statement is formulated and next translated into first, a vision on the to-be-designed human-product interaction, and second, a product vision incorporating the qualitative characteristics the product has to embody. The context view and the visions together form a strong basis for generating innovative ideas and make it easy to see whether a particular idea is appropriate.

d) Limitations:
Designing with this method:
1. can be time-consuming because you take the 'outside curve',
2. requires a lot of conceptual thinking and feeling from the designer,
3. is not easy: especially the transition from context to interaction is tough.

e) Theoretical background: theories/models underlying the tool/method
- Theories on problem solving and creativity (e.g., Smith, Ward, & Finke (1995). The creative cognition approach. Cambridge, Mass: MIT Press).
- Studies on design fixation (e.g. Jansson & Smith, (1991). Design fixation. Design Studies, 12, 3-11).
- Models of the design process and design methods (e.g. Jones (1992). Design Methods. New York: Wiley).
- Simon, H.A. (1998). The Sciences of the Artificial (3rd ed.). Cambridge: MIT Press.

1.3. Images

Please click the thumbnail(s) to enlarge.

1.4. Model of the ViP approach.

(On the left side, from bottom to top is the 'deconstruction' phase; on the right from top to bottom is the design phase).

1.5. Application: where and how has this tool/method been used/tested?

The ViP method has been applied in a great number of graduation projects and courses at our Faculty of Industrial Design Engineering in Delft, as well as in many
workshops and design projects for design firms and the industry. Companies who have tried and tested and/or still work with the method are: Adidas, Audi, BMW, Fabrique, Gispen, G-Star, KLM, KVD, Océ, Philips, Pininfarina, Procter & Gamble, Siemens, Sony-Ericsson, and others.

Figure 2: Description of 'Vision in Product Design' tool/method from the Design and Emotion Society website (see www.designandemotion.org/society/knowledge_base/template.html?item=127)

As can be seen from the above description, the 'Vision in Product Design' tool/method is an 'idea/seed/concept generating' method. Its purpose is to generate innovative ideas based on first developing (in some simple format) a starting point indicating a context. Then a position statement is developed from this context 'seed' and a vision of a human-product interaction is created along with a vision of the qualitative properties of the product. The 'Vision in Product Design' tool/method includes emotion-related issues as it includes behavioural, social and cultural issues.

None of the intermediate processes of the tool appear, however, to be specified or deterministic. The primary characteristic of the 'Vision in Product Design' tool/method is a business process flowchart centred on various steps of vision generation. No part of the functioning of the 'Vision in Product Design' tool/method, however, includes any means of deterministically prescribing parts of the future or new design for the designer on the basis of the tool itself. All such activities, although implicitly part of the tool, are solely in the human activity realm and totally independent of the tool/method. The 'Vision in Product Design' tool/method does not contribute directly to design specification. There is a 'gap' between the outputs of the 'Vision in Product Design' tool/method and the specification of individual design features of a new design.

The 'Vision in Product Design' tool/method has a 'Design Guideline Gap'.

2.3. Other tool/methods

Other tools in the Design and Emotion Society Knowledgebase have made limited incidental attempts to bridge the Design Guideline Gap. For example, the Kn6 IBV Kansei method attempts a brute force approach to linking user information to gross design elements. The attempt is to create a very large database of design elements and products with user perception data about them. The aim is to use associative statistical analysis on this data to help forecast optimal design element outcomes. This approach is, however, *associative* with all the statistical problems of this approach compared to identifying the *causal* relations that would give accurate prediction of the sort needed to create accurate deterministic design guidelines to be used either by human designers, or, better, included in design software. More typically, other Design and Emotion tools/methods in this design specification space are post-facto. The underlying approach is the designer first designs something and then the tool is used to help record what sample users felt happy or unhappy about. The problem again is that this process does not describe a method to obtain design guidelines that prescribe exactly the details of a design, i.e. there is a 'Design Guideline Gap'.

To summarise, all of the methods described in the 'design specification' section of the Design and Emotion Society Knowledgebase illustrate the problem of the Design Guideline Gap.

The next section of the paper describes the '2 Feedback Loop Limitation' of design. This is a parallel and linked problem of Design and Emotion that goes some way to explaining why addressing the 'Design Guideline Gap' is difficult to address and has appeared to be hidden in full view.

3. The '2 Feedback Loop Limitation'

During the last decade, the author and Dr Trudi Cooper investigated complex socio-technical systems and from this became aware of a melange of problem issues found when humans try to understand or predict the behaviour of complex systems. These problems and failures of understanding and design are especially evident when humans attempt to use emotion, intuition or 'creativity' approaches and are well-established knowledge in the systems field and systems researchers had identified a raft of characteristic problems in system design that follow the same pattern. (see, for example, Deming [37], Shewart [38] Forrester[31, 32], Sterman[33] and Meadows[34]). (The author is grateful to one of the reviewers of this paper who pointed to similar analyses by Patrick Suppes at Stanford.)

The contribution of the author was to realise this wide variety of emotion-related problem issues in the complex systems arena appear to have a similar cause in a biological limitation of human thinking and emotions, and that the same problems and cause are found in everyday situations. In particular, they apply in users' and designers' emotions and thinking about designs. This realisation is coined as the '2 feedback loop limitation' hypothesis

The biological limitation is the human inability to understand or predict the behaviour of situations with two or more feedback loops. Put simply, humans are as biologically limited in their ability to understand and predict the behaviour of 2 or more feedback loop situations as they are to be able to jump 20 meters in the air unaided. Design and Emotion designers and researchers have focused on design situations without feedback loops and ignored the existence of anything more than a single feedback loop. The problems emerge when emotion-related designers and theorists attempt to address situations that have 2 or more feedback loops, and when it is realised that many everyday emotion-related design situations have 2 or more feedback loops and are not amenable to being simplified.

The '2 Feedback Loop Limitation' can be described in different ways. One appropriate to Design and Emotion is:

Humans unaided **CAN** predict behaviour of simple situations
with **less than 2 feedback loops**

==========

Humans unaided **CANNOT** predict behaviour of complex situations
with **2 or more feedback loops**

Figure 3: The '2 Feedback Loop Limitation'

The 2 Feedback Loop Limitation appears as a simple consequence of human biological limitations. In the same way that humans cannot unaided jump twenty meters into the air, humans are limited in their thinking, intuition, emotion and feelings. These human emotion and thinking processes are effective only up to and including a single feedback loop design situations.

Forecasting and understanding the dynamic behaviour of design situations with 2 or more interlinked feedback loops requires some form of representational modelling process (usually mathematical) in which designers role is limited to being able to observe outcomes of the behaviour of the model, rather than being able to understand or predict outcomes. This 2 Feedback Loop Limitation correlates with findings emerging from neuro-cognitive studies and with simple practical tests of human ability to understand situations with 2 or more feedback loops. It is effortless to demonstrate human limitations at addressing multiple feedback problems. In addition, inspection of the informatic structure of identification of behaviour of complex systems offers a deep insight to suggest these situations are intrinsically insoluble in terms of predicting the dynamic behaviour of multi-feedback loop design outcomes. (This latter topic is the subject of a different paper.) In essence, evidence from the systems field over a long period and a wide variety of other subject fields together with deictic empirical testing strongly demonstrates the validity of the 2 Feedback Loop Limitation across all humans, regardless of personal skill, intuition, cognitive ability, emotion, feelings, creative skill or education. A formal large-scale trial to test the principle is currently awaiting confirmation of funding as cross-institutional research collaboration.

The 2 Feedback Loop Limitation focuses on the biological limitation of humans in being able to predict dynamic design outcomes. This ability to predict behaviour is important in Design. Prediction of behaviour of a designed

outcome is one of the core competencies of design as a professional activity, as in all other professional activities. Without the behaviour to predict the behaviour of designed outcomes, designers are guessing; charging fees in a situation that opens them to financial litigation and civil and criminal claims against them on the grounds of incompetence.

The 2 Feedback Loop Limitation suggests that there are deep failures in design theory across all design fields, especially Design and Emotion, because these fields have not, to date, routinely differentiated in theory or design methods between simple, complicated and complex (multi-feedback loop) design problems and situations.. The '2 feedback loop limitation' hypothesis provides a simple and well justified explanation for many, or perhaps most, design failures. In addition, it marks a simple boundary that defines the limits of applicability of traditional design approaches, including design thinking, collaborative design, participatory design and intuitive/creativity-based design.

This is a significant issue in Design and Emotion practice and research at this moment because it has recently become fashionable for designers and design researchers to claim that design thinking, designerly ways of thinking, and traditional methods from the Art and Design fields in which the Design and Emotion field is grounded are applicable more widely to, for example, business processes, business strategy, health systems, innovation systems, information systems and other systems that involve two or more feedback loops. The 2 Feedback loop Limitation strongly suggests these claims are false, or rather, that if conventional Art and Design design approaches are used in situations with 2 or more feedback loops then regardless of any immediate success, the outcome will quickly fail due to unanticipated changes of design solution and design context caused by the action of the feedback loops. This is obvious and predictable, and hence lays designers open to prosecution for incompetence.

Early and simple forms of designed outcomes that were foundational to the development of traditional design practices and modes of design thinking do not have any feedback loops (see, Figure 4 below).

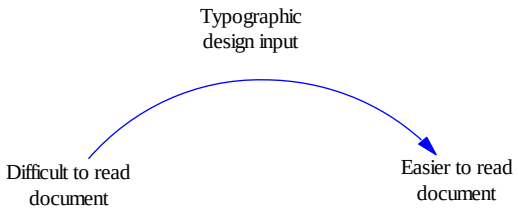

Figure 4: Simple design activity without feedback loops

With the increased exposure of the public to mechatronic control devices such as thermostats, the awareness of single feedback loop models spread from the technical domains of engineering design into other areas of design where it became relatively commonplace. An example is the classic design process with feedback (Figure 5).

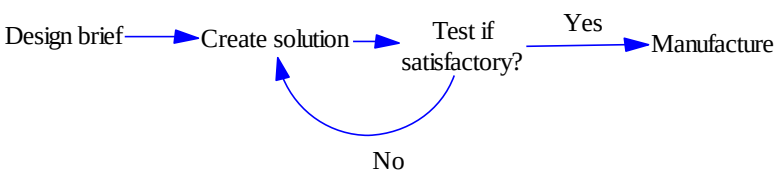

Figure 5: Simple design process with a single feedback loop

It is found in a much earlier form in the Shewart PDCA cycle (see, for example: http://en.wikipedia.org/wiki/File:PDCA_Cycle.svg)

A dominant tradition, in the Design and Emotion field and in Art and Design design fields, has been to assume that ALL design situations can be addressed by human designers' thinking and emotionally-based intuition. Design tools, methods and theories as well as design research approaches predominately and problematically assume:

- All design problems that will be addressed by designers will have no feedback loops or only one feedback loop
- Any design problem can be assumed that it can be converted unproblematically to a design situation with no feedback loops or only one feedback loop
- That traditional design approaches (including design thinking, design intuition, creativity, and feeling-based design) can be applied to any design situation regardless of the number of feedback loops.

These beliefs are supported by a common cognitive delusion[39] in which designers apply design methods that do not work, but subjectively and inappropriately feel that their design activity and the designs are successful.

The 2Feedback Loop Limitation marks a difference between *complex* and merely *complicated* or *simple* design situations:

- *Simple* design situation - low numbers of design elements/functions and no feedback loops or only one feedback loop
- *Complicated* design situation – higher number of design elements/functions with no feedback loops or only one feedback loop or with multiple independent subsystems each with at maximum one feedback loop
- *Complex* design situations – low or high number of design elements/functions with 2 or more interrelated feedback loops

The 2 Feedback Loop Limitation suggests that traditional design approaches only work with *simple* and *complicated* design situations and not with *complex* design situations with multiple feedback loops. Examples of *complicated* design situations are shown in Figures 7 and 8 below:

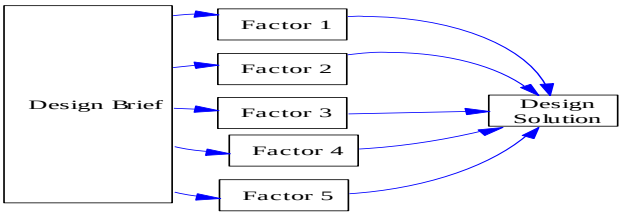

Figure 7: 'Complicated' rather than 'Complex' design situation – multiple single factors [39]

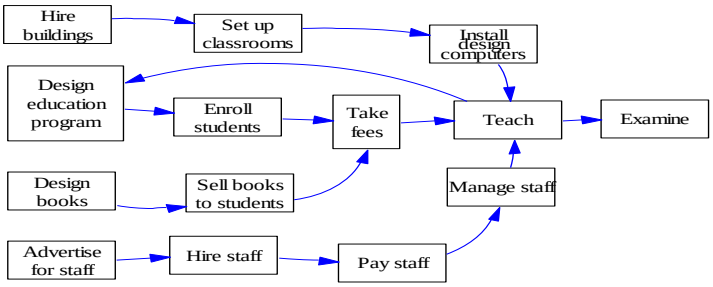

Figure 8: 'Complicated' rather than 'Complex' design situation –a single feedback loop [39]

The above *simple* and *complicated* design situations contrast with *complex* design situations as shown in Figures 9 and 10. Figure 10 shows a design situation obviously in the Design and Emotion design space to which current Design and Emotion design research and practice approaches do not apply. It is the design context of designing interventions to reduce overeating and obesity – similar in form to other addiction-related design interventions

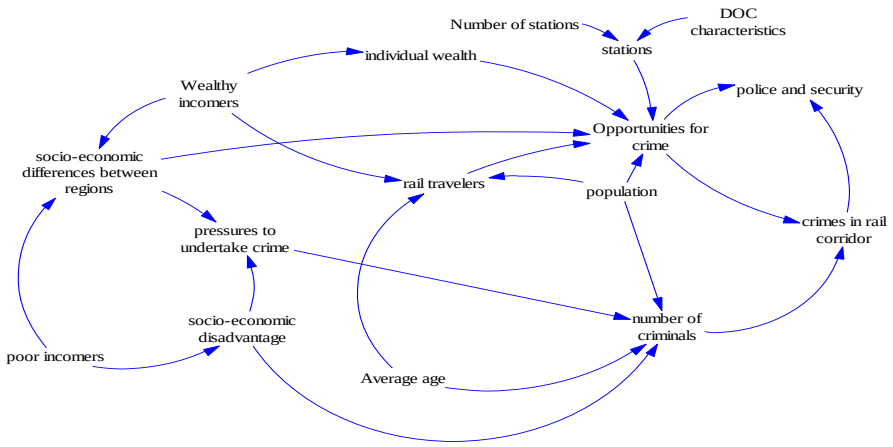

Figure 9: Complex design situation - Preliminary design relationships affecting crime in a rail corridor (unpublished Love, T, Cooper, T, Cozens, P, Morgan, F and Clare, J)

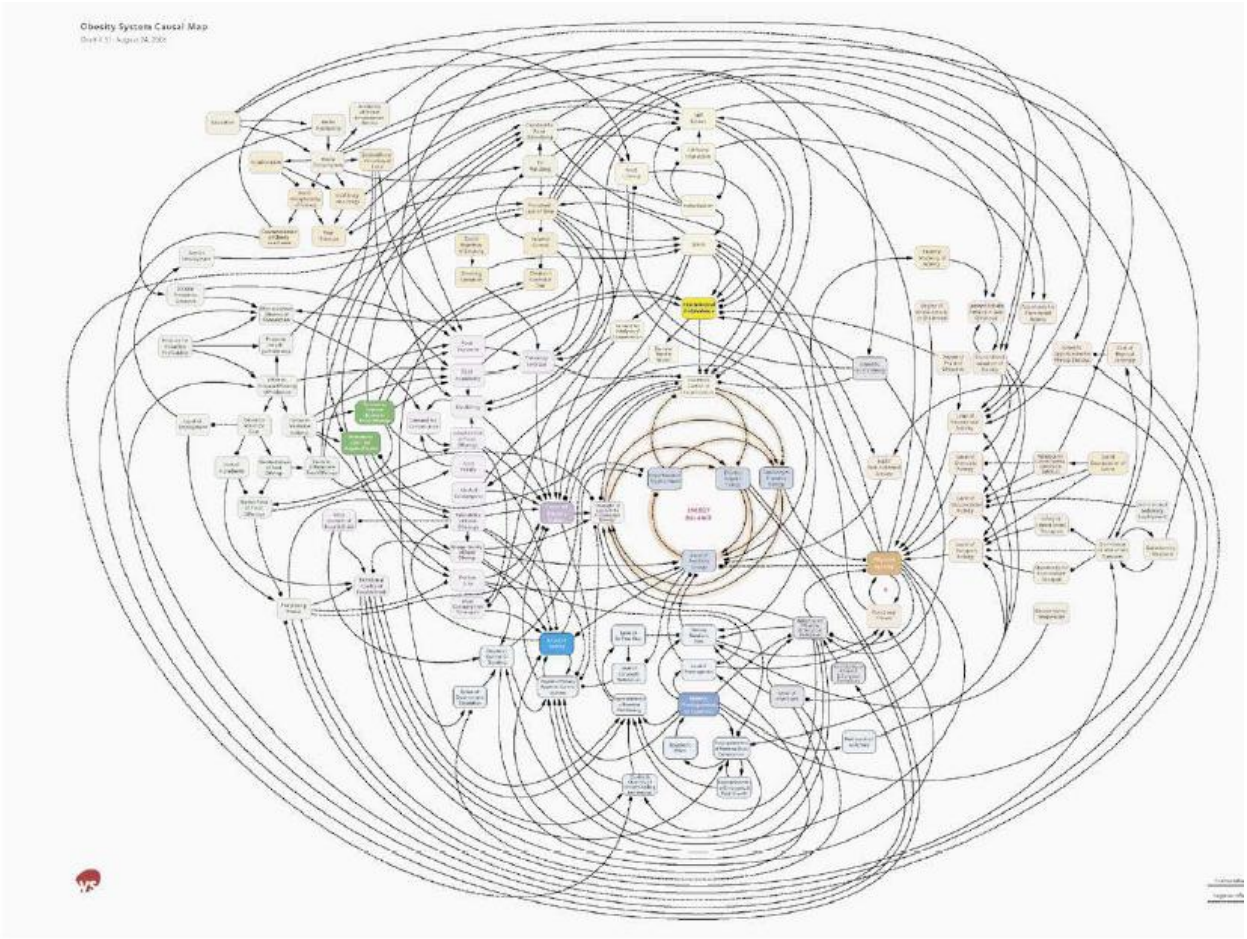

Figure 10: Complex design situation- design of obesity reduction: simplified model of multiple interrelated feedback loops http://www.foresight.gov.uk/Obesity/12.pdf [40] ((c) Crown copyright)

To summarise, in the Design and Emotion field and its literature, the 2 Feedback Loop Limitation challenges a range of widely uninspected assumptions about Design and Emotion theories and concepts and the applicability of design and research methods .

4. Implications

The above three sections have outlined two issues that have potentially deep implications for the Design and Emotion field, its literature, its research methods and design practices. The two issues are highly interlinked. Lack of awareness of the 'design guidelines gap' in 'Design and Emotion and other design fields may be held to be because of the '2 feedback loop limitation'. Awareness of the 'Design Guideline Gap' requires viewing design and emotion theory development epistemologically in terms of multiple feedback loops as a complex design context in and of itself. The human inability to understand and predict the behaviour of design and emotion development in this way results in the inability to easily perceive the 'Design Guideline Gap'. Similarly, design activity can be seen to have been over simplified by designers and design researchers to a single feedback loop model. As a result, many design outcome effects of the design research and design software development are ignored and design is presumed to be an individual or social pursuit. It is by including the less romantic but obvious other significant factors that start to expose the weaknesses in the existing traditional views.

What are the implications of understanding the above two issues for Design and Emotion as a field?

The implications of identifying the Design Guideline Gap include:

- Opening up a new area of research and practice in Design and Emotion
- Conceptually relocating some of the current concepts, research findings, theories and design practices
- Identification of areas of work still to be undertaken in design and research approaches.
- Identification of where claims for ability to provide design specification are invalid.
- Challenges claim that user-based analysis is sufficient to define design solutions.

The 2 Feedback Loop Limitation challenges and potentially invalidates several deeply held beliefs across all design fields including Design and Emotion. Implications include:

- Limits validity conventional design practices involving design thinking, intuition, feelings and conventional design methods, to design situations with less than one feedback loop.
- Challenges validity of claims that conventional design thinking and research methods apply to complex areas of design such as business strategy, health systems, information systems and public governance,
- Suggests the use of participatory design, collaborative design, crowd sourcing and the like are limited in usefulness to situations with less than two feedback loops.
- Redefinition of wicked problems as being straightforward to address rather than impossible (this issue has been addressed by the author in other papers). Predominately, 'wicked' design problems are those with multiple feedback loops and hence cannot be solved using approaches suitable to no feedback loops or only one feedback loop. In essence, this is partial proof of the 2 Feedback Loop Limitation.
- Challenges the belief humans can successfully intuit, feel or have correct insights about complex design situations.
- Draws attention to a major self-delusion that designers can subjectively feel the appropriateness or correctness of design methods and solutions.
- Challenges validity of design theory of complex design situations (and wicked design problems)
- Challenges claims by Design and Emotion sub-field, that complex design situations can be addressed via research into user's emotional responses.
- Provides justification for an alternative design method that resolves all the problems raised by the above challenges.

5. Solutions and Conclusion

There is potential for solutions to the issues above. The Design Guideline Gap has been addressed in more deterministic design and design research fields that involve less feedback loops than Design and Emotion. In more deterministic design fields, the Design Guideline Gap is closed in design research leading to software that produces design solutions. The difficulty with Design and Emotion is there are many simultaneous feedback loops of learning in the ways users and designers interact with objects and systems. By implication of the 2 Feedback Loop Limitation, this suggests typical approaches currently in Design and Emotion (including human design thinking and intuition or participatory design) are likely to be unsuccessful in anything other than simple cases – personal and group delusion is potentially a problem in this situation.

Three obvious approaches to addressing and resolving the 2 Feedback Loop Limitation in the Design and Emotion arena include:

- The use of modelling. This is a well established approach in complex systems design. The three primary modelling tools are causal loop diagrams, systems dynamic models and agent models. All three require substantial research support. Causal loop modelling is restricted as it provides only a snapshot in time and cannot provide understanding or forecasting of dynamic outcomes. This means it will result in faulty designs. For Systems Dynamic modelling and agent-based modelling of design situations with multiple interlinked feedback loops, then the prediction of the behaviour of the designed outcome is only available by watching the system play out in real time. These two provide causally-based design approaches
- Have a pattern equivalent to the design situation in focus that one already knows the dynamic behaviour. This is an associative modelling approach that us is widely used in for example weather forecasting where a pattern of several days weather is compared with similar weather snips from earlier decades. The limitation of this approach is indicated by for example, global warming rendering current weather patterns incommensurate with earlier patterns. It demonstrates the limitations of associated approaches to modelling because causal mechanisms can change and make associative patterns faulty.
- Undertake research to develop an understanding of the causal mechanisms at a causally more detailed scale. An example would be to refocus design research to understand the biological mechanisms that shape human emotional responses on the basis of their perception of the detail of objects and systems.

To summarise, this paper has described two concepts that have significant implications for Design and Emotion. The paper has sketched out the implications of them and has outlined solutions.

6. References

1. James, W., *What is an Emotion?* Mind, 1884(9): p. 188-205.
2. Dewey, J., *The Theory of Emotion. (2) The Significance of Emotions.* Psychological Review, 1895. **2**: p. 13-32.
3. Dewey, J., *The Theory of Emotion. (1) Emotional Attitudes.* Psychological Review, 1895. **1**: p. 553-569.
4. Dewey, J., *Art as Experience*. 1934, New York: Minton. Balch & Co.
5. Tonnies, F., *Community and Association*. 1955, London: Routledge & Kegan Paul.
6. Whiting, C.S., *Creative thinking*. 1958, New York: Reinhold Publishing Company.
7. Coase, R.H., *The Problem of Social Cost.* Journal of Law and Economics, 1960. **October**.
8. Fielden, G.B.R., *Engineering Design (The Fielden Report)*. 1963, London: H.M.S.O.
9. O'Doherty, E.F., *Psychological Aspects of the Creative Act*, in *Conference on design methods*, J.C. Jones and D.G. Thornley, Editors. 1964, Macmillan: New York. p. 197–204.
10. Gregory, S.A., *The Human Perspective, the Design Situation and its Opportunities*, in *The Design Method*, S.A. Gregory, Editor. 1966, Butterworths: London.
11. Sprott, W.J.H., *Human Groups*. 1966, Harmondsworth, UK: Penguin.
12. Eastman, C., *Explorations of the Cognitive Processes in Design (PhD thesis)*. 1968, Pittsburgh: Carnegie-Mellon University.
13. Rapoport, A., *House form and culture*. 1969, Englewood Cliffs NJ: Prentice-Hall Inc.
14. Maslow, A.H., *Motivation and personality*. 1970, New York: Harper & Row,.
15. Forrester, J.W., *Counterintuitive Behavior of Social Systems.* Technology Review, 1971. **73**(3): p. 52-68.
16. The Tavistock and Portman Clinic (2010) *The Tavistock and Portman NHS. Our History*. **Volume**,
17. Design and Emotion Society. *About the Design & Emotion Society*. 2010 [cited 2010; Available from: http://www.designandemotion.org/society/about/.
18. Sloman, A. *The Birmingham Cognition and Affect Project* 2010 [cited 2010; Available from: http://www.cs.bham.ac.uk/research/projects/cogaff/.

19. Love, T., *Constructing a coherent cross-disciplinary body of theory about designing and designs: some philosophical issues.* Design Studies, 2002. **23**(3): p. 345-361.
20. Love, T., *Philosophy of Design: a Meta-theoretical Structure for Design Theory.* Design Studies, 2000. **21**(3): p. 293-313.
21. Love, T. and T. Cooper, *Motivational Information Systems: Case study of a University Research Productivity Index and 6th Extension to Ashby's Law* in *ANZSYS'08: 14th International Conference*, T. Love, C. Cooper, and W. Hutchinson, Editors. 2008, Edith Cowan University: Perth, WA. p. CDROM.
22. Jung, J. and T. Love. *A strategy for creating design methods based on social behaviours for pleasurable user experiences in human–computer interaction. .* in *6th Conference on Design & Emotion 2008.: Dare to Desire*. 2008. Hong Kong Polytechnic University: The Hong Kong Polytechnic University.
23. Love, T. and T. Cooper, *Complex Built-environment Design: Four Extensions to Ashby.* Kybernetes, 2007. **46**(9/10): p. 1422-1435.
24. Love, T. and T. Cooper, *Successful Activism Strategies: Five New Extensions to Ashby*, in *Systemic development: local solutions in a global environment. ANSYS 2007 proceedings*, K. Fielden and J. Sheffield, Editors. 2007, Unitech: Auckland.
25. Love, T. and T. Cooper, *Digital Eco-systems Pre-Design: Variety Analyses, System Viability and Tacit System Control Mechanisms*, in *2007 Inaugural IEEE International Conference on Digital Ecosystems and Technologies 21-23 February 2007 Cairns, Australia*, E. Chang and F.K. Hussain, Editors. 2007, IEEE: Los Alamitos, CA. p. 452-457.
26. Love, T., *System dynamics modelling of national design infrastructure development* in *Systemic development: local solutions in a global environment. ANSYS 2007 proceedings*, K. Fielden and J. Sheffield, Editors. 2007, Unitech: Auckland.
27. Love, T., *A Systems Analysis of the Problem of Professional Practice in Design: "Why Mac Computer Systems Reduce Creativity and Inhibit Quality Improvement of Novel Innovative Design" - Plenary*, in *WonderGround, Designing interdisciplinary discourse, conspiring for Design Leadership, Design Research Society International Conference 2006 Proceedings Book*, E. Corte-Real, K. Friedman, and T. Love, Editors. 2006, IADE - Instituto Artes Visuais Design Marketing: Lisbon, Portugal.
28. Love, T., *Social, environmental and ethical factors in engineering design theory: a post positivist approach*, in *Mechanical and Materials Engineering*. 1998, University of Western Australia: Perth. p. 358.
29. Love, T., *Social, environmental and ethical factors: their implications for design theory*, in *Design for People*, M.A. Groves and S. Wong, Editors. 1996, Edith Cowan University: Perth. p. 199-206.
30. Love, T., *Systems models and engineering design theory*, in *Systems for the Future*, W. Hutchinson, et al., Editors. 1995, Edith Cowan University: Perth Western Australia. p. 238–246.
31. Forrester, J.W., *Understanding the counter-intuitive behaviour of social systems*, in *Systems Behaviour*, Open Systems Group, Editor. 1972, Harper & Rowe Ltd: London. p. 270-287.
32. Forrester, J.W., *Counterintuitive Behavior of Social Systems, 1970*, in *Collected papers of Jay W. Forrester*, J.W. Forrester, Editor. 1975, Wright-Allen Press Inc.: Cambridge Massachusetts.
33. Sterman, J.D., *All Models are Wrong: reflections on Becoming a Systems Scientist.* System Dynamics Review, 2002. **18**(4): p. 501-531.
34. Meadows, D., *Leverage Points. Places to Intervene in a System*. 1999, Hartland, VT: The Sustainability Institute.
35. Love, T., *Design and Emotion: Time for a New Direction?*, in *IASDR 2009 Proceedings*. 2009, IASDR with KAIST: Seoul. p. 40.
36. Love, T. *Beyond Emotions in Designing & Designs: Epistemological & Practical Issues*. in *Design & Emotion '02*. 2002. Loughborough.
37. Deming, W.E., *Out of the crisis*. 1986, Cambridge, Mass: Massachusetts Institute of Technology and Cambridge University Press. xiii, 507 p.
38. Shewhart, W.A. and W.E. Deming, *Statistical method from the viewpoint of quality control*. 1986, New York: Dover. ix, 155 p.
39. Love, T., *Can you feel it? Yes we can! Human Limitations in Design Theory (invited keynote)*, in *CEPHAD 2010*, P. Galle, Editor. 2010, Denmark DesignSkole: Copenhagen.
40. Vandenbroeck, P., J. Goossens, and M. Clemens, *Tackling Obesities: Future Choices – Building the Obesity System Map*. 2007, London: Department of Innovation Universities and Skills (c) Crown Copyright.