AN INVESTIGATION INTO THE CONCEPT OF MOTIVATION WITHIN DESIGN

ABSTRACT

This thesis argues that there is a need for design practitioners and design researchers to more clearly articulate and understand the role of design in motivating and engaging human behaviour.

Reflecting upon a multifaceted design process adopted in the course of the development of a Public Engagement with Science Exhibition; Ergonomics Real Design hosted at the Design Museum, London in late 2009 and early 2010, this thesis profiles research exploring the concept of human motivational engagement as part of the design and utilisation of a museum exhibition. The role of design and designers in motivating humans is discussed and a number of factors that impact upon the motivational engagement of humans in the museum environment are identified. These factors are synthesised in this thesis in the form of a Motivational Design Framework.

The thesis builds upon its definition of factors regulating the motivation of users within the design of multi-touchpoint sociotechnical systems, specifically within the museum environment, through documentation and case-based reflection upon an applied design process that sought to adopt a philosophy of motivational design and elicit the motivational engagement of its participants. Finally this thesis presents an approach to evaluating the motivational engagement of users following their interaction with a designed, multi-touchpoint user experience. The results of these research objectives are recorded and discussed in terms of their implication for design practitioners interested in consciously motivating and engaging user behaviour.

This thesis synthesises some key concepts, methods and tools of interest to designers and design researchers who wish to support the motivational energisation, engagement and generative behavioural potential of their users. This thesis advocates for, and contributes to, the formalisation of motivation as a tractable and syntactic concept within the field of exhibition design specifically, and within the broader field of design research more generally.

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ACKNOWLEDGEMENTS

Its amazing to sit and think how many people over the past three and a half years, or one thousand, two hundred and sixteen days to be more precise, have contributed to, or supported my own motivation to complete this MPhil, and its even more difficult to attempt to acknowledge all those who have contributed to this process in other ways over that time, or even before it started. However,

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THE TWITTERSPHERE (NOVEMBER, 2008 – PRESENT)

It's entirely fair to say that this thesis wouldn't exist without Twitter so Biz, Jack and Evan, thanks. It is of course ironic that as a result of a medium that limits messages to 140 characters, the world is now bequeathed with this 524,884+ character, 77,000 word monstrosity, but it is less about the length of those tweets and more about the people and ideas with whom and with which I was able to connect throughout this

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1. INTRODUCTION

This thesis articulates, with reference to key decisions faced in the course of the design and implementation of a public engagement with science project *Ergonomics Real Design*, an exploration and postulation of the role of motivation within the design process, specifically exploring the value for design practitioners and design researchers of the concept of human motivation in the ideation, utilisation and post-use evaluation phases of the design of a museum exhibition. In addition to affirming the modernist-era cultural norm of designing to extrinsically motivate user behaviour (Krippendorff, 2004; Pink, 2010), the argument asserted and the framework, tools and evaluation approach adopted and developed in the course of this research encourages and assists design practitioners and design researchers to better conceptualise, support, and capitalise upon, their users' motivational engagement. This thesis is developed and the theoretical aims which underpin it evaluated in terms of users' interaction with a public engagement with science exhibition, within the context and physical constraints of a museum. The development of a framework of motivational design is presented in this thesis as an approach to support collaborative and co-creative design projects and practices, by informing design practitioners and researchers of the role of motivated behaviour of users in dynamically interacting with a product, system, service or experience and making explicit what is otherwise tacit (Cross, 1999) or 'complex' or 'mysterious' (Martin, 2009) for designers and users alike within the

process of designing and using of products, systems and services. Put more simply, it is rare that design practitioners or design professionals stop to consider what it was specifically that made their own, or their users, interaction with a product, system or service so motivating or engaging or conversely what made it so demotivating or disengaging. It is rarer still that a design professional or design researcher articulates at the outset of a design project any facet of user behaviour or motivational engagement they wish to consciously engage or motivate use of, as part of their design solution or the designed sociotechnical experience they are developing. Part of the reason for this dearth of conscious articulation of end-user motivational engagement is, for the very fact that, as Krippendorff (2004) has argued, the tools and methodologies of Modernist, industrial-era designers are not well equipped to take account of, or support, motivation as a concept or malleable entity within the design process. This thesis seeks to redress this contention, the central premise of which it also concurs, design practice does motivate and engage user behaviour, so design practice needs to become more accomplished at understanding and conceptualising this fact.

Building on the premise of motivational psychologist Reeve (2008), that motivation refers to the energisation and direction of all human behaviour, this thesis will synthesis of a number of factors that designers can take account of about human behaviour and motivation in order to deliberately, as well as implicitly, energise or direct user behaviour and through which designers can support users to more sustainably energise and direct their own behaviour in interacting with designed products, systems and services. This will be of specific interest to designers interested in supporting public engagement with science or the motivational engagement of users within museums and exhibitions. This thesis should also be of interest to design researchers and design practitioners engaged in designing or understanding dynamic user-product, user-system or user-service interactions within more complex sociotechnical systems and those interested and engaged in designing to consciously articulate, influence, evaluate, and reward their users' motivational state and behavioural engagement.

1.1 BACKGROUND TO ERGONOMICS REAL DESIGN EXHIBITION AND THE RELATIONSHIP WITH THIS RESEARCH

To begin to substantiate its aims, this thesis articulates, summarises and draws heavily upon a body of research and applied design practice conducted in connection with the award, in 2008, of an Engineering and Physical Science Research Council (EPSRC) Partnerships for Public Engagement research grant to Dr Mark Young in the School of Engineering and Design at Brunel University. The partnership, between Brunel University, Loughborough University, Laura Grant Associates and the Design Museum, London, with support from The Institute of Ergonomics and Human Factors sought, over eighteen months and through the design of an exhibition at The Design Museum, London, to engage the public, design practitioners and design students with the science of ergonomics. The partnership, *Making Things Better* included the full-time employment of a Design Researcher, the author of this thesis, to research and manage, with the project manager Dr Young, the design of the exhibition and, in the process, facilitate collaboration amongst the partners and the stakeholders of the exhibition. Such responsibilities demanded, in conceptualising and designing the engagement strategy of the project, a clear understanding of the role of design in influencing motivation and engagement of the intended audience. Explicitly the design brief for this project required the design researcher to visualise, communicate, energise and

direct the motivational engagement of the wide range of project stakeholders in the development, implementation and evaluation of this public engagement exhibition. The conceptualisation therefore of design, and specifically museum and exhibition design as a process of motivational engagement, is one which this thesis also asserts, but is also an assumption, it is argued, that is a) hitherto unfounded within the design research and museum and exhibition design literature and b) is an assumption about the role and value of design that has much value more broadly then simply ensuring the successful fulfilment of the public engagement aims and longer term perceptual and behavioural change objectives of the public engagement project.

A formal design research based methodology was thus sought to influence and sustain the motivation and engagement of the end users of this project - the visitors to the exhibition. This methodology was sought to help guide the early user engagement in the design process, underpin the concept development of the exhibition and provide a framework to assess the impact of the exhibition on users' overall levels of motivational engagement throughout the development process of this sociotechnical system. Whilst references to motivation are prevalent within design research, and a number of models of motivation in design (Sampanthar, 2010; Keller, 1983; Giacoma, 2009) were found, none of these pre-existing models of motivation however, support a generative or participatory design approach appropriate to the development of a multi-touchpoint, multi-user sociotechnical experience, such as the *Ergonomics Real Design Exhibition*. Furthermore, there seems little recognition within the field of design of the role of motivation as a designed concept or construct, with instead aesthetic and functional approaches to design being more prevalent and broadly recognised. There has in recent years been an emergence of more closely related concepts such as Design for Emotion in the late nineties and Design for Behaviour over the past five years, but none of these discretely address or provide a generative, participatory or instructive approach, as the Ergonomics Real Design Exhibition Project demanded, to designing to support or explicitly regulate the motivational engagement of the users

of a designed product, system or service. Such an approach would therefore need to be developed, but prior to this understanding of the component parts of motivation and engagement would need to be ascertained and understood.

The aforementioned aesthetic, functionalist, emotional and behaviourist models and approaches to design are rooted in, and manifest at the intersection of the fields of Industrial Design, Interaction Design and Service Design, and can also be observed in the literature and methodologies of other sociotechnical systems perspectives. The absence of a formalised approach to addressing user motivation and engagement within the design process of multi-user, multi-touchpoint designed services however, particularly those systems or services containing artefacts or tangible products and physical touchpoints, is attributed to the fact that most industrial designers see motivation and the energisation of human behaviour as a Modernist era by-product of affective engagement. In other words, designers have traditionally ignored motivation as a discrete concept throughout the design process and active use phase of the product or service delivery process, instead opting to focus on aesthetically shaping or functionally adapting the design to elicit user behaviour, engagement and value (Jordan, 2000; Vargo and Lusch, 2004; Norman, 2004; Morelli, 2009). Such 'value' is often thereafter post-rationalised as engaging or motivating, but is arguably rarely conceptualised as motivating or motivational beforehand during the design development phase. This identified industrial-era, mass-produced, goods-dominant logic view of value creation (Morelli, 2009; Vargo and Lusch, 2004) therefore represents a static, deterministic and, this thesis argues, disempowering view of end user behaviour and their capabilities. It is this disempowering or post-rationalised view of user motivation and engagement that this thesis seeks to redress within the field of design and instead present a theoretical, practical and empirical alternative to.

The traditional 'goods dominant', 'end-user' view of user capability, outlined above also poses significant extrinsic and technologically deterministic limits upon end user behavioural engagement and their motivation, empowerment, and the ability of users to collaborate within the design process - negatively impacting on its generative potential. The notions of user-centred design, human centred design and inclusive design have offered something of a progressive shift away from these industrial-era conceptions of the role of design in engaging human behaviour. However, user-centred design is discussed as a process of designing for a static conception of a user (Gregor, Newell and Zajicek, 2002) and this thesis argues that from a designers' perspective such static conceptualisations whilst useful, do not aid conceptualisation of the latent growth or motivational energisation and behavioural potential within their audience or user-base (Shirky, 2008), nor do they support the design and development of a public engagement with science exhibition that was designed to elicit the sustained motivational engagement of its participants. Furthermore, this thesis argues that such user-centred models as those highlighted above, do not explicitly inspire or support designers to consider how to empower their users or to encourage their users to be motivated to acquire, use or participate with, or of, their products and services or the user's relationship with those products, systems and services.

Further, and in relation to exhibition design, the context of application of the theoretical aspects of this thesis, such an 'industrial-era' static conception of the user as that identified above manifests itself in a preoccupation amongst exhibition and designers and museum curators of the aesthetic and functional design of the exhibition without necessary consideration of the impact of these extrinsic dimensions of user experience in supporting or diminishing user motivation or engagement. The inabilities or refusal designers to consider the behavioural and motivational elements of user experience in this context, this thesis argues, results in museum experiences where users are unable to contribute knowledge or experience, or actively participate, in a manner that could otherwise add value to the experience of the exhibition for all

visitors and stakeholders. In broad principle this represents an approach to exhibition design that therefore privileges the extrinsic dimensions of user experience, such as those outwith the locus of control and influence of users, over the intrinsic dimensions and drivers of user behaviour and experience. In other words it results in museum and exhibition experiences where the static artefacts and exhibits are privileged over the visitors to the museum. It is these user-oriented and embodied 'intrinsic' dimensions of designed experience and motivation that this thesis will seek to articulate and synergise with the preestablished 'extrinsic' notions of user experience. This thesis argues that design and designers are well suited to reconcile these intrinsic and extrinsic dimensions of user experience in both the museum environment and more generally within the design and development of complex sociotechnical systems, but to do this design as a discipline and designers as practitioners need to understand more about what constitutes motivation and motivational engagement and how they can integrate an understanding of this within their existing and preestablished design approaches and processes. These two objectives will form the basis of the enquiry of this thesis.

Whilst the previously identified models of motivational design within the literature such as that of Keller (1983) and Giacoma (2009) are undoubtedly of relevance to the enquiry of this thesis, they are representative of the more recent shift within design research circles, energised by the growth of Service Design, Interaction Design and the Cognitive Systems approach to design, as part of a move away from static, deterministic models of user behaviour and user capability. This thesis will investigate the shift from Industrial-era to the so-called 'Experience Economy' models of user engagement, (Pine and Gilmore, 2007) or, as it has already been phrased above, the shift from extrinsic to intrinsic dimensions of user experience. This thesis will explore how metaphorically and literally that shift can be conceptualised within a philosophy of motivational design and underpin the design of multi-touchpoint user experiences, particularly those within a museum and educational context.

1.2 OVERVIEW OF THE SCOPE AND APPROACH OF THIS RESEARCH

This research is instigated with an extensive review of the literature exploring the concept of engagement in relation to the design of multi-touchpoint, multi-user educational experiences, principally centred around a museum context. A broad literature review exploring the concept of engagement as it relates to museum and exhibition design is then followed by an extensive review of the motivational psychology literature investigating the behavioural transformation that occurs in participants of a multi-touchpoint, multi-user service experience. This review is consolidated with reference to the design research literature, exploring how a case-based analysis of the design and evaluation of a public engagement with science exhibition, *Ergonomics Real Design*, detailed in chapters three and four can support designers to understand and address the challenges associated with deliberately designing to motivate and engage their users with both the development and use of a museum exhibition and sociotechnical systems more generally. The empirical data, and design methodology recorded in these chapters is discussed, and a number of recommendations for design practitioners and further design research are made in chapter five, alongside the presentation of the fully synthesised Motivational Design Framework which is otherwise elucidated and expanded throughout chapter two. In its current form, and as part of an emerging post-phenomenological (design) research

agenda (Ihde, 2009; Verbeek, 2006), the literature explored within this thesis can support designers to create more motivating or engaging design concepts and design solutions through adherence to, or development of, their own motivational design philosophies and the subsequent blurring of the traditional boundaries in design practice and design research, between static system capabilities (extrinsic behavioural affordances) and dynamic user capabilities (intrinsic behavioural potential and energy). As described above, three research objectives underpinned the initial literature review and objectives of this thesis.

1.3 OVERVIEW OF THE LITERATURE REVIEWED

Section 2.1, the first chapter of the literature review, explores what this thesis conceives of, and has outlined in the previous section as the shift from static to dynamic conceptualisation, within design, of user capabilities. In relation to public engagement with science this shift has been articulated by others as a shift in the public engagement with science agenda from a process concerned with designing for societal 'awareness' of science to one concerned with social 'engagement' with science' This shift from 'awareness to engagement' emphasises an increased social participatory perspective both within governmental policy in the UK over the past eleven years, and specifically in how designers designing to implement and utilise public engagement with science should consider the latent or hitherto informally conceived social capabilities and dynamic behavioural capacity of their users; in other words their capability and capacity for motivational engagement. Such a shift, it is argued by Stilgoe and Sykes (2009), moves people 'upstream' from awareness of science to fuller engagement with it. Section 2.1 concludes with an outline argument for the role that design can play in supporting public engagement with science as it mirrors this increasingly global participatory and transformative socio-political shift with the emergence of the 'service design' and 'social' design research and design practice paradigms.

Reflecting upon traditional approaches to modelling user behaviour and capability and upon recent progressive shifts in the field of design research such as the user-centred and human centred design perspectives and the evolution of generative and critical approaches to design, Dunne states, "…[when]…using electronic objects the use is constrained by the simple generalised model of a user these objects are designed around: the more time we spend using [such devices] the more time we spend as a caricature" (1999, p. 30). This view typifies and underpins that of this thesis, that designers and design professionals whether practicing in a museum and exhibition design process or elsewhere have to work harder to understand and explore how to energise and engage their users dynamic behavioural capacity and capabilities, rather than constraining these through the design of static and deterministic products, systems, services and exhibitions.

Section 2.2 therefore considers what it articulates as the shift from static to malleable or dynamic and socially mediated, models of user interaction within design and explores how these can be represented and generate value in the museum environment. This section also discusses how such a transition is, from the perspective of exhibition designers and from the perspective of curatorial practitioners and researchers, epitomised and embodied in the gradual shift over the past fifty years from interpretive approaches to museum curation to that of more interactive and performative modes of engagement and interaction. Much like the socio-political landscape in which it sits, the increased socialisation and participatory focus of the exhibition space, fuelled and supported by technology that helps democratise it, is one of the key themes drawn out from this section of the literature review. This synthesis is thereafter adopted as analogous with similar transitions within the field of design and this observation of the transition from static to dynamic models of user behaviour underpins the argument of this thesis that designers need to develop better, more generative, more dynamic and more social models to truly understand the engaged behavioural state of their users. This, by implication, demands designers

1. RESEARCH INTO, AND SYNTHESIS OF, THE FACTORS IMPACTING UPON THE MOTIVATIONAL ENGAGEMENT AND SELF-REGULATION OF USERS AS THEY INTERACT WITH DESIGNED PRODUCTS, SYSTEMS AND SERVICES

  ch. 2.1 PUBLIC ENGAGEMENT WITH SCIENCE

  ch. 2.2 MOTIVATIONAL ENGAGEMENT WITHIN A MUSEUM CONTEXT

  ch.s 2.4 – 2.8 MOTIVATIONAL & ITS RELATIONSHIP TO DESIGN

2. IDENTIFICATION AND REFLECTION UPON A MOTIVATIONAL DESIGN PROCESS, SPECIFICALLY, THE DELIBERATE PHYSICAL AND SOCIAL MOTIVATIONAL ENGAGEMENT OF USERS WITHIN THE DESIGN AND USE PHASES OF A PUBLIC ENGAGEMENT WITH SCIENCE EXHIBITION WITHIN A MUSEUM ENVIRONMENT

  ch. 3.2 CASE BASED REFLECTIONS

  ch. 3.3 CONTEXTUAL INTERVIEWS & RESEARCH

  ch. 3.4 CONCEPT DEVELOPMENT

3. IDENTIFICATION AND REFLECTION UPON AN APPROACH TO MEASURING END-USER MOTIVATIONAL ENGAGEMENT IN INTERACTING WITH (USING) A PUBLIC ENGAGEMENT WITH SCIENCE EXHIBITION SET WITHIN A MUSEUM CONTEXT.

  ch. 3.5 CONCEPT EVALUATION

  ch. 4 RESULTS OF INVESTIGATION

  ch. 5 DISCUSSION OF RESULTS

MYSTERY

HEURISTIC

$X + Y = Z$

ALGORITHM

MARTIN (2009)
'Design Thinking Funnel'

RESEARCH OBJECTIVES

CHAPTER OF THE THESIS THAT ADDRESSES THIS OBJECTIVE

FIG. 1 DIAGRAM OUTLINING THE RESEARCH OBJECTIVES OF THIS THESIS, WHERE THEY ARE ADDRESSED IN THIS THESIS, AND HOW THESE OBJECTIVES RELATE TO THE PRINCIPLES OF MARTIN'S 'DESIGN THINKING FUNNEL', WHICH ITSELF WAS INSTRUMENTAL IN STRUCTURING THE EXPLORATORY ENQUIRY OF THIS THESIS

become more accomplished and more transparent about the way they converse about, visualise and evaluate the motivational impact and the behavioural self-regulation afforded and demanded of users by their work.

The philosophical and ethical basis of motivation is explored in section 2.3 with reference to the role of artefacts in communicating and transferring information both within the museum environment and more broadly within the field of design research, through the successful integration of artefacts within complex sociotechnical systems. As has been asserted in the introduction to this thesis, designers have historically made their design more appealing and thus by simplistic Industrial-era implication, more motivating, through manipulation of form and by enhancing users' phenomenological interpretation of experience. Consequently, design as a profession and academic research discipline has pursued a broad agenda of adding, refining and evaluating the dimensions and richness of the experience of individuals in interacting with products, systems and latterly services. This phenomenological approach has involved user-centred engagement and increased participation of users within the design process in a bid to assist designers and researchers in better understanding how users use and experience such products, systems and services, physically, psychologically and socially. These insights have supported designers in capitalising upon the simultaneously increasing technological mediation of design, and further, assisted designers in supporting generative and collaborative approaches to new product and service development.

The literature review and argument of this thesis therefore traces the role of motivation in determining and defining users' physical, cognitive and social behaviour in response to, and in anticipation of, such experiences. This is argued as analogous to what, in the motivational psychology literature might be termed users' approach and avoidance seeking behaviour. A case is made that designers possess a toolkit of established methods and processes to create or eliminate discrepancy in their users' perceptions

of the world around them and which can support designers in the process changing public perceptions, and by implication, energising and directing user behaviour, user interaction and supporting users to derive knowledge and acquire skill.

Finally, and more pragmatically, having considered from a design perspective the socio-cultural context within which the design of the *Ergonomics Real Design Exhibition* sits, in terms of the public engagement with science agenda in the UK, and where it sits within the context of industrialised design practice and research, this thesis, in sections 2.4, 2.5, 2.6, 2.7 and 2.8 seeks to gather from literature insights into how designers might specifically and pragmatically influence and direct the motivation and engagement of their users, and identifies the tools and approaches that designers already possess to most effectively converse about, visualise and evaluate the transactional and dynamic process of motivational engagement. It is proposed that examining, synthesising and visualising established theories of motivation, as this thesis does, might provide designers and design researchers with a basic foundational framework (Buchanan, 2005) through which to understand better how they might motivate and engage their users and stakeholders and how they can imbue their design processes with such an understanding. Such a basic framework is exemplified and signified in this thesis in the synthesis of a Motivational Design Framework, developed from a review of motivational psychology, human factors and design research literature. This framework as a tool to support designers is discussed in full in chapter five, but is incrementally developed throughout the literature review process, as a visualised concept map, as outlined above, to support understanding of the emergent and distinct properties of the relationship of motivation and design.

1.4 RESEARCH OBJECTIVES

The scope of this thesis can be summarised into three broad research objectives.

RESEARCH OBJECTIVE 1

Research into, and synthesis of, the factors impacting upon the motivational engagement and self-regulation of users as they interact with designed products, systems and services: What are the factors that motivate and demotivate them?

RESEARCH OBJECTIVE 2

Identification and reflection upon a Motivational Design Process, specifically, the deliberate physical and social motivational engagement of users within the design and use phases of a public engagement with science exhibition within a museum environment: What can designers do to take advantage of the previously identified motivational factors and embed and integrate them within their design process and philosophy?

RESEARCH OBJECTIVE 3

Identification and reflection upon an approach to measuring end-user motivational engagement in interacting with (and using) a public engagement with science exhibition set within a museum context.

1.5 CASE BASED REFLECTIONS

One of the key contributions of this thesis and one of the means by which it addresses the second of its research objectives, to identify and reflect upon a motivational approach to design, is through the use of case-based reflections. The methodology that underpins and justifies the use of this approach is detailed in section 3.2, however much of the utility of these reflections as they relate to the enquiry of this thesis comes from the fact that these reflections are interspersed throughout the literature review of this thesis found in chapter two. Within the literature review these case-based reflections can be identified through their yellow background and their san-serif font in contrast to the serif font and white background of the rest of the text of this thesis.

The case-based reflections recorded in this thesis are set within the context of the challenges associated with designing the *Ergonomics Real Design Exhibition* and as design researchers and practitioners, consciously articulating the role of motivation and overall motivation engagement of visitors to the exhibition. This echoes the precedent set, within the field of Design Research, by the work of Ingemann (2010) to use first hand case based reflections of the design process of a public engagement exhibition as the basis of a wider discussion and reflection, of, in this case the role of design in influencing and regulating human motivation. This approach is used

THESIS

EXHIBITION

THESIS AIMS &
DEVELOPMENT
PROCESS

ERGONOMICS
REAL DESIGN
PROJECT

RO1
SYNTHESIS OF
MOTIVATIONAL
FACTORS IN DESIGN

RO2
IDENTIFICATION OF
A MOTIVATION
DESIGN PROCESS

RO3
EVALUATING USERS
MOTIVATIONAL
ENGAGEMENT

PROJECT
INSTIGATION

Project instigation &
funding determined
context of 'public
engagement' would be
a museum

REVIEW OF
MUSEUM
LITERATURE

Background and
context of research,
identification of a
number of
conceptual parallels
and ideas from
museum design and
public engagement
with science worthy
of investigation in
the context of
design and design
research

REVIEW OF
PUBLIC ENGAGEMENT
WITH SCIENCE
LITERATURE

Review of this thesis
informed that of the
Ergonomics Real Design
Exhibition

REVIEW OF PUBLIC
ENGAGEMENT
LITERATURE

REVIEW OF
MUSEUM DESIGN &
CURATION
LITERATURE

REVIEW OF
ERGONOMICS
LITERATURE

Review of this thesis
informed the design of
the exhibit list for the
Ergonomics Real Design
Exhibition

EVALUATION

DESIGN

REVIEW OF
MOTIVATIONAL
PSYCHOLOGY LIT.

Exploration of the
facets of human
behaviour and
motivation that
might be utilised
within the
previously identfied
context by
designers and
design researchers

REVIEW OF
DESIGN
RESEARCH LIT.

REVIEW OF
INSTRUCTIONAL
DESIGN LIT.

Development of Ergonomics
Real Design Exhibition used as
context in which RQ1 was
explored

BASELINE
ENGAGEMENT
DATA GATHERING

RQ1
CONVERSATION AS
A MOTIVATIONAL
TOOL

PRE-EXHIBITION
ENGAGEMENT
DATA GATHERING

Ergonomics Real Design
development conversations used
as basis for investigations into
visualisations for thesis

EXHIBIT LIST
DEFINED

RQ2
REFLECTIONS UPON A
MOTIVATIONAL DESIGN
PROCESS

DESIGNER
COMMISSIONED

Visualisations developed as
part of research of thesis
informed and supported
concept design of exhibition

EXHIBITION
CONCEPT
FINALISED

RQ3
EVALUATING USERS
MOTIVATIONAL
ENGAGEMENT

Evaluation of the
motivational impact of
the exhibition
supplemented
evaluation of the
Ergonomics Real Design
team

EXHIBITION
BUILD

EXHIBITION
LAUNCH

POST-EXHIBITION
ENGAGEMENT
DATA GATHERING

SYNTHESIS OF A
MOTIVATIONAL
DESIGN
FRAMEWORK

SERIES OF CASE
BASED REFLECTIONS
ON A MOTIVATIONAL
DESIGN PROCESS

The process of developing the
Ergonomics Real Design
development recorded as a series
of case based reflections on the
concept of designers designing to
support the motivational design
and engagement of a public
engagement exhibition

POST-EXHIBITION
CO-CREATION
WORKSHOP

SERIES OF
RECOMMENDATIONS
FOR FUTURE DESIGN
RESEARCH

PROJECT
REPORT
WRITTEN

PROTOTYPE
METHODOLOGY FOR
EVALUATING
MOTIVATIONAL
IMPACT OF DESIGN

PAPERS
SUMMARISING
LEARNING FROM
PROJECT
PUBLISHED

FIG. 2 DIAGRAM OUTLINING THE RESEARCH OBJECTIVES & PROCESS OF THIS THESIS
IN RELATION TO THAT OF THE ERGONOMICS REAL DESIGN EXHIBITION PUBLIC
ENGAGEMENT PROJECT

to make the literature reviewed more accessible and tangible to designers, using a process of reflective practice (Schön, 1983), and to highlight the research reflections in practical context. The yellow boxes throughout the dissertation relate the theory and literature explored to the challenges and process observed in the design of the Ergonomic Real Design Exhibition. This case study approach to recording, learning and critically reflecting is further outlined in the methodology section of this thesis - section 3.2, as is the precedent for using such reflections as the basis of theoretical frameworks (see Eisenhardt, 1989).

2. ENGAGEMENT WITH SCIENCE AND ENGAGEMENT WITH AND WITHIN DESIGN

As has been explained in the introductory chapter, the research contained in this thesis is rooted in the theory, experiences and observations derived from empirical design research and practice in the field of public engagement with science. As such, and as part of the argument and contribution of this thesis, the parallels and relationship between public engagement with science, its ethics and its politics and recent moves within the field of design research have already been loosely outlined. In this chapter some of these parallels and relationships between public engagement and design research and practice are further explored. The overall conclusion of this section is that the context of public engagement with science and indeed, the context of the design of exhibitions within a museum environment enable and afford many rich insights and observations for designers particularly those interested or occupied with the design of multi-touchpoint, multi-user product and service experiences or the design of educational services and systems.

2.1 INTRODUCTION TO CONCEPT MAPPING AND THE MOTIVATIONAL DESIGN FRAMEWORK

In addition to the case based reflections outlined in the previous chapter and introduced as reflections on the literature reviewed throughout this chapter and as part of the overall contribution of this thesis, this chapter will utilise conceptual diagrams as part of a process of exploring and synthesising the literature reviewed. The literature brought together in this thesis to create and discuss the concept of motivational engagement within the field of design and specifically the design of museums and exhibitions will therefore be juxtaposed and synthesised in relation to the overall conceptual framework established in this thesis; the Motivational Design Framework.

The framework itself will be discussed and summarised more fully in the discussion chapter of this thesis and its utility for design practitioners and design researchers more broadly than its application in this thesis will also be reviewed. However, in the interim and in order to support readers' understanding of how the various elements of the literature reviewed in this literature review support both a conceptualisation of the role of motivation within design (RO1) and can support development and substantiation of a Motivational Design Process (RO2) and further, might support designers to evaluate the motivational engagement of their work (RO3). The basic

tenets of the framework will be introduced here, as they will be revisited and referenced numerous times throughout the course, and as part of the critical discussion, of this literature review.

INDIVIDUAL

SOCIAL

INTRINSIC

EXTRINSIC

INDIVIDUAL

AUTONOMY

PHYSICAL

COMPETENCE

COGNITIVE

RELATEDNESS

ORGANISATION

SOCIAL

INDIVIDUAL

AUTONOMY

PHYSICAL

COMPETENCE

COGNITIVE

RELATEDNESS

ORGANISATIONAL

SOCIAL
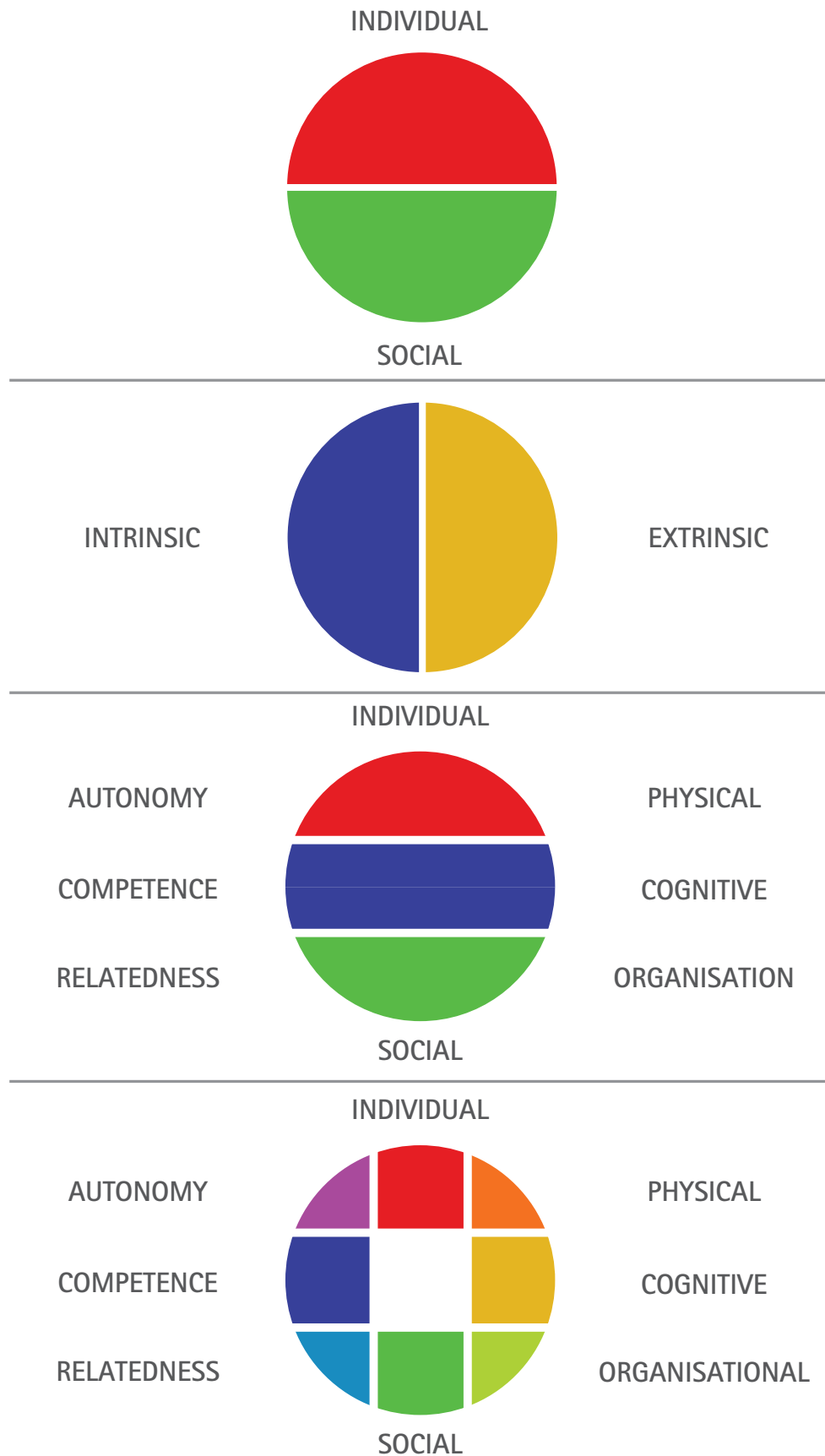
FIG. 3 DIAGRAM OUTLINING THE BASIC CONCEPT AND STRUCTURE OF THE MOTIVATIONAL DESIGN FRAMEWORK DEVELOPED AS PART OF THIS THESIS, INSOFAR AS IT SUPPORTS UNDERSTANDING OF ITS ROLE IN SUPPORTING THE LITERATURE REVIEW OF THIS THESIS

2.1.1 THE MOTIVATIONAL DESIGN FRAMEWORK IN DETAIL

The framework draws its core distinction of the individual and societal motivators or personal or social instigation of human behaviour from the work of Ajzen (1991) who conceptualises that human behaviour can be directed at an individual and social level. This individual - social continuum thus forms the basis of the diagram working from top to bottom. This basic conceptualisation is further elaborated through the work of Krippendorff (2004) as well as White (1959) and Deci and Ryan (1985). A conceptual representation of these latter works and the fundamental principles they espouse of both human motivation and behaviour and in the case of Krippendorff (2004) a design professionals role in mediating or determining such behaviour is therefore established between the intrinsic and extrinsic (left and right) dimensions of the framework (fig. 3). This continuum can be further expanded through Brown (2009) and Martin's (2009) assertion that the value of design is in making explicit, which is to say extrinsic what is otherwise an intrinsic human need orientation. It is also possible to utilise this intrinsic - extrinsic dimension in terms of conceptualising how users might assimilate or embody the patterns of behaviour (Lockton, 2008) or affordances (Gibson, 1979; Gaver, 1991; Norman, 1999) as they engage with, or start to use designed products, systems and services. These two intrinsic and extrinsic dimensions are further expanded with reference to the work of Deci and Ryan (1985) who conceptualise the 'intrinsic needs' dimension of human experience, as illustrated in the Motivational Design Framework as possessing three component parts (Autonomy Seeking, Relatedness Seeking and Competence Seeking). Deci and Ryan argue that these dimensions of intrinsic motivation are loosely coupled and not mutually exclusive in any given situation, in otherwords there will always be some manifestation of each of these elements of intrinsic human needs. In the case of the extrinsic dimension of the framework this is similarly expanded by the International Ergonomics Association (IEA) definition of ergonomics and human factors, which outlines the extrinsic dimensions of human experience as physical, cognitive and

organisational human factors, an assessment reinforced by the early cited work of Krippendorff (2004) which elaborates Human Factors as an industrial-era discipline that is inherently extrinsically determining in its tools, application and philosophy.

There are parallels between the three tiers, or continuums that this then breaks each left and right hemisphere of the diagram into, in that working from top to bottom, the top layer of 'autonomy - physical' describes many of the elements of human behaviour that are addressed in the developmental psychology literature and, within the field of design research literature are preoccupied with describing the role of designers in shaping users phenomenological experience and the impact that this has on the physical elements of human experience (see Gibson, 1979 for a further exposition of this direct-perception perspective on human experience). This top layer can also be considered as indicative of a first-order systems perspective on human behaviour, in relation to how it might be conceived of in the field of systems design and cybernetics - the first-order 'pinball-user' (Bisset and Lockton, 2010). Working downwards within the diagram the 'relatedness - cognitive' spectrum is considered to represent a second-order systems representation of either human cognitive capacity and reflective psychological experience or the related, but more intrinsically motivated 'social-relatedness' motivation. The third tier of the diagram conceptualises a competence-organisational continuum for the manner in which competence is considered to be either derived as a social construct, and thereby considered as conceptually adjacent to the 'social' component of the framework, or alternatively competence is derived from the relative 'organisation' or orientation of physical and cognitive artefacts, schema and experience. There is potentially a tension in the latter two tiers of the diagram as it could be considered that conceptually social-relatedness as an intrinsic 'need' or factor from which motivation is derived or energised should be positioned adjacent to the social segment of the framework, in other words swapped with the competence - organisational tier. This is a question that will be greater explored throughout this thesis and will be addressed again in the discussion chapter.

The purpose of this framework is to present a number of 'lenses' through which designers can conceptualise or explicitly address the motivational needs of their users or how to engage their users within the process of design. The framework is also valuable as a concept map of motivation to support designers understand at a glance a hughly generalised, but accessible definition of the component elements of human behaviour, or design, that designers might be able to manipulate or reorient as part of a process of motivationally engaging the users and stakeholders of their design interventions. In relation to the literature review of this thesis the framework is utilised for its potential in being able to support identification of conceptual similarities and synergies between the literature reviewed and what it reveals about the various ways that it is possible to motivationally engage users within a public engagement museum or exhibition context or within the course of a design intervention more generally. This approach to using the Motivational Design Framework as a conceptual tool to both validate and substantiate the synthesis and argument of this thesis also supports validation of its theoretical application, and the application of the ideas recorded in this thesis in terms of their utility in motivating and engaging individuals in the design of the Ergonomics Real Design Exhibition. The concepts explored and included within the Motivational Design Framework, as outlined above, can also generalisably be extended to summarise a number of facets of design research and practice, specifically in outlining the hypothesised motivational preoccupation of three key fields of design research and design practice, these are illustrated in fig. 4 and will be further explored in terms of their premise and implication throughout the course of this thesis. The design of the Ergonomucs Real Design exhibition, recorded as a series of case based reflections throughout this thesis, spans the breadth of these three design disciplines and utilises a number of tools and approaches from each of them, these are themselves detailed in chapters three and four of this thesis.

INTRINSIC FACTORS

EXTRINSIC FACTORS

INDIVIDUAL ENGAGEMENT

AUTONOMY

PHYSICAL

INDUSTRIAL DESIGN

ACCESS

INTERACTION DESIGN

RELATEDNESS

COGNITIVE

INFORMATION

SOCIAL DESIGN

PARTICIPATION

COMPETENCE

ORGANISATIONAL
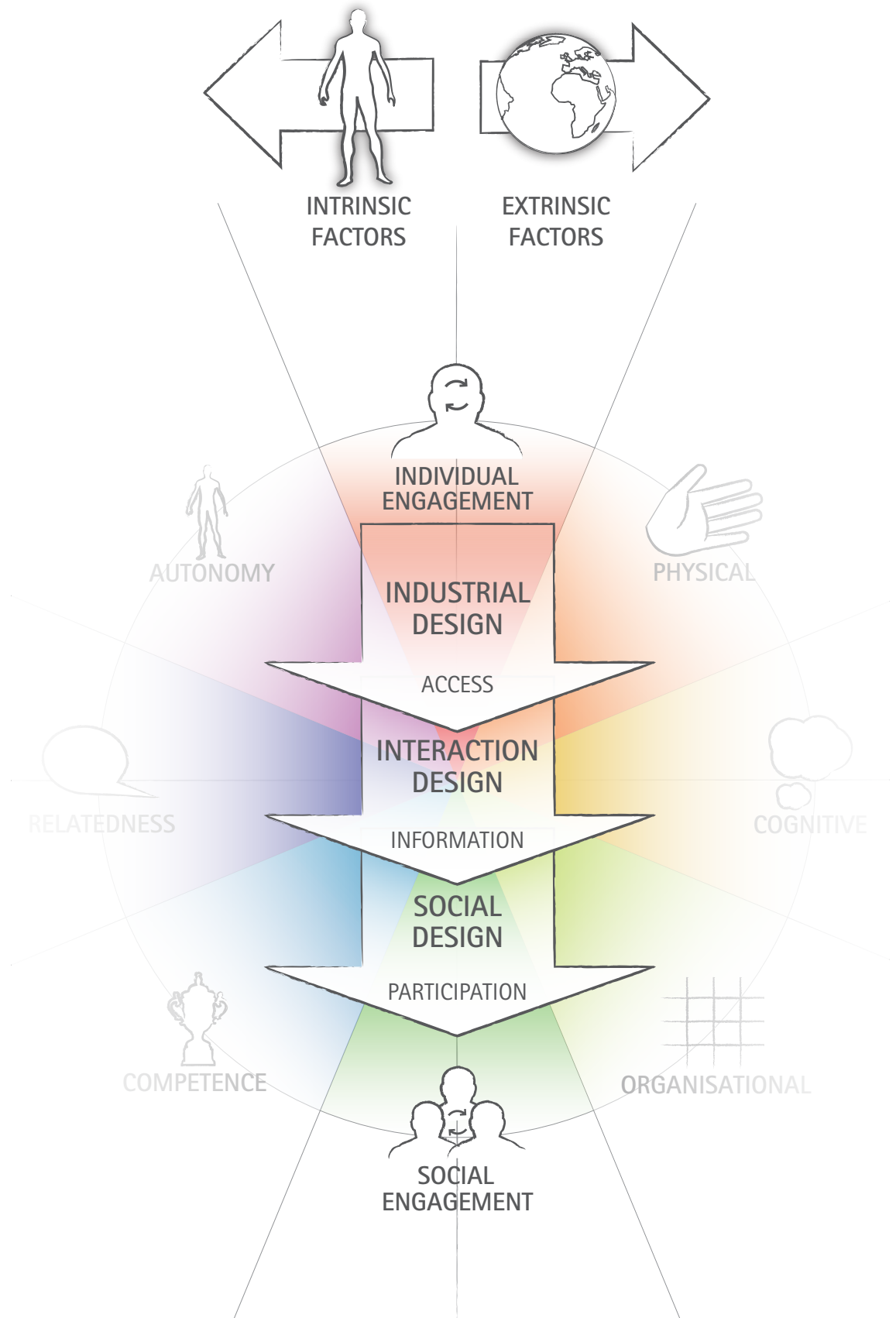
SOCIAL ENGAGEMENT

FIG. 4 HYPOTHESISED CONCEPTUALISATION OF PUBLIC ENGAGEMENT AS A CONTINUUM BETWEEN INDIVIDUAL AWARENESS AND SOCIAL PARTICIPATION AND ITS RELATIONSHIP TO DESIGN PRACTICE WHICH THIS THESIS ARGUES MIGHT UNDERPIN AND SUPPORT PUBLIC ENGAGEMENT WITH SCIENCE

2.2 PUBLIC ENGAGEMENT WITH SCIENCE; THE RELATIONSHIP OF SCIENCE TO THE INDIVIDUAL AND TO SOCIETY

This section explores the context in which the *Ergonomics Real Design Exhibition*, the case study of this thesis, was constructed and explores the social dynamics and context that underpin the design and development of this exhibition and as a consequence the need for designers engaged in these contexts or activities to better conceptualise and support the motivational engagement and self-regulation of behaviour by and for their users.

2.2.1 PUBLIC ENGAGEMENT WITH SCIENCE AS A TRANSITION FROM 'AWARENESS' TO 'ENGAGEMENT' WITH SCIENCE IN THE UK.

As a result of the 2000 Science and Society Report from the House of Lords Select Committee (cited in Stilgoe and Sykes, 2009), the Engineering and Physical Science Research Council's (EPSRC) Partnerships for Public Awareness became Partnerships for Public Engagement (PPE). The aim of PPE since then until the programme's termination in mid-2011, has quite literally, been attempting to move the public beyond simple awareness of science and instead to induce full public engagement with science; empowering reflection and interaction with science and its influence upon society.

Indeed, the distinction between science as an influence upon society, and as an influence within society, is, this thesis argues, exemplary of the distinction that the Science and Society Report made and indicative of the distinction this thesis makes between design for public engagement as a process of 'doing unto' one's users, and instead 'doing with' one's users. This thesis, within the context of such a distinction, aims to explore the respective impact these extrinsic and intrinsic approaches have on motivational engagement and empowerment. Against this backdrop, PPE was a programme intended to confront media demagoguery of science, help inform rather than shape public perception, and empower the public with knowledge about the aims of science, rather than just impose or articulate such a view. PPE can further be interpreted as seeking to engage the public with the underlying principles and skills of science and scientists so that the public can, this thesis asserts, access science, interact with it and understand it, as opposed to feeling threatened by it. This is intended to create a situation where, as members of society and as taxpayers, all UK citizens can actively participate with science, rather than potentially being treated as recipients or subjugates of the scientific process and its outcomes. Science as an expert discipline funded largely by the UK taxpayer, in an era Ihde (2009) describes, as one of "big science" is thus a discipline and process that, this thesis argues, the

UK public are ultimately investors in, and stakeholders of. This thesis explores the notion that to design successful public engagement with science, designers need to be capable of acknowledging the range of ways that such engagement initiatives can exert influence on users' motivation to engage with science and the impact that such public engagement initatives can exert on user behaviour.

Ihde (2009) also describes the past decade as one where science has come to be seen as socially constructed, technologically mediated and gendered in its practice. These extrinsic determinants and mediants of the value of science and the public's engagement with science, particularly the social and technological are considered in this thesis. This thesis seeking to explore how designers of public engagement initiatives and experiences can adapt and influence the social and technological representation of science. This thesis, by implication is also written in the assumption that, if, as Ihde articulates, science is technologically and socially mediated, creating and adapting the way that individuals can socially construct or technologically interact with science will have a profound impact on the way in which individuals intrinsically represent and construct definitions of science.

Following the assertion here of the distinction between the intrinsic and extrinsic mediation of public engagement with science and the role that design and design research can play in informing and constructing such a distinction, it can furthermore be hypothesised that from a more utilitarian perspective, PPE is an approach that aims to motivate and empower individuals to successfully access, interact with and embody the values of science as opposed to being apathetic to or evasive of them. Motivational psychology and research into motivated behaviour, consider such attitudes to be amotivated and avoidance-oriented, respectively (Weiner, 2007), constructs that, in the argument of this thesis, represent a significant and valuable framework for designers and design researchers to consider the challenge of designing for public engagement.

Ergonomics Real Design Case Study Reflection 1

The case of Ergonomics Real Design, a PPE project with ergonomics, that sought to engage members of the public with the applied scientific discipline of Ergonomics. As former head of the House of Lords Select Committee for Science and Technology Lord Winston states "the watchword is 'engagement' and with it, 'dialogue'… so-called 'upstream engagement', where members of a concerned public recommend what research might be most useful" (Stilgoe and Sykes, 2009). It is recognised that upstream engagement requires broader application beyond scientific research, "Rather, the challenge is to find mechanisms for infusing basic research and emerging technologies with public values and aspirations" (Stilgoe and Kearnes, 2007). Thus, public engagement by this definition and insofar as it relates to the Ergonomics Real Design PPE Project, is concerned with equipping individuals with the necessary skills and knowledge to access, observe, interact with and ultimately co-create the value of ergonomics as it relates to their everyday lives. This conceptualisation, developed in this thesis of access, awareness, information and participation, based on the firsthand experiences of the design researcher appointed to work on Ergonomics Real Design Project, will be further explored and expanded in the course of this thesis, with continued reference and case based reflection upon the experiences from the *Ergonomics Real Design Exhibition* Project. It is suggested that the experiences from this PPE project that focussed heavily on the integration of PPE with established design practice, design research and ergonomics and human factors methods and approaches also represents a rich case study from which to ellucidate the mechanisms that Stilgoe and Kearnes (2007) mention above are required to 'infuse basic research and emerging technologies' with public values and aspirations.

INTRINSIC
FACTORS

EXTRINSIC
FACTORS

INDIVIDUAL

AUTONOMY

PHYSICAL

DESIGN TO
MEDIATE
PERSONAL
EXPERIENCE

DESIGN TO MEDIATE
INFORMATION
EXCHANGE

RELATEDNESS

COGNITIVE

DESIGN TO MEDIATE
SOCIAL COHESION,
PARTICIPATION &
CO-CREATION

COMPETENCE

ORGANISATIONAL
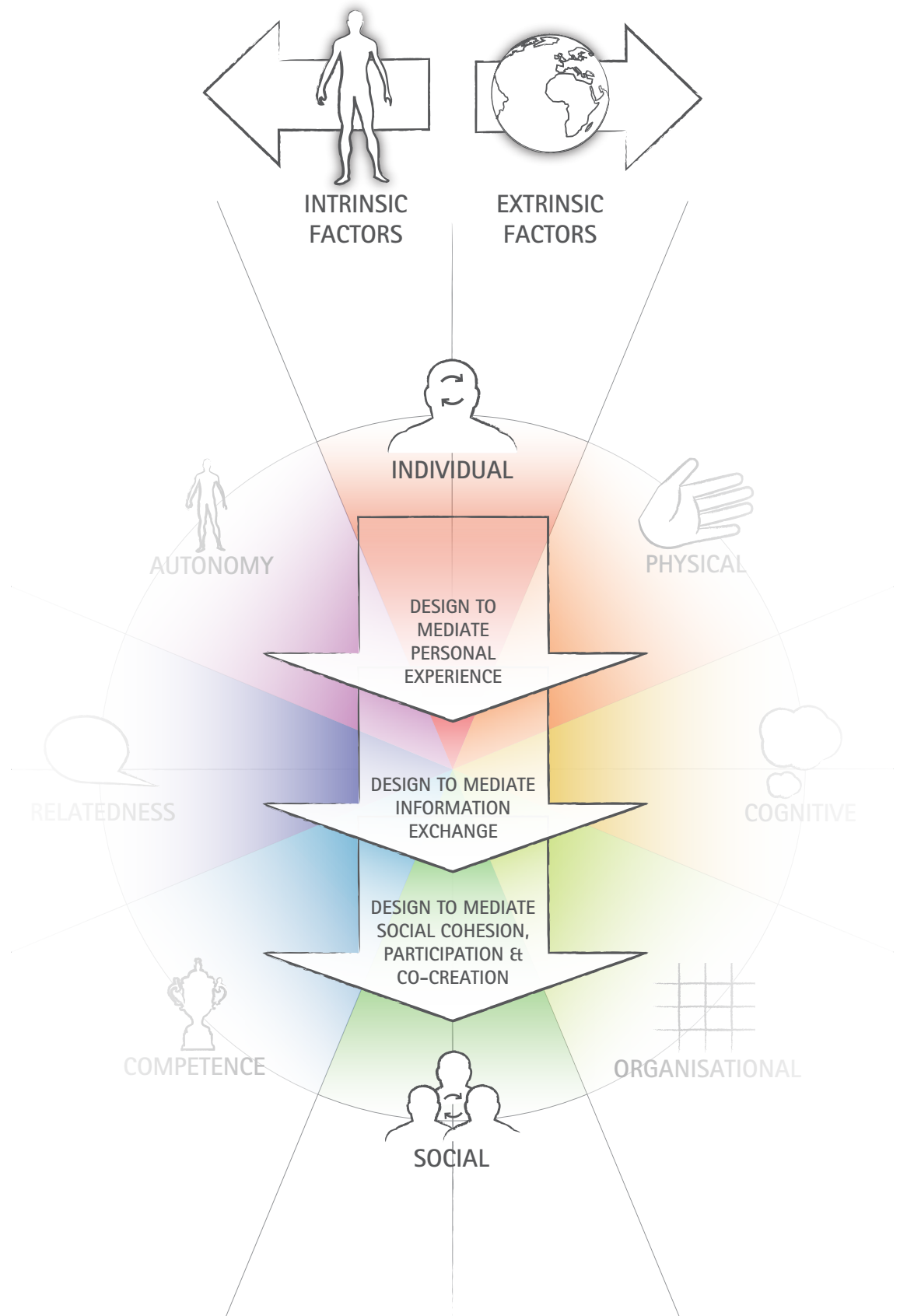
SOCIAL

FIG. 5 HYPOTHESISED SHIFT FROM BOTTOM TO TOP OF THE FRAMEWORK; PUBLIC ENGAGEMENT AS PROCESS OF MAKING PERSONAL OTHERWISE INTANGIBLE SOCIAL POLICY ISSUES OR AS PROCESS OF MAKING SOCIAL OTHERWISE PERSONAL EXPERIENCES?

As part of the process of elucidating 'mechanisms' for the integration of public values and basic scientific research, and in order to establish more clearly the role that design and design research can play in such a process this thesis also argues, as it outlined earlier that it is important to set the role of design and design research within the context of the basic behaviours that the public engagement process demands of its participants. Public Engagement with Science is a process of making science relevant to the wider public. It therefore demands designers employed in public engagement activities to have an appreciation and understanding of how their design decisions can support end user motivation and participation, in a bid to enhance users' perceptions of the relevance of science to them personally and to society at large. The distinction of the intrinsic or extrinsic mediating influence of science upon the individual, has already been drawn out and will be explored in more detail in due course. In the terms of the motivational and behavioural psychology literature, this model of human behaviour represents an expectancy-value approach to engaging human behaviour. Such a model and means by which designers might utilise such a conception of behaviour will be greater explored and more fully empirically evaluated in the course of this thesis. Such a model of motivational engagement and motivated behaviour will also be explored in comparison to more emergent theories of motivation such as Self-Determination Theory models of motivation (Deci and Ryan, 1985). This, unlike the argument asserted by Stilgoe and Sykes (2009) presents, in relation to public engagement with science, a more need-oriented perspective, but one that emphasises a focus on empowering the individual with the design and engagement process. The distinction and relative merits of these two approaches will be drawn out through the course of this thesis. This thesis will also explore how existing models and conceptions of user needs and values, from the industrial design era, the information design era through to the social 'network' era respectively, can be leveraged to support this process, and how such conceptions could better inform the ability of design practitioners and design researchers to consciously and deliberately motivate the users of their products, systems and services.

2.2.2 HOW TO ENGAGE DESIGN IN THE PROCESS OF PUBLIC ENGAGEMENT WITH SCIENCE?

"A consistent theme [of Public Engagement projects is] the importance of understanding audiences...includ[ing] the knowledge, interests and needs of the audience, and how you might address them" (EPSRC, 2003). Further elaborating this point the EPSRC go on to say "your audience believes that it has got on perfectly well without you so far. To engage them you need to be able to demonstrate that you have something they want" (EPSRC, 2003). They conclude with the following warning:

> "Be prepared to be responsive to your audience's suggestions. If what they want is different from what you want to give them, work on the principle that you've got to start where they are. By all means aim to change people's views and attitudes and try to engage them in unexpected ways. But if you start from the premise that you've got something that's good for people and they really ought to want it, you're probably heading for some lonely [engagement] activities" (EPSRC Partnerships for Public Awareness, Good Practice Guide, p.10).

This clearly suggests the challenge of public engagement is far greater than simply the provision of information or facts. Approaches to engagement that expand upon such didactic provision of facts or affordances by designers are, as they relate to public engagement with science, explored further in the following sub-sections, but with respect to the overall focus of this thesis highlight the need for designers to engage empathetically with the audience on both a personal and social (societal) level.

2.2.2.1   THE CONCEPT OF INDIVIDUAL (PERSONAL) ENGAGEMENT

"Engagement refers to the intensity and emotional quality of a person's involvement with an activity" (Connell and Wellborn, 1991; Skinner and Belmont, 1993). Reeve (2005) notes that as a term, engagement captures the intensity of a person's motivation and is thus often used loosely and interchangeably with involvement. Thus when you include notions of self-involvement, involvement in using an object or artefact, involvement within a conversation or idea, or involvement with the environment or wider community; the term engagement is broad in its scope and definition. Throughout the literature there are examples of "engagement and motivation… [being]…used interchangeably" (Kay and Knaack, 2008) to describe an individual's relationship with a given subject, artefact or system.

Amotivation, often exemplified by frustration and despondency, can occur when we as individuals attempt to participate in a task, such as playing sport (Hodge, 2004) or interacting with a museum exhibit and our performance does not fulfil visualised expectation; this is explored further from a motivational psychology perspective in section 2.3 but put explicitly, if our performance does not live up to our visualised expectations, or the expectations demanded of us by our audience or by the designer of the task, there is a risk of demotivation occurring. The breakdown in engagement and motivation here can be considered as a result of an inability to correctly perceive the demands of the task or the performance environment, or as a result of an inability to sufficiently regulate the resultant discrepancy between our capabilities and what the task demands of us (Carver, 2004). For a further exposition of this task capability perspective, see Fuller (2000).

Frustration, despondency and in some cases mistrust of either ourselves, or as a secondary consequence, mistrust of the product or service we are using can occur if we are not able to perform the task or achieve the outcome that we believe the system

is supposed to afford us. The default response after a period attempting to engage with the task might be to adopt an apathetic response "oh well, it doesn't matter anyway" or "I didn't really want to do that now" or in more extreme cases the circumstances might lead to adoption of a helpless, avoidance response or result in the participant being forced to seek assistance from others to resolve our personal difficulties with the task. In relation to public engagement with science and the investigation of this thesis, personal engagement is one such experience. In other words, an individual's relationship with the outcomes of science is governed or regulated by whether or not the individual perceives any of the factors governing this relationship to be within his or her comprehension or capabilities. Public engagement with science seeks to promote greater personal and social engagement with science. Design for public engagement with science has to seek to address the demands of motivating and engaging individuals and society at large, with in this case, the aims, processes and outcomes of science.

Ergonomics Real Design Case Study Reflection 2

Public engagement in relation to the *Ergonomics Real Design Exhibition* demanded that the design team consider and attempt to empathise with, and accommodate, the personal relationship that visitors to the museum might have with ergonomics in order to ensure that the exhibition was engaging on a personal level. If conducted effectively, the concept of motivation and engagement articulated thus far in thesis would thereby ensure the exhibition, as a designed sociotechnical system, did not provoke a sense of learned helplessness or result in amotivation amongst its users. As users attempted to physically or cognitively interact with the museum, effective design for public engagement and consideration of the motivational implications of the design, by the design team, ensuring that users might find the experience informative and successfully participate in the experience.

If an individual's experience, whether in engaging with science or, more generally in interacting with designed products, systems or services, is recurrently disempowering, we as humans are prone to adopt a learned-helpless response to the artefact, concept or subject matter (Weiner, in Elliot and Dweck, 2007). For example, if we are persistently unable to operate our mobile phone or persistently unable to understand the purpose of science of technology, we as humans will begin to increasingly distance ourselves, physically or psychologically from the subject matter in hand, or the source of the dissonance. In a commercial context, this clearly has a potential knock on effect on the organisation or service provider that provided the artefact or product or service. In very extreme cases, such learned-helplessness and disempowerment may result in significant psychological damage to an individual's sense of autonomy and self-confidence.

We as humans may, in these extreme instances, seek to avoid all future interaction with such artefacts or contexts and experiences, assuming we have that option. These are the consequences of user disempowerment, apathy and outright avoidance seeking behaviour, so called anti-motivational goals (Carver cited in Dweck and Elliot, 2007). In the context of design research, this observation elucidates the well-documented psychological impact of designers failing to accommodate users' and societies' psychological needs, from a motivational capability perspective.

Therefore credible design for public engagement with science, or successful end user engagement within the design process in general, must consider the means of motivating or sustaining end user engagement, or at least seek to conceptualise how users currently motivate or sustain their engagement prior to the design intervention. Such intentionality must take account of the positive values, outcomes and experiences that users seek of their interaction and engagement, alongside any prior negative outcomes that might be inhibiting users' motivation to engage and perceive the relevance of a given product, system or service to themselves as potential customers

or as participants in the process of public engagement with science. On a macroscopic level, detrimental or demotivating human behavioural responses can occur in relation, to not just designed artefacts, systems or services but also in relation to social or political issues. Indeed, there is a tendency for the perceived disempowerment of the individual to increase as products, systems, services, and social policy and issues of governance increase in their scale and impact.

Public engagement with science can thus be conceptualised as the process of moving public consciousness of science from a matter of social or governmental priority and comprehension, to one that members of the public can personally and tangibly engage with or be given a voice within. This is also the challenge faced by designers tasked with designing to support engagement; how to deconceptualise a complex topic to make it relevant, engaging and personally resonate with members of the public?

Considering design to support public engagement with science from a motivational perspective also poses the question: do we as individuals exhibit an empowered response to the role of science within our everyday lives because we clearly understand the aims of science and because we trust the processes and rules that govern the scientific process as well as trusting those participating in the scientific process? Or, do we in society disengage and become apathetic towards science because we don't understand the aims or the rules that govern it and determine its outcomes and overall impact? In other words, what denotes the motive for public engagement with science itself, and, are such motivations positive or negative?

With reference to Deci and Ryan's Self Determination Theory (1985, 2000), discussed in further detail in section 2.3, this question of the motives of PPE could be asked in a different way: are we as a society disengaged with science because we fail to relate to, or be shown, how we might be able to participate in and develop our autonomy

and competence in this domain? Are the values of science presented in too much of an extrinsic utilitarian manner (see Eccles and Wigfield, 1995), for us to effectively internalise and attain them? Or are we in society quite content in understanding what we do about science and our present level of engagement with it, and is PPE rather an attempt by scientists to post rationalise their work and it's impact? In an attempt to address these questions this thesis will continue to explore what designers can learn from a greater appreciation and adoption of the insights found in the motivational psychology literature in order to assist or lead the process of designing to support individuals' personal responses to, and motivational engagement with science. The motivational implications of this for Public Engagement as a process will be drawn out in due course, as well as the potential learning for all designers and design researchers themselves interested in promoting user autonomy and their users' voice within the design process.

The role that designed artefacts, systems and services play in supporting personal engagement and motivational energisation will also be explored, together with consideration of the role principles of motivational development could play within the design process to increase user self-determination within the experience of individuals interacting with products, systems and services, and furthermore, how these could be used to evaluate the motivational impact and engagement of a user's experience of interacting with a designed multi-touchpoint user experience.

INTRINSIC FACTORS

EXTRINSIC FACTORS

INDIVIDUAL

AUTONOMY

PHYSICAL

THE PHYSICAL

THE SUBJECTIVE

RELATEDNESS

COGNITIVE

THE OBJECTIVE

COMPETENCE

ORGANISATIONAL

SOCIAL
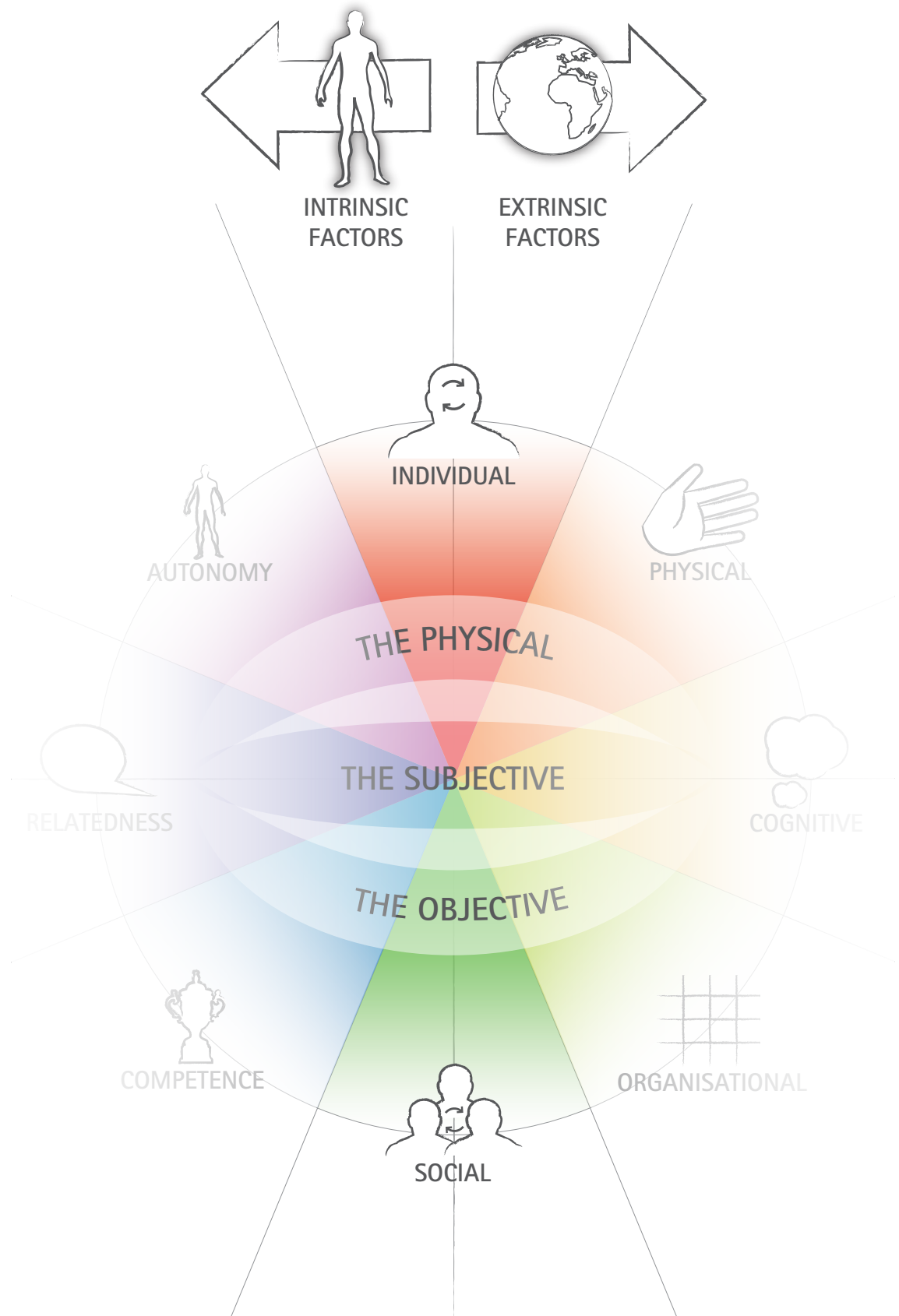
FIG. 6 POPPER'S THREE WORLD THEORY (1978) – AS A CONCEPTUAL FRAMEWORK FOR SUPPORTING THE DECONCEPTUALISATION OF THE CONCEPT OF ENGAGEMENT & FOR FOCUSSING ON THE ROLE THAT DESIGNERS CAN PLAN IN ENGAGING USER BEHAVIOUR.

Ergonomics Real Design Case Study Reflection 3

The importance and responsibility for wider personal or societal engagement is recognised by the Institute of Ergonomics and Human Factors (IEHF), something they should arguably be well equipped to demonstrate more clearly than many other scientific disciplines being, as it is: "the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design in order to optimise human well being and overall system performance." (IEA, 2010); (Dul and Weerdmeester, 2003). The IEHF mirroring their international counterparts adopt a broad three step categorisation to explain the impact of ergonomics as relating to the understanding of physical, cognitive & organisational human factors. This three stage continuum together with other complementary or similarly generative conceptualisations of the impact of ergonomics and human factors, will be considered throughout the course of this thesis.

INTRINSIC
FACTORS

EXTRINSIC
FACTORS

INDIVIDUAL

AUTONOMY

PHYSICAL

THE PHENOMENOLOGICAL

CONVERSATION
FOR ACTION

THE PRAGMATIC

RELATEDNESS

COGNITIVE

THE RATIONAL

CONVERSATION
FOR POSSIBILITY

COMPETENCE

ORGANISATIONAL
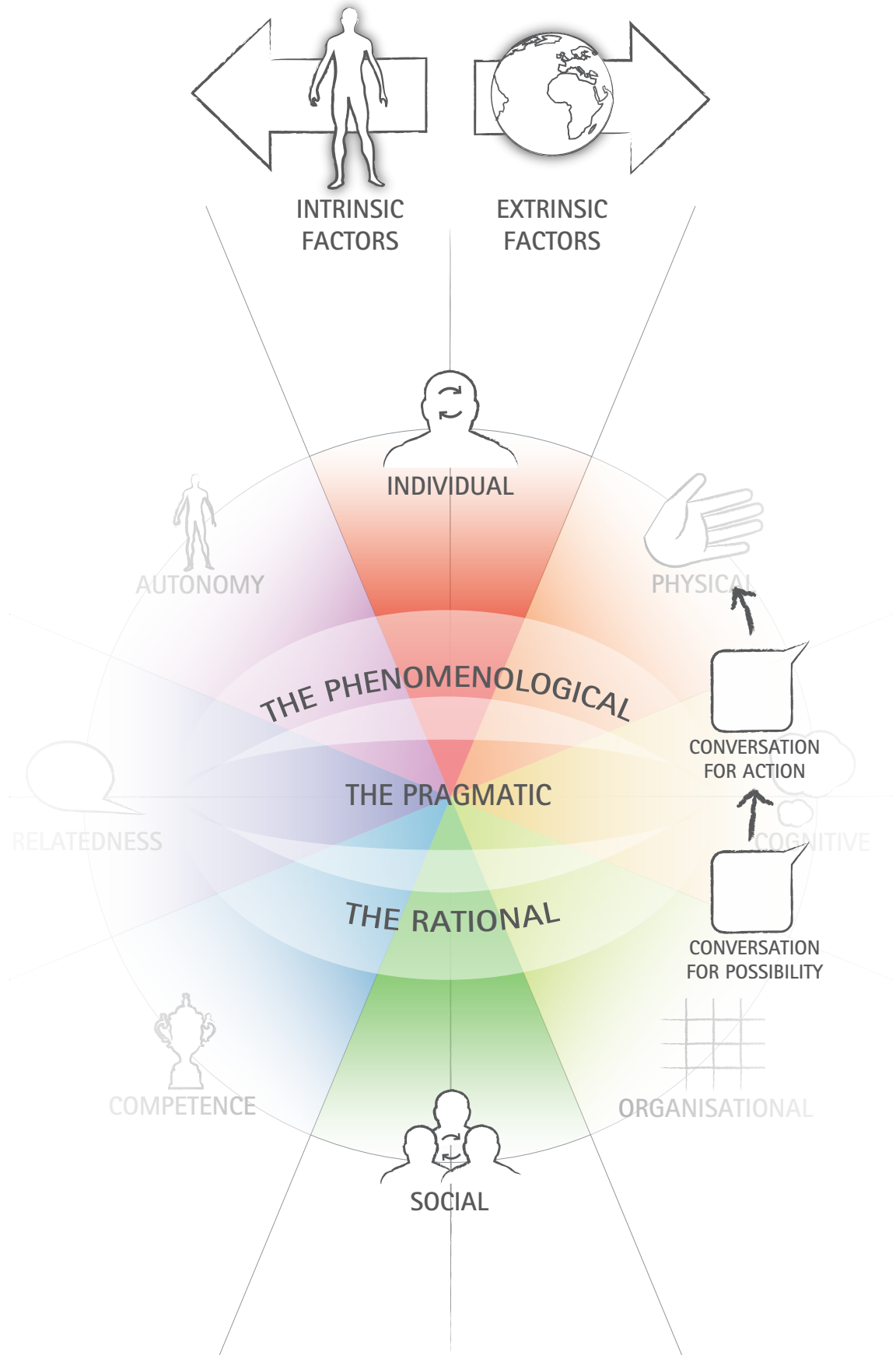
SOCIAL

FIG. 7 SYNTHESISED FROM JONES & DUBBERLY (2010) – THE THREE EPISTEMOLOGICAL ORIENTATIONS OF CONVERSATION TOGETHER WITH FIRST & SECOND–ORDER CONCEPTS OF CONVERSATION FOR POSSIBILITY & ACTION

2.2.2.2   SOCIAL ENGAGEMENT

As has been outlined previously, public engagement with science can literally and metaphorically be conceptualised as a process of personal exploration and developed affinity with science; supporting individuals to develop personal autonomic and competence-oriented relationships with science and technology. Public engagement can also be considered a public conversation about science. This relates to theories of motivation and engagement such as Bandura's (1978) Social Learning Theories that posit engagement as a process of developing shared models and understanding, in this case, of the public's relationship with science. Engagement is defined as involving a two way reciprocal process of understanding one's stakeholders and understanding one's own values, organisationally or as an individual. Designers attempting to support or facilitate engagement should thus attempt to reciprocate and support such affinity of values, in a bid to enhance an individual's personal and affective response to science, or in an attempt to develop a shared, social model of the value of science to society at large.

This research explores and models the concept of conversation as it relates to human interaction with sociotechnical systems and, with the intent of understanding how a user's voice can be better integrated within the design and public engagement process, this research explores how conversation underpins personal and social interaction and inquiry. Conversation may offer one of the simplest means by which designers can better understand and support the motivational requirements of their users, but the challenge comes for designers and design researchers in converting such conversational engagement into more meaningful and transformative engagement. Future research could consider the relevance of social constructivist models such as the social model of disability (Shakespeare and Watson, 2001) to modelling and visualising public engagement with science, as one of the most tangible examples of social constructivism influencing public policy. Arguably it is society that creates

barriers for effective engagement of science, rather than the responsibility of science to demonstrate its value to society. Exploring this distinction, particularly with reference to the earlier cited distinction between approach and avoidance motivation is potentially another avenue of research to greater understand the concept of public engagement with science. This is not however, the avenue of enquiry adopted in this thesis, instead the concept of social engagement will be explored, in the course of this research on a more individual level of abstraction. Therefore the concept and construct of conversation will now be expanded in more detail, as it relates to the design and construction of physical, cognitive and social systems.

2.2.2.3   SOCIAL ENGAGEMENT AND CONVERSATION

Jones and Dubberly (2010, p.1) suggest:

> "Conversation [as a key mechanism of social engagement] is seen as a form of communication in which a particular exchange takes place between at least two people at a time, representing individual interests or intentions, or collective interests represented by individuals".

They continue to state:

> "Several implicit models of conversation can be identified that guide participation in very different ways. Three epistemological orientations include the pragmatic, the rational and phenomenological" (p.2).

There is some dissonance in this definition with that offered by Ihde (2009) who presents the phenomenological and the pragmatic as more closely related. These philosophic orientations are pertinent to the role of design in influencing society's perception of science as they explore a number of disparate and either deliberate or unconscious approaches to conversation and information or knowledge transfer that the individual can adopt. The EPSRC prefer the term 'dialogue' to conversation, however the principle is the same, these distinctions sharing much with Popper's (1978) Three Worlds conception of the physical, subjective and objective. Ihde (2009) notes that Popper's definition is inherently modernist in its phraseology. This modernist conceptualisation of the objective and subjective has consequently had a profound influence on the field of motivation in the conceptualisation of motivation as intrinsic and extrinsic.

Jones (2010) suggests that the engagement process might be usefully considered as comprised of a series of conversations. With specific relation to designing tasks for user engagement, it can be interpreted that designers should seek to accommodate the physical demands of the task or experience, accommodate the psychological demands of the task or experience, and accommodate the values or epistemological

orientation of the task, as far as possible as discrete designed elements of the overall user experience.

This three-tiered conception of the disparate influences on successful engagement became a key focus of this research, for the very means by which it enables designers to evaluate the impact of their work at three discrete levels as opposed to viewing it as one amorphous whole. At its simplest level of interpretation the ideas discussed here indicate the three aspects of a given experience that can be considered significant in promoting engagement to individuals on either a personal or social level. Conversation is the process of individuals sharing their personal subjective or pragmatic reasoning, something that can be shared objectively or rationally with other individuals. The designers role is then to translate this, or support the translation of this into something more phenomenological, 'for action'. This is a process that in turn leads others to reflect phenomenologically on the nature of their own perceptions and understanding and develop their own intrinsic interpretation of a given topic or experience. This latter phase is perhaps that least typical of many current efforts at public engagement with science, as it requires the necessary expertise, and physical venue and resources to convert and mediate the abstract or high level thought and conversation into something tangible and accessible to, in this instance, non-specialised audience members and individual consumers and visitors. It also requires the specialised 'interaction design' skillset of understanding how the concept of conversation can be conveyed through static artefacts or artefacts capable of a very basic level of interaction with users. Defining this interaction design skillset in relation to motivational engagement is something that this thesis will address in due course.

Ergonomics Real Design Case Study Reflection 4

In relation to the *Ergonomics Real Design Exhibition*, conversations or engagement activities that explored the value of ergonomics could occur, according to these models, on three levels; in the first instance to reflect upon individuals' personal (or rational) understanding of ergonomics. Alternatively conversations or engagement activities might address or relate to more objective (informative) measures of the value of ergonomics. Finally, conversations or designed activities might seek to elicit and reflect upon social definitions of ergonomics, a level of interpretation that might be considered second-order by cyberneticists and systems theorists.

Jones and Dubberley (2010) suggest engagement in the form of conversation can be further delineated into 'conversations for possibility' and 'conversations for action'. Thus, there are two distinct phases to addressing and transitioning between rational, objective or phenomenological engagement with tasks or experiences. One stage where as designer or facilitator you must acknowledge and converse with the participant about their existing experience or understanding, and the subsequent where you should converse with the participant about changing or expanding this definition. This sequence of engagement and this systematic perspective is presented here as one of many of the other concepts and philosophical or theoretical models of engagement that could form the basis of a Motivational Approach to engagement. These constructs also form the basis of the Motivational Design Framework that is emerging throughout this thesis to support designers to anticipate and manipulate the multi dimensional role of motivation in supporting individuals to regulate their relationship with their environment.

Ergonomics Real Design Case Study Reflection 5

In the context of reflecting upon the motivational basis for the *Ergonomics Real Design Exhibition*, this conceptualisation of engagement as a multifaceted conversational process begs the question of whether the purpose of the process of public engagement with ergonomics is to express through conversation the purpose or benefits of ergonomics - the extrinsic or rational motives for it (a second-order reflection)? Or whether it is to energise and consolidate participants' existing understanding and relationship with ergonomics (a first-order reflection) – to focus on enabling and empowering the individuals' intrinsic understanding and phenomenological self-representation of what ergonomics means to them personally and in turn to society at large? The delineation of conversation into two phases of consensus and action respectively is of significant potential for designers and generative design methodologies looking to simplify the complexity of engaging users with the design process or, in this case, the public engagement process.

The implication here, supported by Jones (2010) and Dubberly and Pangaro (2009), is that it is inadvisable to attempt to engage or sustainably motivate individuals by jumping straight to the 'action' phase of the conversation or, in the context of design, motivate individuals by focusing on the 'designing or testing phase' of the process, without first establishing trust or engagement, through a conversational, iterative process that might, for one example, focus on participants' existing perceptions and levels of engagement. By this definition, participants in this conversation about ergonomics have to be afforded the opportunity to allow their ideas and self-representation of what ergonomics is to converge prior to them being then asked or empowered to shape an alternative representation. This must occur, whether with reference is to intrinsic benchmarks, established contextual or metaphorical

references or through affinity with social and wider value-led 'rational' benchmarks, before individuals can be expected to embody or assume ownership of any new understanding of ergonomics the conversation or designed experience might seek to promote.

Ergonomics Real Design Case Study Reflection 6

In relation to the *Ergonomics Real Design Exhibition*, for a public engagement project to be successful in modifying or expanding people's beliefs about ergonomics, and their engagement with it as a discipline, the conversation to be conducted with the public should start at a familiar 'physical' or 'rational' level, for example, with exhibits that visitors would be able to identify, interact with and understand tangibly without any great shift in perception or without any great additional skill or knowledge demands. This would require that ergonomics was made physically accessible, and framed conceptually or thematically within the limits of an individual's current awareness and reflective capability. An example of this might be, by referencing the role of ergonomics in a familiar everyday scenario for instance, rather than the alternative of framing it within a context with which the individual might have no prior experience or understanding.

Facilitating this level of rational exploration should enable a convergence of understanding amongst the conversational participants. This in turn would support progression to a higher order understanding of ergonomics, at Popper's 'objective' and Jones' 'rational' levels of inquiry. Allowing participants to explore ergonomic artefacts tangibly, and within the limits of their physical capability, would move them towards a new or expanded definition of ergonomics. The aims of the project clearly state, in the terms of the Science and Society Report,

a requirement to move participants from awareness of Ergonomics to active-self reflection of and engagement with it.

2.3 ENGAGEMENT IN A MUSEUM CONTEXT

Research objective one of this thesis focuses on understanding how designers can best conceptualise and understand the concept of motivational design or design for engagement and implement a praxeology that embodies this perspective. This enquiry is based on the experience, and case-based reflections of researching and designing a public engagement with science exhibition and specifically addressing the motivational engagement of visitors to an exhibition. Therefore, the literature around the design of exhibitions and museums is reviewed, to provide parameters through which to consider and constrain the enquiry of this thesis. Engagement in the context of a museum can, within the enquiry of this thesis, be conceptualised in terms of the curatorial concept of interpretation.

2.3.1 ENGAGEMENT IN A MUSEUM CONTEXT; INTERPRETATION

The American Association of Museums define interpretation as: "a dynamic process of communication between the museum and the audience" (Black, 2005). This view is underpinned by the work of Tilden:

> "Interpretation is revelation based on information...[thus] ...any interpretation that does not relate what is being displayed or described to something within the personality or experience of the visitor will be sterile." (Tilden, 1977 in Black, 2005, p.181)

Design for engagement in a museum context is design to support the revelation of information. With regards to public engagement with science in a museum context, designers need to support the revelation of information pertaining to a range of artefacts on display within the exhibition context.

Further clarity is provided by Alexander:

> "good interpretation contains...[these]...basic elements...
>
> 1.   To teach certain truths,
> 2.   To reveal meanings,
> 3.   To impart understanding
>
> ...it is based on original objects, whether animate or inanimate; natural or man made; aesthetic, historical or scientific" (1979, p.195).

Alexander's layers of interpretation are incorporated into the model detailed in fig. 8, and are drawn to aid the understanding of design practitioners of the relationship between the elements of interpretation he outlines, important in a museum or exhibition context, and the subsequent impact on the motivation of individuals participating in them. The hypothesis outlined, and synthesised here is that the layers of interpretation Alexander specifies are coherent with the previously defined tiers of motivational engagement synergised within the Motivational Design Framework.

INTRINSIC
FACTORS

EXTRINSIC
FACTORS

INDIVIDUAL

AUTONOMY

PHYSICAL

to reveal meanings

to impart understanding

RELATEDNESS

COGNITIVE

to teach certain truths

COMPETENCE

ORGANISATIONAL

SOCIAL
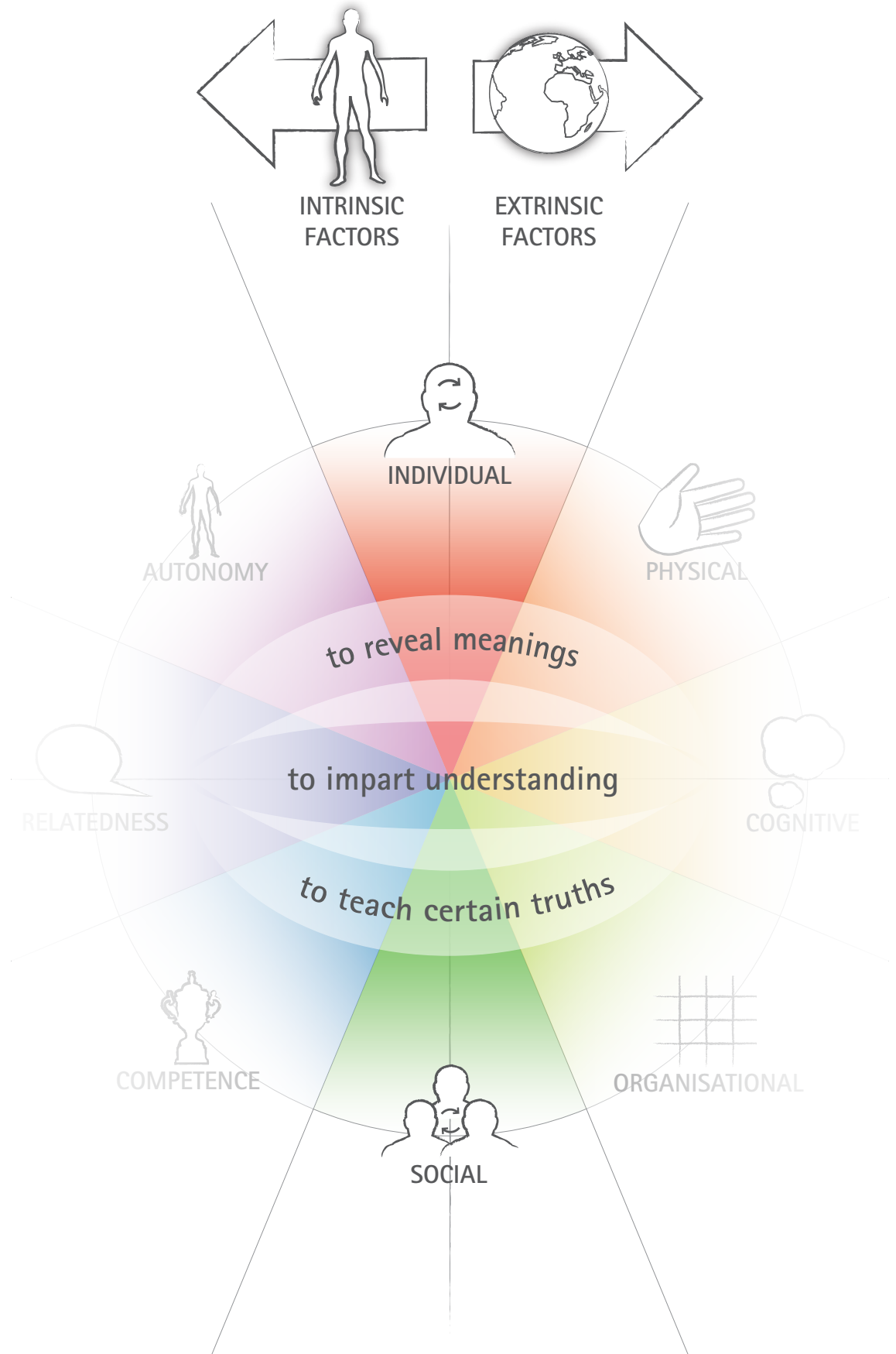
FIG. 8 ALEXANDER'S MODEL OF INTERPRETATION, FRAMED IN JUXTAPOSITION WITH
THE MOTIVATIONAL DESIGN FRAMEWORK

These approaches do not restrict the subject matter or content that visitors to an exhibition could be engaged with. Rather, they focus on mandating the manner in which, independent of the content, the interpretive design of an exhibition should be considered. In summary, successful and engaging exhibition design should consider the content and artefacts on display alongside the interactive processes through which visitors may choose implicitly or explicitly to engage with these artefacts. These two tiers, just like the physical and interactive layers of the Motivational Design Framework can be considered primary to the 'truths', learning or social engagement the exhibition will afford its users. It is also clear from reviewing museum and exhibition curatorial literature that design for engagement is usually independent of the process of designing content and artefacts in an exhibition environment. In design product management terms this would be considered a separation of the functional specification of a product or service, from the benefits and features of that product (Crawford and Di Benedetto, 2008).

2.3.2 ENGAGEMENT IN A MUSEUM CONTEXT; LAYERS OF MEANING

Black (2005) conceptualises the interaction between an exhibition, as a collection of physical artefacts, within a separate physical location and separate from the audience who visit or interact with this constructed space. The conception, has in the manner of other models referenced in the literature review of this thesis been conceptualised in the model in fig. 9. This synthesis further reinforces the prevailing concept of the research conducted so far in this thesis which is that the physical and interactive components of an a exhibition or designed product or service provide a platform for the 'learning' or understanding of 'concepts' (Black, 2005) or 'truths' (Alexander, 1979), users motivation or engagement to elucidate such learning or truth is, this thesis has thus far discerned, physically, cognitively and organisationally mediated in response to users intrinsic needs for autonomy and social relatedness and self-competence.

Black states:

> "the challenge with a museum exhibition must be to provide an environment in which audiences – if they desire to – can learn from the experience of their visits" (Black, 2005).

When designing for engagement in a museum context, a designer is effectively considering the role design can play in supporting learning and the acquisition of 'new' or alternatively informed personal truths and meanings. The synthesis outlined in fig. 9 infers that users pursuit of personal truth and meaning is most effectively energised or motivated by their pursuit of greater autonomy, social relatedness and self competence.
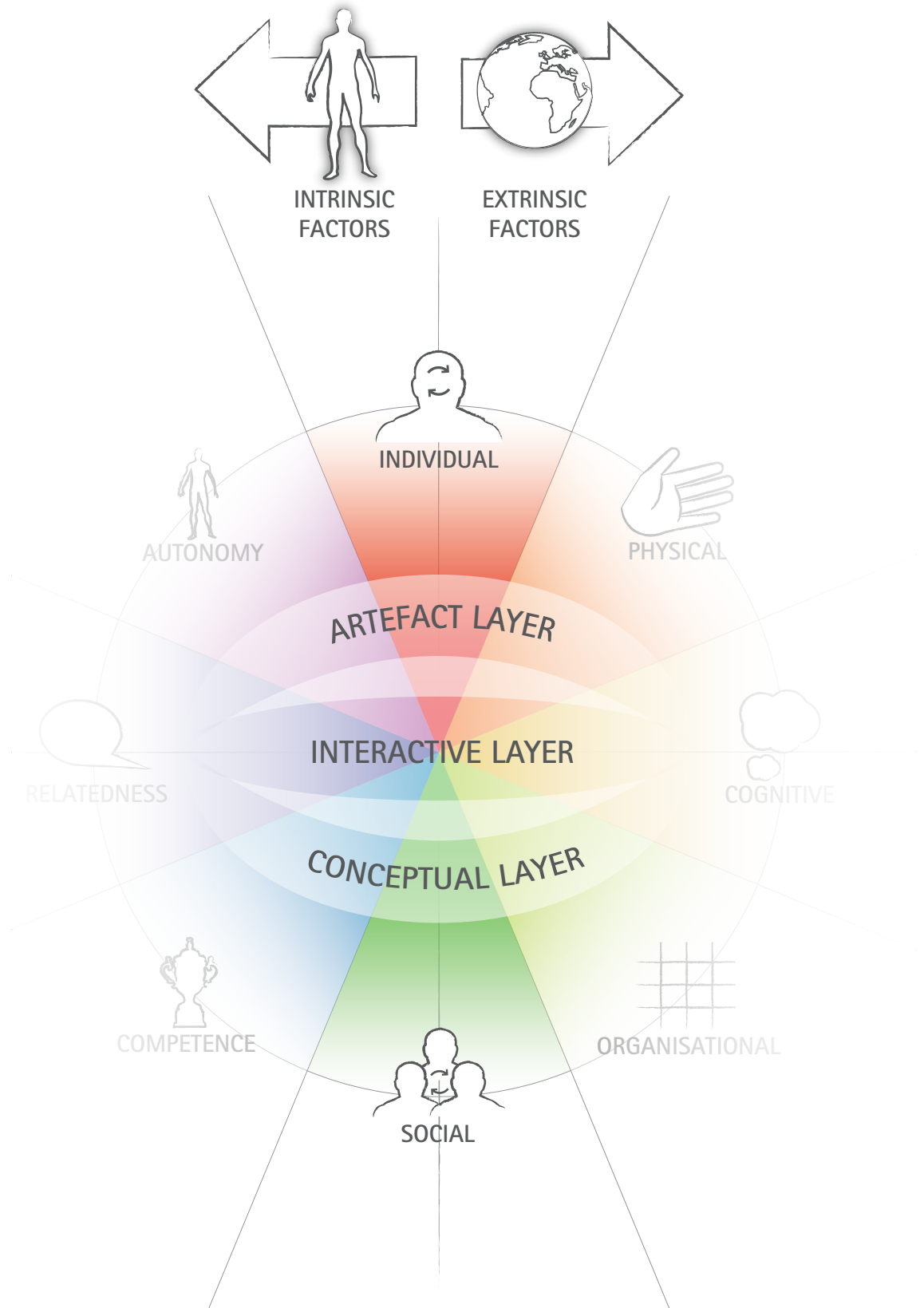
FIG. 9 DEVISED FROM BLACK'S (2005) LAYERS OF MEANING, FRAMED IN
JUXTAPOSITION WITH THE MOTIVATIONAL DESIGN FRAMEWORK

2.3.3 ENGAGEMENT IN A MUSEUM CONTEXT; LEGISLATING FOR, OR EMPOWERING THE VISITOR'S UNDERSTANDING?

Casey (2003) believes the conception of museum as the provider of epistemological truth is an aging one. It is a 19th century construct whereby:

> "The museum researched and preserved curios, exotica, rare, and sanctified objects (Weil, 1995). The aim of the Legislating Museum was, and in some cases still is, to present the paragons of the aesthetic and intellectual pursuit, to create a venue for display not debate" (Casey, 2003, p.2).

When viewed from a design perspective, the legislating museum can be considered to cater purely for the rational, through a collection of physical artefacts with no design intention to engage visitors beyond their entry point of understanding. Progress has been made though and by Casey's account, museums have evolved to occupy a new paradigm, the interpretive museum where:

> "[r]ather than having objects speak for themselves, museum professionals interpret cultural significance for visitors by structuring art and artefacts around easily identifiable chronologies, geographies, formal themes, and narratives" (Casey, 2003, p.3).

Ergonomics Real Design Case Study Reflection 7

The task of engagement in the *Ergonomics Real Design Exhibition*, was one of motivating a broader interest in, and understanding of, the work of ergonomists. This, if viewed from the legislating museum perspective would present ergonomics as a series of static Ergonomic artefacts. An interpretive perspective would see ergonomics presented in terms of meaningful chronology. This might involve presenting ergonomics in terms of its sixty-year growth as an applied scientific discipline, or

in terms of the formal research areas that constitute it. The respective merits of these approaches in motivating and engaging individuals are explored throughout this thesis.

Design to support engagement, ensure revelation of information and advance personal understanding can be likened, theoretically, to the process of designing for conversation and social interaction. This incorporates what Casey refers to as debate and Alexander calls interpretation, but both of these concepts infer a degree of reciprocity and interactivity and thus, as fig. 4 in this thesis as already inferred for designers to address and enable such 'debate' or 'interpretation' tools from the design disciplines of interaction design and social design may be most important.

The process of instilling 'debate' or 'interpretation' within the design process therefore requires a focus upon conversation to first generate understanding through dialogue (Jones and Dubberley, 2010; Winograd and Flores, 1986). In an exhibition or museum this could be convesation between users and designed artefacts, processes or sensory affordances or with other users that aim to ensure clarification and convergence of the visitor's newly acquired autonomic levels of understanding. Successfully engaging the audience, by this definition, is the process of leading them from a disembodied level of prior understanding to an active and newly embodied state of involvement with the subject matter at hand through their interaction, within the exhibition space with other visitors, or through conversation and interaction with static or interactive physical artefacts and exhibits.

Simon (2010) discusses how objects or artefacts on display can be made social, conceptualising the levels of dialogue, conversation and phenomenological interpretation referenced previously. She lists five criteria required of designers and curators to enable this to happen (p.138):

"1. Asking visitors questions and prompting them to share their reactions to the objects on display.
2. Providing live interpretation or performance to help visitors make personal connections to the artefacts.
3. Designing exhibitions with provocative presentation techniques that display other objects in juxtaposition, conflict or conversation with each other.
4. Giving visitors clear instructions on how to engage with each other around the object, whether in a game or guided experience.
5. Offering visitors ways to share objects either physically or virtually by sending them to friends or family." (Simon, 2010, p.138)

This refers specifically to the process of encouraging and designing social interaction into the exhibition itself. Simon also suggests designers consider supporting participation of audiences and visitors to the museum environment, and suggests modelling it in a number of ways, throughout the design and development of the exhibition. Such modelling, or visualisation, also enables designers to observe, monitor and regulate conversations and dynamic interaction once the exhibition is open.

2.3.4 ENGAGEMENT IN A MUSEUM CONTEXT; A PARTICIPATORY OR INDIVIDUAL ACTIVITY?

In relation to participation, Junginger and Sangiorgi caution that:

> "[The] problem of 'raising expectations and generating more engagement and motivation,' relate to the...[stakeholder's]... unquestioned understanding and definition of participation. In particular we found "participation" to be highly dependent on the reflective capacity of students, on the[ir] capacity to generate and exchange knowledge among project participants, [and] on the concept of participation itself among staff (2009, p. 4342)".

If designing for participation and if engagement is to be effective, designers need to design to personally and socially motivate and engage the behaviour of their users. Modelling or visualising provides support for this process, and for the benefit of all project stakeholders. The distinction between reflective, generative and participatory capability, with relation to the design of socio-technological systems, is helpful as it supports the claim that effective interpretive engagement requires objects that reveal epistemological truths (Pangaro and Dubberly, 2009; Alexander, 1979). Pangaro and Dubberly (2009) assert that for designers "engaged in interface design, interaction design, experience design, or service design. [Or] ...where designers are concerned with [human] "ways of behaving" cybernetic theory and modelling can be invaluable"., cognitivist theories and cybernetics theory considering that the first step to creating a participatory experience, or indeed any experience being to model it.

In conclusion, designers interested in understanding and supporting public engagement and motivating a change in user behaviour, knowledge or skill acquisition, should focus on conversing with, and visualising the experience of individuals' participation with public engagement. Conversation and visualisation as two approaches to problem solving are thus key to formalising an approach for designers to influence and direct the motivation and state of engagement of their users.

2.4 MODELLING ENGAGEMENT IN A MUSEUM CONTEXT

"The museum acquires social authority by controlling ways of seeing,
and the objects around which museal vision is directed gather meaning
from their context within the museum" (Casey, 2003).

The process of visualisation; directing and communicating the vision of a public
engagement experience in a museum context is clearly a multi-faceted one. It includes
the vision of the curators and designers of the exhibition, as well as supporting visitors
to the museum to construct their own vision and interpretation of the exhibition.

The focus of museums is changing and becoming more participatory (Simon, 2010;
Casey, 2003). Influencing the social context in which the museum communicates its
exhibits is becoming an increasingly important area of consideration when designing
for effective and sustainable engagement. This is visualised in the diagrams below:
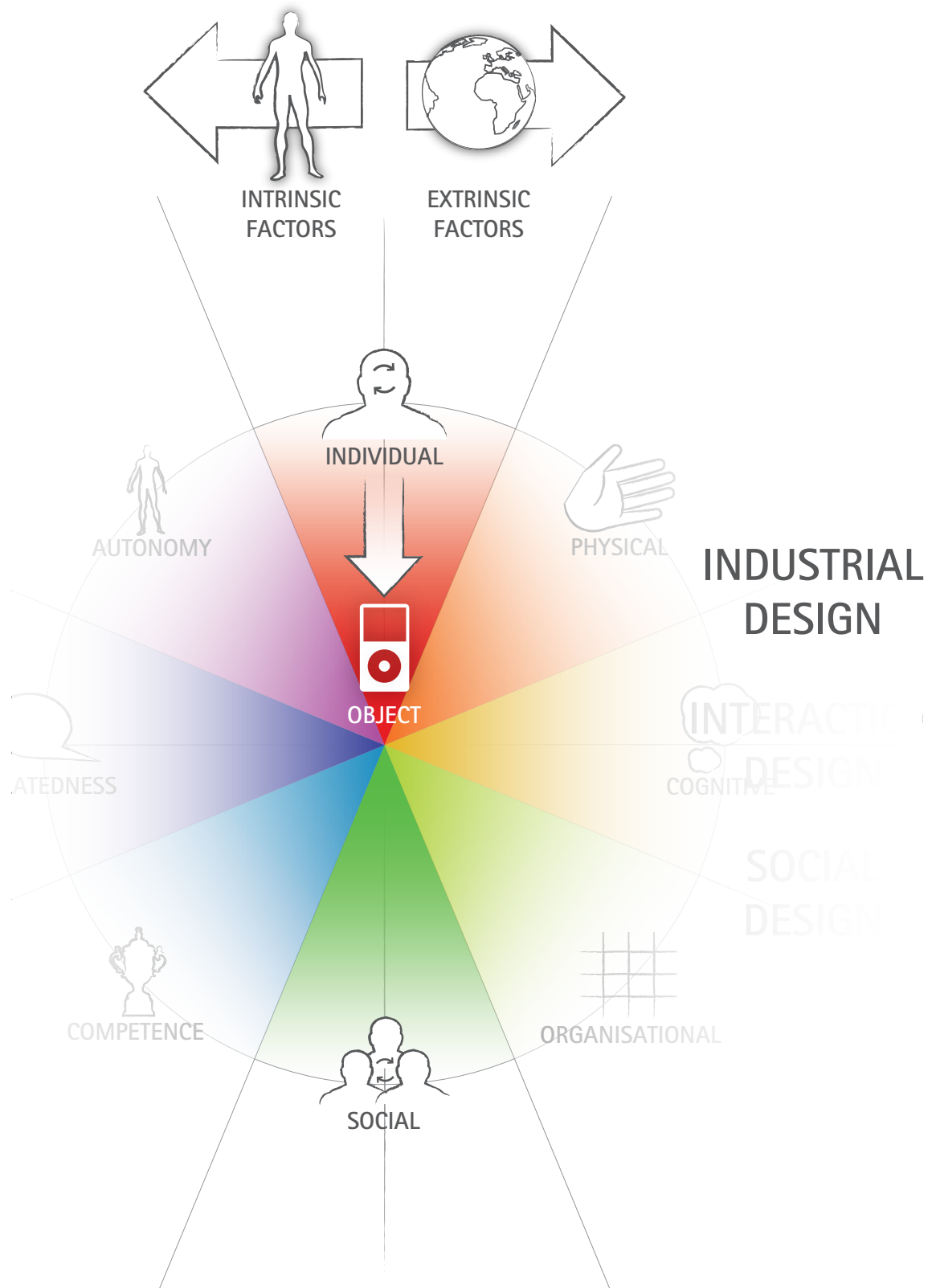
FIG. 10 CASEY'S (2003) CONCEPT OF THE RELATIONSHIP BETWEEN THE INDIVIDUAL (SUBJECT) AND THE OBJECT WITHIN HER CONSTRUCT OF THE LEGISLATING MUSEUM – WHERE THE MUSEUM REVEALS OR DETERMINES 'TRUTHS' & PRESENTS THESE TO USERS

INTRINSIC FACTORS

EXTRINSIC FACTORS

INDIVIDUAL

AUTONOMY

PHYSICAL

INDUSTRIAL DESIGN

OBJECT

INTERACTION DESIGN

COGNITIVE

ATEDNESS

SOCIAL DESIGN

COMPETENCE

ORGANISATIONAL

SOCIAL
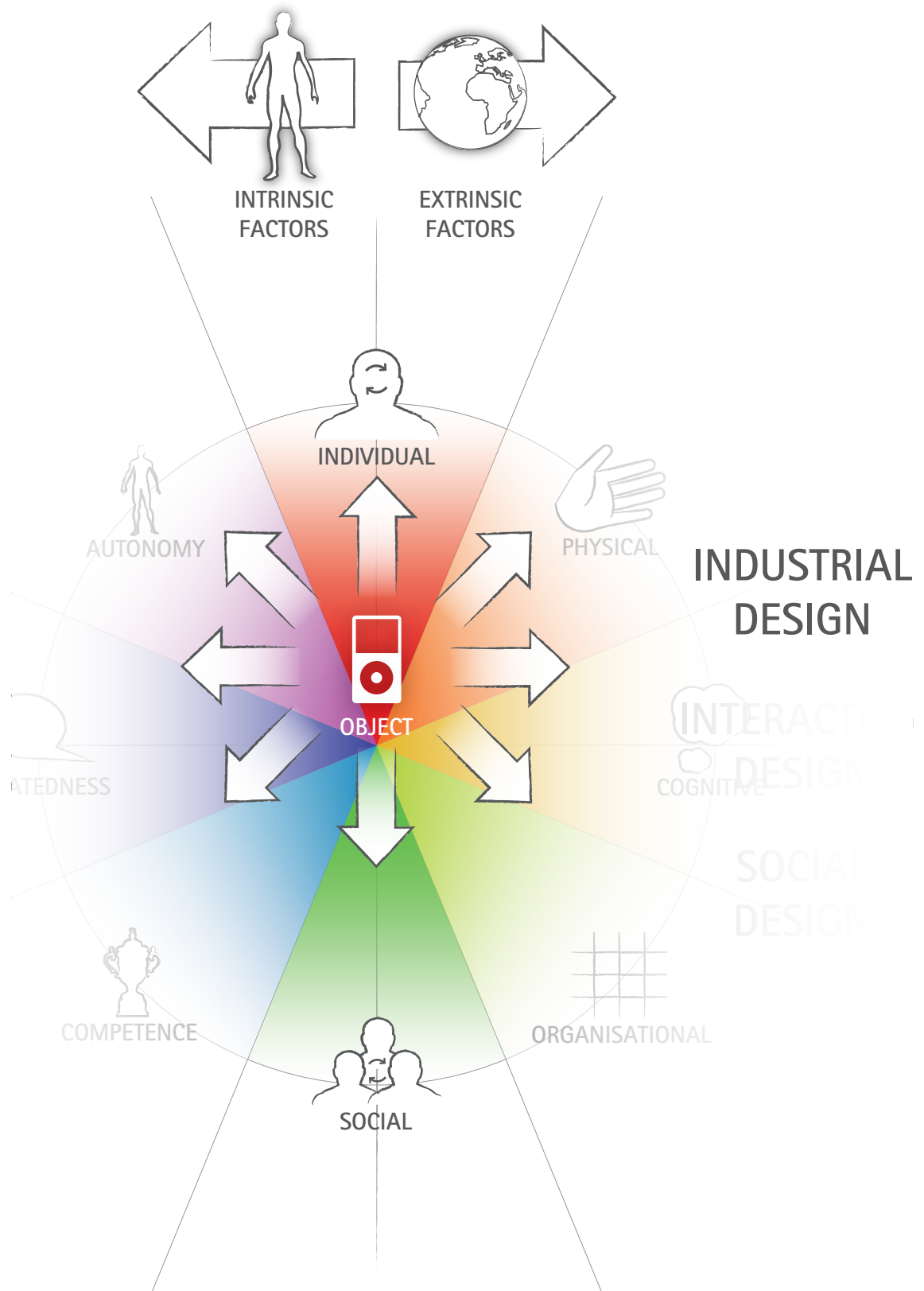
FIG. 11 CASEY'S (2003) CONCEPT OF THE IDEAL MEDIATION BETWEEN THE INDIVIDUAL (SUBJECT) AND THE OBJECT WITHIN HER CONSTRUCT OF THE LEGISLATING MUSEUM – WHERE THE MUSEUM REVEALS OR DETERMINES 'TRUTHS' & PRESENTS THESE TO USERS

FIG. 12 CASEY'S (2003) CONCEPT OF THE RELATIONSHIP BETWEEN THE INDIVIDUAL (SUBJECT) AND THE OBJECT WITHIN HER CONSTRUCT OF THE INTERPRETING MUSEUM – WHERE THE MUSEUM REVEALS OR DETERMINES 'TRUTHS' THROUGH ITS INTERPRETIVE APPROACH

INTRINSIC
FACTORS

EXTRINSIC
FACTORS

INDIVIDUAL

AUTONOMY

PHYSICAL

INDUSTRIAL
DESIGN

INTERPRETATION

INTERACTION
DESIGN

NESS

COGNITIVE

SOCIAL
DESIGN

OBJECT

COMPETENCE

if the interpretation is 'split' i.e. it
privileges the museum's interpretation
more than the visitor's the hypothesis of
this thesis is that this results in a more
extrinsically mediated experience

SOCIAL
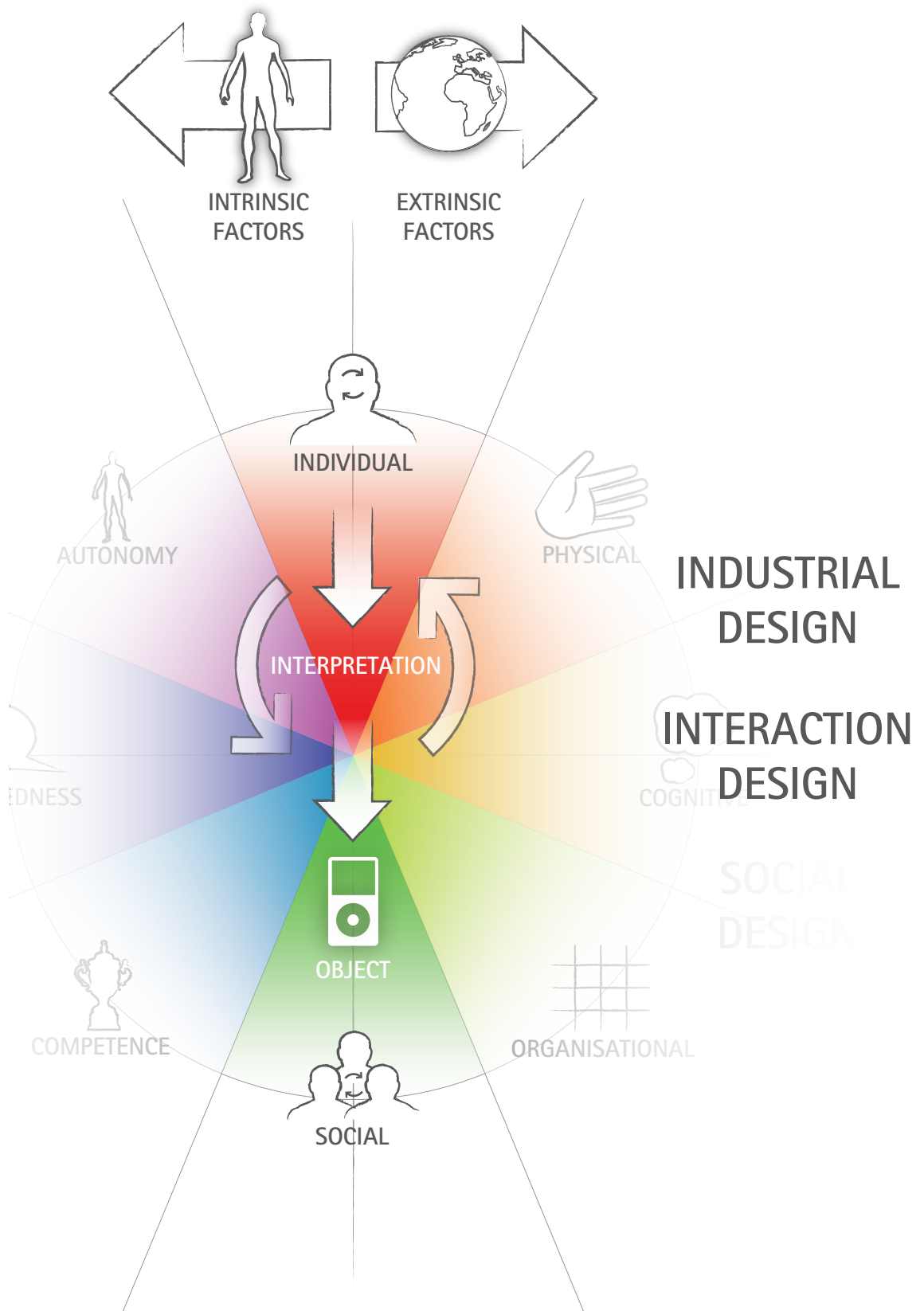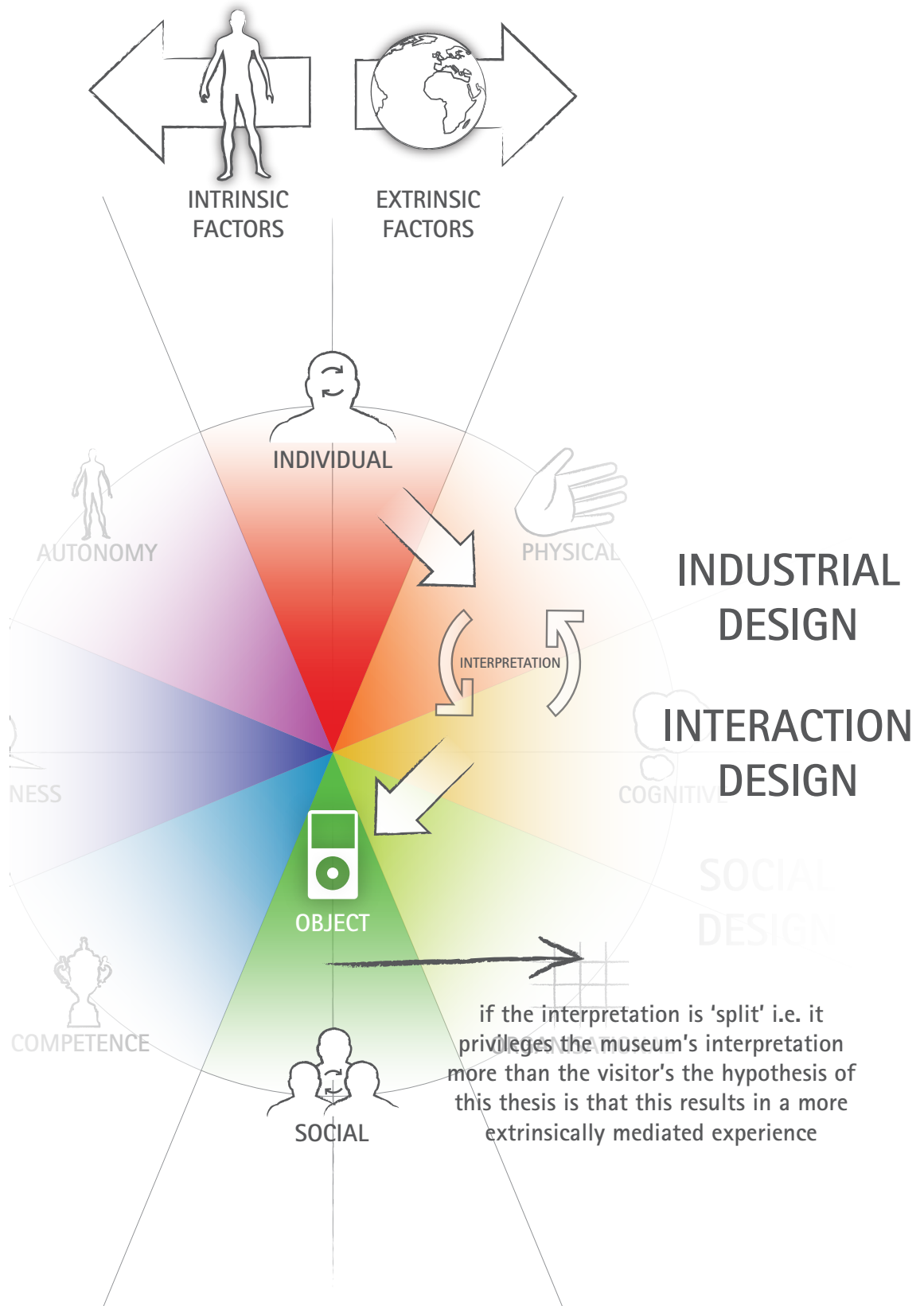
FIG. 13 CASEY'S (2003) CONCEPT OF THE RELATIONSHIP BETWEEN THE INDIVIDUAL
(SUBJECT) AND THE OBJECT WITHIN HER CONSTRUCT OF THE INTERPRETING MUSEUM –
WHERE THE MUSEUM REVEALS OR DETERMINES 'TRUTHS' THROUGH ITS INTERPRETIVE
APPROACH & THE IMPLICATIONS OF THIS INTERPRETATION DOMINATING THE
EXPERIENCE

The challenge here is striking a balance between increased engagement as a result of the grouping or 'lens' of interpretation, versus a situation where the interpretive or engagement approach becomes too dominant or limiting of the visitors own personal appreciation, internalisation and learning within the exhibition (the split view or privileged interpretation as illustrated in fig. 10).

Reflecting upon this distinction however, it is possible that visitors to an exhibition might come to experience the museum's interpretation (the privileging view) as much as they come to view the museum's latest exhibitions and artefacts. That is, they might wish to be recipients, not participants, and their motivation to engage with the exhibition will be guided by their visualised expectations of this. Designers working for, or within, a museal context need to attempt to reconcile both of these factors if successful engagement is to occur. An alternative approach, outlined previously with reference to Popper and the difficulties of conflating layers of interpretation, would require designers to identify one approach or engagement strategy, and make it apparent to all stakeholders which lens is being privileged in the design of the exhibition, to manage expectations and support prior visualisation and support users' schema construction.

Ergonomics Real Design Case Study Reflection 8

The subject in the *Ergonomics Real Design Exhibition* was the visitor to the museum, the objects were the ergonomic artefacts showcased, and the interpretation was the message or caption accompanying the artefacts and the process through which the subject is expected to interpret or interact with such a message.

With guiding reference to the Motivational Design Framework, it is posssible to draw out the following further insights as Casey highlights a number of factors influencing

affective and cognitive engagement in the museum context that would need to be ascertained if successful public (social) engagement is to occur:

- a clear understanding of the museum's visitors
- the museum's interpretative approach
- as well as the proposed collection of artefacts or objects.

Successful design for engagement and motivation requires a balancing and reconciliation of these various competing elements. These are visualised and outlined in fig. 14.

INTRINSIC
FACTORS

EXTRINSIC
FACTORS

INDIVIDUAL

AUTONOMY

PHYSICAL

PROPOSED COLLECTION OF ARTEFACTS

THE MUSEUM'S INTERPRETVE
APPROACH

A CLEAR UNDERSTANDING & THE INVOLVEMENT
OF USERS

NESS

COGNITIVE

INDUSTRIAL
DESIGN

INTERACTION
DESIGN

SOCIAL
DESIGN

COMPETENCE

ORGANISATIONAL

SOCIAL
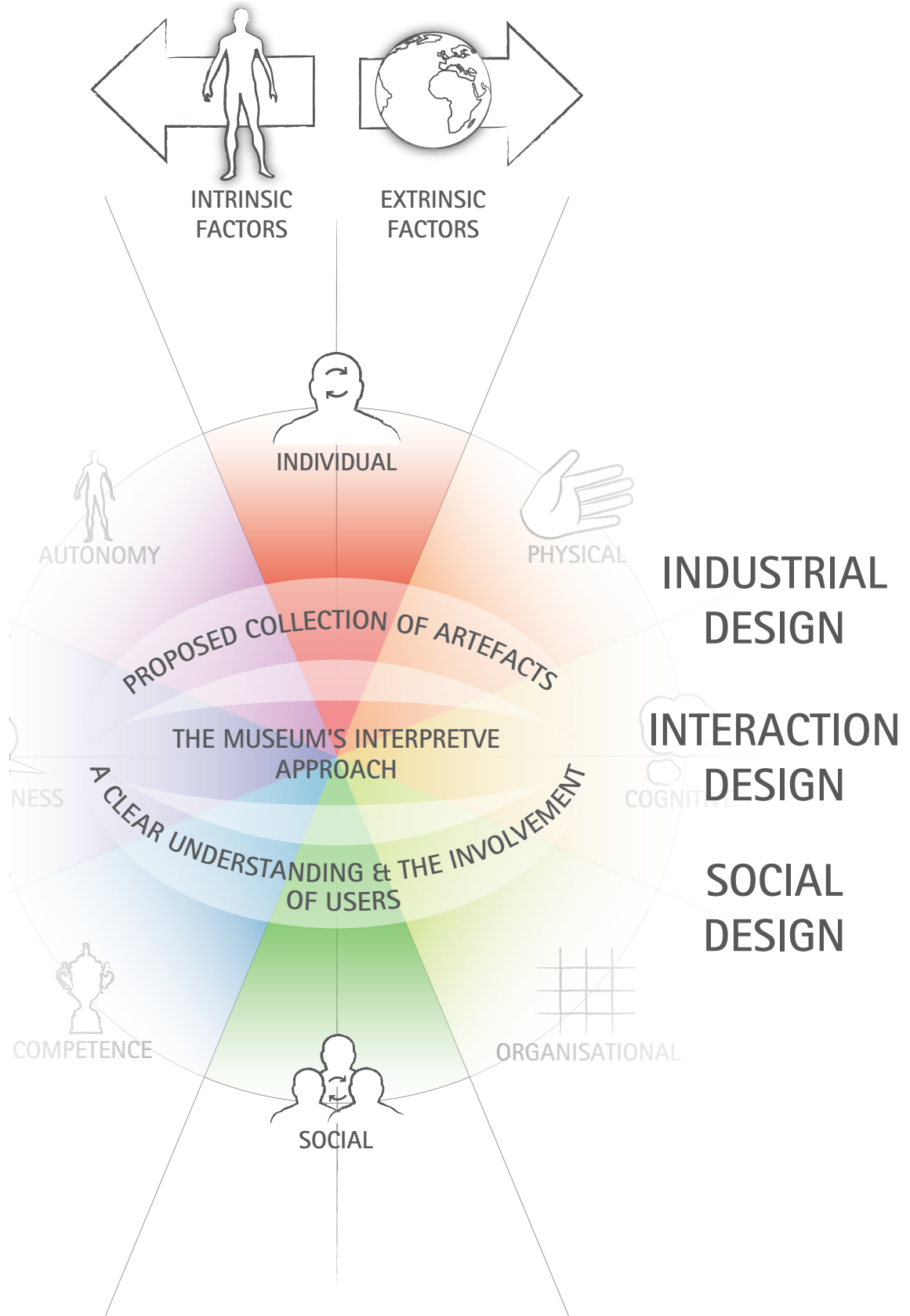
FIG. 14 SYNTHESISED FROM CASEY (2003) FACTORS EFFECTING AFFECTIVE AND COGNITIVE ENGAGEMENT, MAPPED IN JUSTAPOSITION WITH THE MOTIVATIONAL DESIGN FRAMEWORK

Museums are evolving into performative spaces in an attempt to provide richer, more engaging, and more sociable exhibitions (Simon, 2010; Casey, 2003). This approach to learning and interpretation relates to Bandura's (1978) Social Learning Theory, which suggests social spaces are beneficial for promoting greater motivation, learning and engagement with the subject matter in question. It also builds on Deci and Ryan's Self Determination Theory of Motivation, (1985; 2000; 2004) that states humans are motivated by social relatedness, in this context their motivation to engage with the exhibition and its subject matter as enhanced by the performative and social energisation of motivation.

Further consideration is required to better conceptualise and visualise the design process through which people might internalise the messages that the exhibition environment affords them, and the implications of this on their motivation to continue to engage with the subject matter or the experience of acquiring this information. Furthermore, it is arguably worth reflecting upon what impact such internalisation will have on an individual's overall understanding and motivation to partake in the engagement process. These considerations form the second and third research objectives of this thesis respectively and are researched and outlined in the following sections of the literature review of this thesis.

2.5 MOTIVATION AND ITS RELATIONSHIP TO DESIGN

The previous section highlighted considerations for designers in relation to designing for engagement in a museum environment. It suggested from this research so far that they need to consider the social and organisational influences upon human motivation and perception as well as the primary tangible processes through which individuals gather this information as they interact with their environment, in order to ensure successful motivational engagement. It also suggested considerations for designers in utilising the higher-order ways in which individuals reflect, or in the first instance will converse about information and experience during, or before or after, their interaction. This section reviews the meta-motivational, learning and skill development literature in an attempt to understand the processes impacting upon human motivation and skill acquisition and draws implications for designers to support various forms of engagement such as conversation, visualisation and representation within their design research and practice. The impact of these various difference approaches to supporting overall motivational engagement and design for motivational engagement, will be discussed throughout.

The assumed focus of the museal interpretive process, elucidated in the previous section is to energise the visitor's physical, cognitive and social interaction with a subject matter, artefact, context or theme, either through artefacts (legislating museum

experience) or groupings of artefacts (interpreting museum experience), through performance (performing museum experience) or through involving the visitors to the museum in self-representation or performance themselves (participatory museum experience). These broad conceptualisations have a profound impact on the role of the designer or design team employed to implement such strategies as well as the relationship of the designer and the visitor to the museum. Ostensibly, the role of the designer involves regulating the experience in a manner consistent with the overall strategy of the engagement experience within the museum context, either by expanding or reducing the energy exerted by the user as they interact with the context in question. At a broader level of abstraction and returning to some of the definitions briefly outlined in section 2.2 of this thesis, the designers role within the engagement and curatorial definition process can also be considered to be about ensuring a coherence of interpretive or engagement strategy across the various layers or levels of experience that the process of public engagement in a museum environment affords the users. Such a behavioural pattern or schema can then be considered or utilised by the designer or design team to support the energisation of users' behaviour and engagement in transitioning from an amotivated bystander or 'visitor' to motivated 'participant' within the experience (fig. 4), and consequently, supporting the individual's transition to a newly embodied state of behaviour or comprehension as a result of that experience. There are myriad models of this transition and skill development process that could be considered of pertinence to the enquiry of this thesis, some of which will be elaborated in due course, however, building on the earlier distinction and focus upon human motivational engagement adopted in this thesis, the initial model for consideration is that which has been articulated by Deci and Ryan (2000; Reeve, Deci and Ryan, 2004) in the form of their Cognitive Evaluation Theory (CET), itself a component of their Self Determination Theory (1985, 2000, 2004).
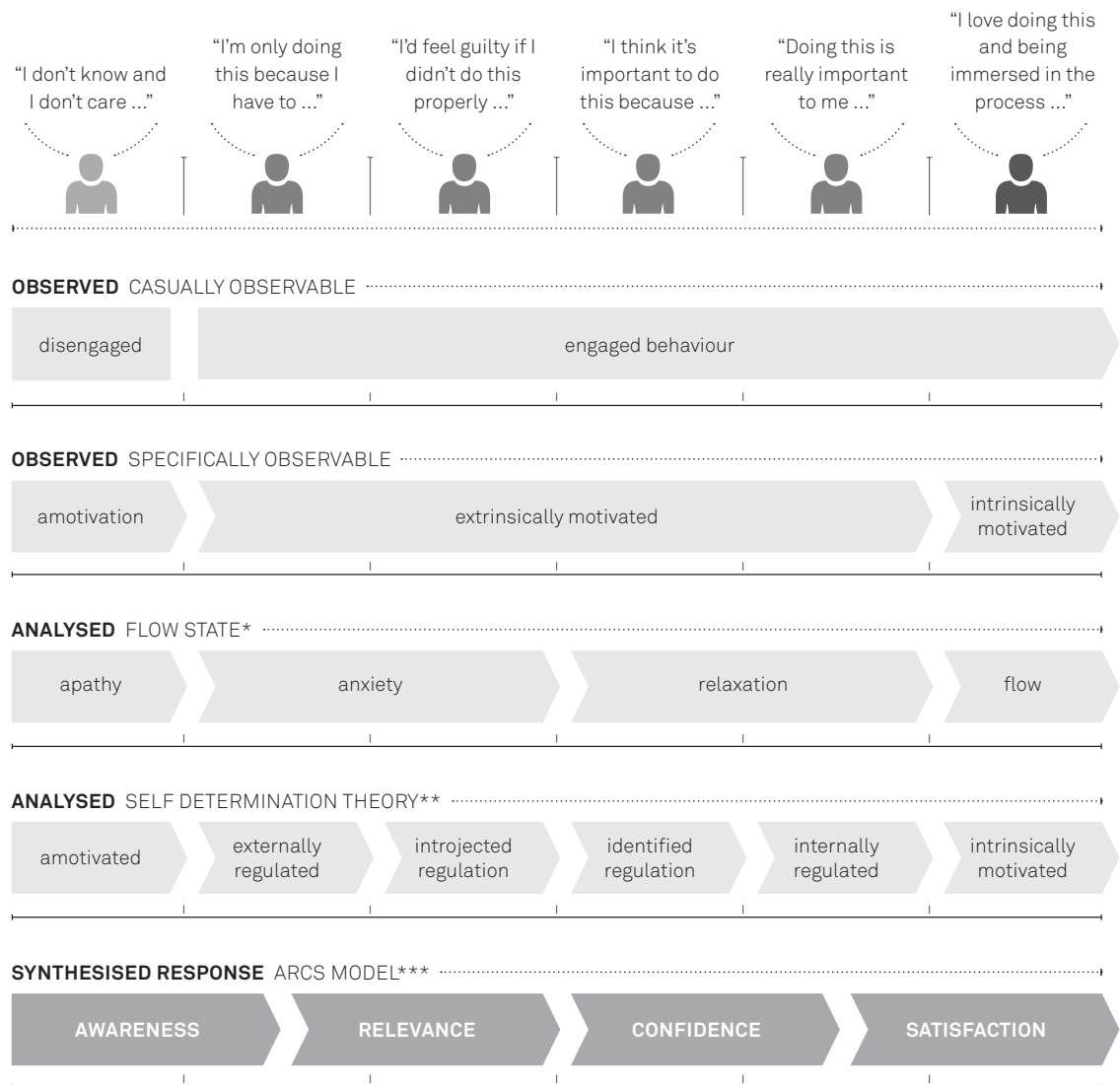
FIG. 15 SYNTHESIS OF OBSERVABLE AND ANECDOTAL OBSERVATIONS OF MOTIVATED BEHAVIOUR * CSIKSZENTMIHALYI, (1998) AND STAVROU, (2008) ** DECI AND RYAN (2008) *** KELLER (1983) ORIGINALLY FROM BISSET (2010).

This approach to modelling the interplay of individual skills, ad-hoc heuristics, rules and knowledge from a motivational perspective, can enhance and support designers and design researchers in "...relat[ing] what is being displayed or described to something within the personality or experience of the visitor..." (Black, 2005, p.181).

Ergonomics Real Design Case Study Reflection 9

At the outset of the *Ergonomics Real Design* Project there was no clear design philosophy to answer the question of how best the exhibition design and management teams would ensure their goal of motivating and engaging the general public, design practitioners and ergonomists with the process or outcomes of ergonomics. Additionally, there was little precedent for considering how such a process of public engagement should be implemented and its overall impact measured.

Within the project team, there was a tendency to assume or defer to the institutional processes of The Design Museum as a project partner and host of the exhibition, or the established processes of the EPSRC, as the funding provider of the project. It can be argued that this constitutes deference to what Casey (2003) has described as a privileging interpretation approach to the design of museums and exhibitions. There was additionally the tendency to defer to established definitions of ergonomics, as defined by the Institute of Ergonomics and Human Factors, another project partner. In relation to the literature reviewed in section 2.1 this pragmatic approach, whilst reasonable given

the financial, temporal and resource constraints of the project, saw the project running the risk of privileging the interpretative approach of the museum over an approach that specifically sought to address and develop its users' capabilities and expand their perceptions of ergonomics by allowing them, as Simon (2010) encourages, to participate and perform within the process.

There is consensus amongst researchers that attempts to conceptualise motivation in terms of a universal grand theory have repeatedly failed (Reeve, 2008; Ford, 1992). There is no clear concept or framework for designers, through which to consciously consider the role of motivation as part of their design practice, or as a central tenet of their personal or organisational design philosophy. As evidenced in the experience of the *Ergonomics Real Design* case study within this thesis, the absence of a clearer model or framework of motivation within design and public engagement presents a risk of deference to other more static, or established priorities and engagement approaches which do not consciously support or consider the motivational state and self-regulatory, dynamic capabilities of their end users. With this in mind, this research sought to investigate and synthesise a conceptual model or framework of motivation within the process of design, particularly with respect to supporting designers conversing about and visualising the impact of user motivation as they address wider design challenges building upon, and affirming the three layered conception of human interaction and engagement developed as a result of the literature reviewed in the previous section. The final synthesis of this framework can be found in fig. 41.

Any act of design impacts upon user behaviour and the environment around it (Lockton, 2008). As Ajzen (1991) states:

"Explaining human behavior in all its complexity is a difficult task.
It can be approached at many levels, from concern with physiological

processes at one extreme to concentration on social institutions at the other".

As designers seek to tackle ever more wicked (Rittel & Webber, 1973) and complex social and environmental problems (Brown, 2009; Martin, 2009) a deeper understanding of the behavioural and motivational consequences of designers' work is required. This section seeks to explore the impact design can have upon motivation, specifically intrinsic motivation, and will attempt to explore some of the underlying processes affecting motivation that designers can address. It is suggested that whether motivation is, or should be, a focus and matter of conscious consideration within the design process, can become a matter of the individual design philosophy of each designer.
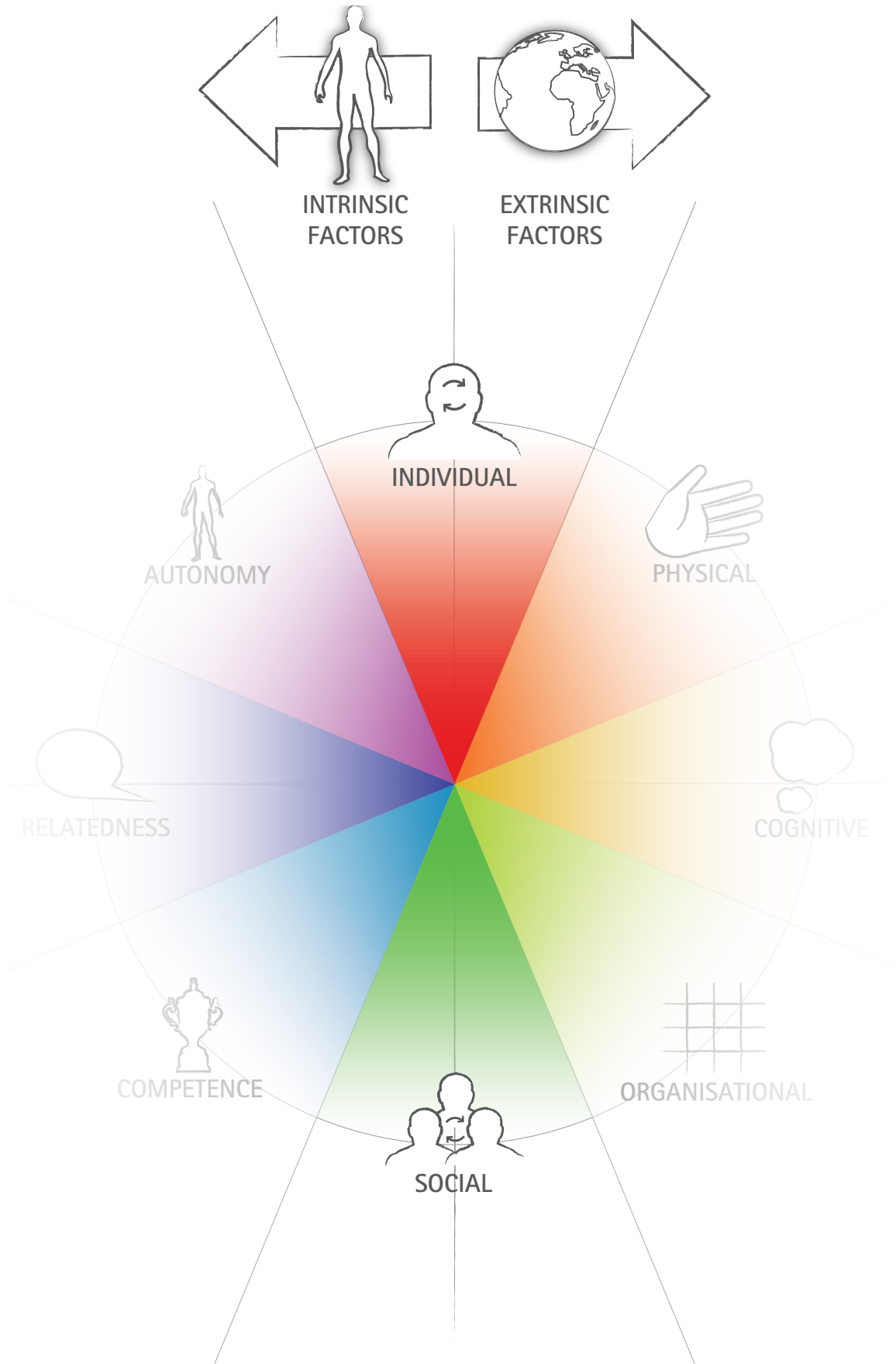
FIG. 16 DEVISED FROM AJZEN (1991) THE INDIVIDUAL AND SOCIAL INFLUENCES ON BEHAVIOUR AS THE SPECTRUM OF HUMAN BEHAVIOUR IMPLICATED IN THE PROCESS OF PUBLIC ENGAGEMENT

All individuals, and therefore all designers, have their own philosophy (Pirsig, 1999) and by implication, their own attitude towards their ability or desire to influence or effect human behaviour and motivation. Sometimes this might be implicit, never consciously articulated or of lesser importance to other aspects of their work, design research or practice. Some designers consciously focus on influencing the form of an artefact, system or service, the manufacturing processes and use of material. Alternatively, some designers choose to consider how the user will interact with the product, an approach ever more important in a world where more and more product hardware contains its own software or operating systems that users are expected to interact with (Norman, 1988).

At a broader level of abstraction, designers are capable of determining motivational or amotivational self-regulation and energisation of the behaviour of users, who interact knowingly or unknowingly with their products, systems or services. If the physical form of a mobile phone, whilst attractive, makes the device difficult to use, the chances are that over time users will become more demotivated about using it. Alternatively, if every time they use it they are reminded by how functionally or aesthetically appealing it is they will continue to be motivated by it, thereby increasing their long term engagement and sustained interaction with it. Whilst acknowledging the social and participatory implications of this assertion, it is likely that an individual energised and engaged by their own experience of a product, system or service, will in turn be more likely to share that enthusiasm or experience with others and vice versa. Therefore there are implications and an imperative for designers interested in supporting the physical interaction of users with products, systems and services to consider the motivational implication of their work. This relationship between the personal and the interactive aspects of human experience has previously been explored in sections, 2.3 and 2.4 of this thesis, particularly as it relates to the motivational design of museums and exhibitions.

Design and design research is fundamental to the process of refining theories (Edelson, 2002). In this case, refining a theory of the role of motivation in design, especially in terms of how it relates to public engagement with science. Design research is integral in converting complexity that designers face, whether they are industrial, interaction, or social designers, into scalable, testable and marketable products or services (Martin, 2009). Just as it is a challenge for designers to anticipate the physical size and shape of their user, as a physical ergonomist might support a designer to understand, so too is it a challenge for designers to anticipate the motives that individual users might have for interacting with or using a particular product or service and indeed how using a product or service might impact upon an individual's motivation.

Ergonomics Real Design Case Study Reflection 10

This thesis calls for design research to focus on advancing understanding of what motivates human behaviour, and identify a common, consistent language or framework to support future research in this area. The proposed framework should support the adoption and implementation of a motivational approach to design and public engagement with science, particularly by practitioners such as those employed to design and develop the *Ergonomics Real Design Exhibition*.

With reference then to Martin's Funnel of Design Thinking (fig. 17), the role of motivation in design generally and the role of motivational design in supporting public engagement with science specifically is, it is contended here, at the 'mystery' phase, or implicit within the process of design. Considerable research within motivational psychology can support designers' understanding; this research sought to translate this complex literature from a mystery for designers into something of a heuristic

INTRINSIC
FACTORS

EXTRINSIC
FACTORS

INDIVIDUAL

?

MYSTERY

AUTONOMY

PHYSICAL

$x \approx y \approx \$$

HEURISTIC

RELATEDNESS

COGNITIVE

$x+y=\$$

ALGORITHM

COMPETENCE

ORGANISATIONAL

SOCIAL
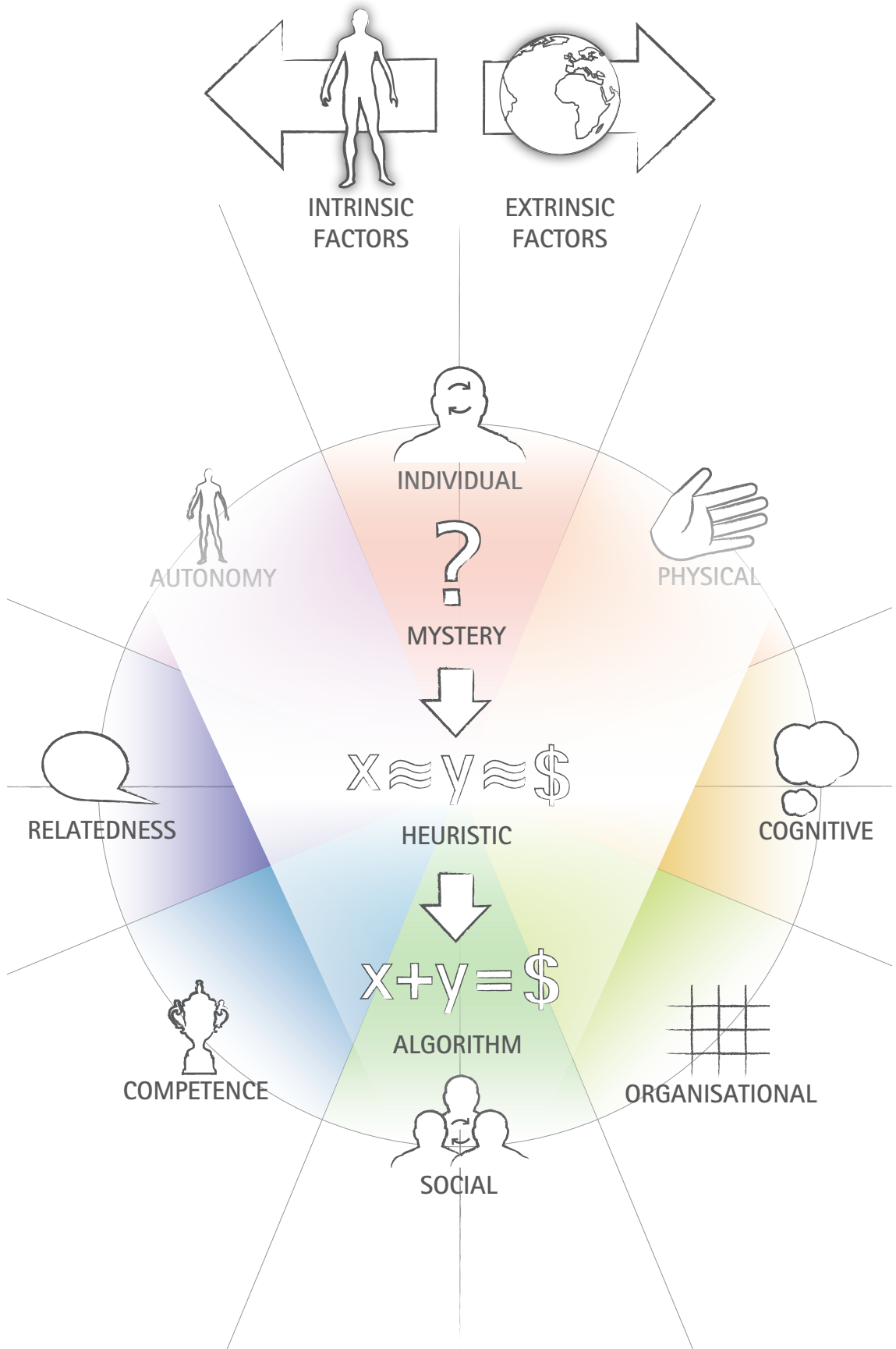
FIG. 17 SYNTHESISED FROM MARTIN (2009) THE FUNNEL OF DESIGN THINKING & THE HYPOTHESISES IT GENERATES FOR THE POTENTIAL OF DESIGN PRACTICE & DESIGN RESEARCH TO INFLUENCE FACETS OF MOTIVATED BEHAVIOUR

approach to design, that in turn can be more scalable and flexible, in design research terms; generative, in its broader use and application.

2.6 MOTIVATION IN MORE DETAIL

This discussion about the essence of motivation builds upon Ajzen's (1987) observation that human behaviour can be considered at a personal or social level, a framework that this thesis has already built its structure upon and leveraged heavily. All human behaviour, and by implication the motives that underpin such behaviour, are the human organism's attempts to balance its intrinsic interests and needs with the pressures exerted upon it by the environment (Maslow cited in Azjen, 1987) or, framed conversely, the human organism's attempt to utilise extrinsic affordances to develop or further its intrinsic interests.

Ergonomics Real Design Case Study Reflection 11

In many ways transparency of this tension between the intrinsic interests of the public and those of science or indeed the extrinsic outcomes of science and how they do or do not support the intrinsic or extrinsic interests of society, represents a novel way to conceptualise the process of public engagement with science. Indeed the process of public engagement with science could be considered as a debate, discussion and the participation of broader society in determining the aims and interests

of science. Indeed, the notion of a transparency of dialogue is foundational to the approach this research maintains designers should adopt in order to greater enhance and energise the motivational consequences and behaviour accordant of their design activity. The distinction between individual experience of ergonomics and how this translates to society's experience of ergonomics was also a tension that needed to be explored by the the design team behind the *Ergonomics Real Design Exhibition*. Determining individual's experience of ergonomics and their existing intrinsic schema of ergonomics was also considered fundamental to the question of how then the design team might attempt to engage the public further with the scientific discipline of Ergonomics.

2.6.1 CONCEPTUAL SYNERGIES BETWEEN MOTIVATION AND DESIGN

The literature explored thus far has resulted in the emergent Motivational Design Framework, being split into dimensions of Personal and Social (Ajzen, 1991), Intrinsic and Extrinsic (White, 1959) and at a closer level of abstraction includes the intrinsic dimension being sub-sectioned into Autonomy, Relatedness and Competence (see fig. 16). Physical navigation of the environment which is to say autonomous navigation in pursuit of accumulation of sensory experience and greater competence or relatedness, is a more primary developmental need and prerequisite of motivated behaviour than relatedness and competence-seeking behaviour or conversely, avoidance-seeking behaviour, is in its own right (Kowal and Fortier, 2000; Deci and Ryan, 1985; Vallerand et al, 1997).

In relation to design, a conscious focus in designing to support users' sense of relatedness or competence, and by implication their intrinsic motivation, requires that users are on some basic level capable of autonomously using the product, system or service, or in the case of this research navigating the museum environment. It is noted however, that autonomy should therefore potentially be privileged as a more primary design concept for designers interested in designing to support motivation. This observation, whilst more specific, correlates with some of the theoretical suppositions outlined at the onset of this research, as recorded in section 2.2. A fuller investigation of this observation, and the implications of this, particularly for design research disciplines such as that of Inclusive Design, should be the subject of future research and exploration but will also be greater expanded throughout this thesis. Further justification for the role of autonomy, relatedness and competence as components of intrinsic motivation can be found in deCharms (1968), Baumeister and Leary (1995) and Harter (1978).

Ergonomics Real Design Case Study Reflection 12

With reference to the design of a public engagement exhibition it is apparent that a significant focus of the designers work will be in ensuring the users' autonomous navigation of, and interaction with, the *Ergonomics Real Design Exhibition* environment, if the experience is to be motivating.

There are a number of dimensions to autonomy itself from a design perspective; the first is the functional accessibility of the exhibition space that needs to be designed in accordance with Health and Safety and broader accessibility legislation. This would ensure that the exhibition is designed to support user's physical autonomy. The second dimension is ensuring a conceptual clarity of the exhibition's purpose and its content that enables individuals to understand with complete clarity what the exhibition sought to offer them and how it did so. This information enables users to make a series of informed decisions about how they choose to navigate the exhibition or interpret from their experience. Such conceptual clarity would also allow visitors to the exhibition to highlight specific areas of interest to them personally. The counter argument is of course that conceptual vagueness might result in visitors attending the exhibition in a bid to test their autonomy, because they were motivated to see what it was about, for the very fact that it might not have been made more explicit

prior to this point. This represents the discrepancy problem of motivational enquiry (Dornyei, 2001).

2.6.2 INTRINSIC AND EXTRINSIC MOTIVATION

One of the earliest recorded definitions of motivation is that of Thrasymachus. His view was that as humans we are primarily selfish; we are interested in identifying affordances, or aggregates of affordances in pursuit of the sensory experience they provide, we desire experience therefore to fulfil our hedonistic sensory demands, the argument being that we ultimately seek to fulfil those demands, even if they conflict with others around us (Mook, 1987). This supports White's observations on intrinsic motivation, that the "fundamental need for individuals [is] to be effective in negotiating their environment, the prototypical manifestation of which is the infant at play" (White cited in Elliot and Dweck, 2007, p.5). The relationship of such ludic engagement and intrinsic motivation is something that will be explored further in this chapter and throughout the empirical aspects of this thesis.

2.6.2.1 PLAY AS A CONCEPTUAL MODEL OF INTRINSIC MOTIVATION FOR DESIGN?

Play is considered critical to developing basic physical, cognitive and social literacy; with some equating successful play as analogous with the design of successful learning, the belief being that as humans we innately play with and learn about our environment from a young age (see Polaine, 2010). It is however, a relatively recent notion that play could be a positively designed feature of a wider product or service system. The emergence of the concept of gamification builds on the increasing prevalence of context aware mobile devices and integrates decades of psychological understanding about child and adult development (Deterding, 2010). This knowledge was put at the disposal of designers as part of the Design for Persuasion movement pioneered by Fogg his research group the Persuasive Technologies Lab at Stanford University (see Lockton, 2008 for context). Caution however, must be exercised to ensure that conceptualising play as a concept useful for designers in designing to support motivation, does not trivialise or limit the role of motivation in design, to that of a value-added feature, as, this thesis has argued thus far motivation is integral to designing to support all human behaviour.
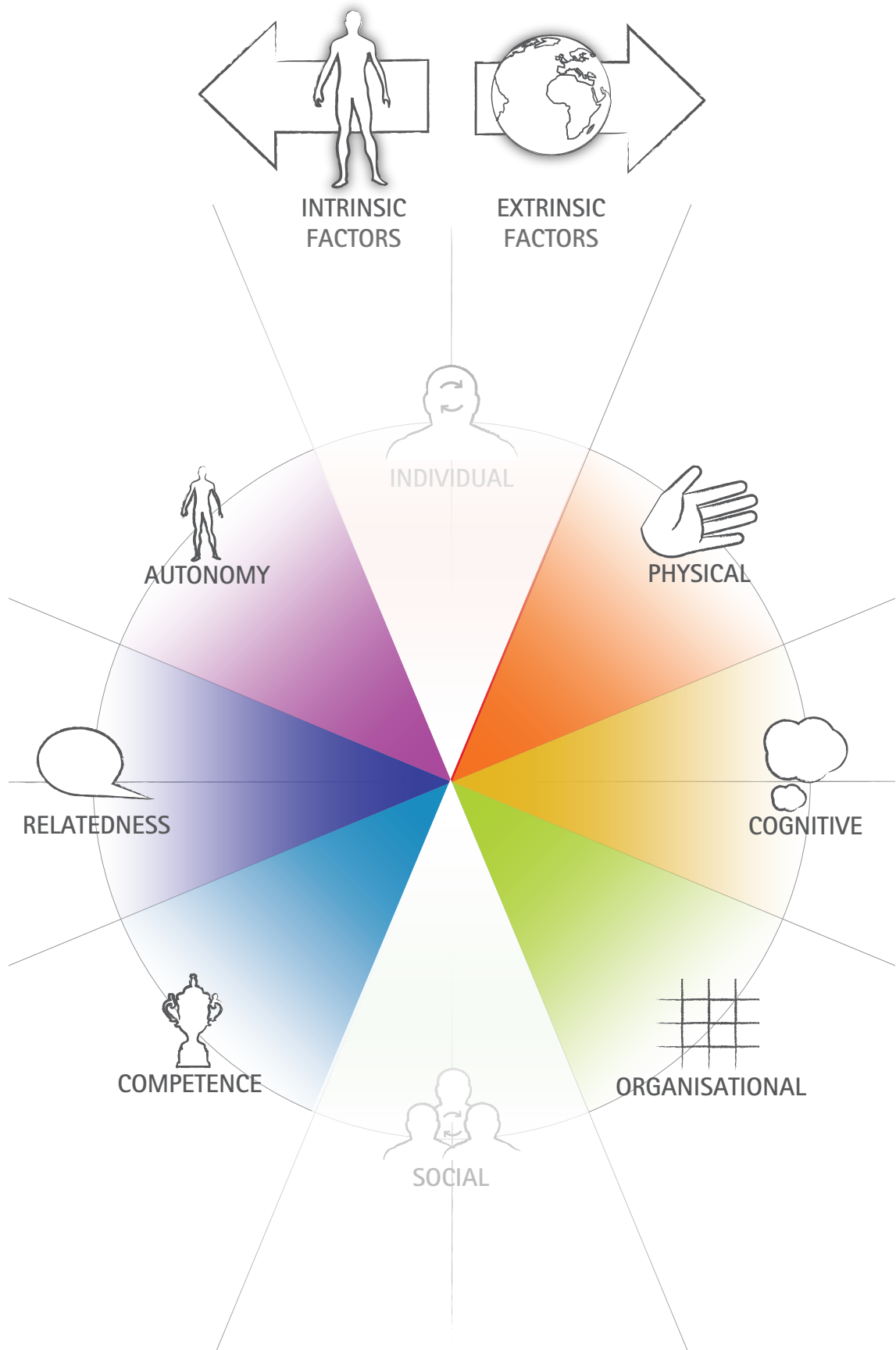
FIG. 18 DECI & RYAN'S SELF DETERMINATION THEORY OF INTRINSIC MOTIVATION FRAMED IN JUXTAPOSITION TO THE IEA'S THREE FACETS OF EXTRINSIC DESIGNED EXPERIENCE AND HUMAN FACTORS AND ERGONOMICS

Motivation is arguably as old and as colloquially well understood a notion as play, but as with the concept of play, understanding of the conscious role of motivation within the design or use of products, systems and services is in its infancy. Deci and Ryan (1985; 2000) maintain such an intrinsic motivational process is driven by three fundamental and universal psychological needs. These might also be considered as three fundamental human goals (Locke & Latham, 1990) possessed by all individuals:

The needs, or goals for/of:

> Autonomy

> Social Relatedness, and

> Self-Competence.

As individuals we are all innately intrinsically motivated in pursuit of greater autonomy, establishment and maintenance of social relationships and in affirming our own self-competence.

In its simplest form, Deci and Ryan's theories of Self-Determination and Cognitive Evaluation Theory of motivation (2000; Reeve, Deci and Ryan, 2004), contend that living organisms are born with the predisposition for growth and fulfilment of greater autonomy and autonomic behaviour, social relatedness and development. Humans have, it is argued, an innate disposition to seek affirmation of our personal sense of competence. Motivation is the energisation process that underpins this development and exemplifies the process of seeking fulfilment of these needs; this is at times a process that is self-initiated and self-determined, at others technologically-initiated and technologically determined and at others still, socially-initiated and socially-determined, (Verbeek, 2006; Ihde, 2009) or put another way at some points intrinsically motivated and regulated behaviour, at others behaviour motivated and regulated by designed products, systems and services.

The role and relevance of motivation within the design of the Ergonomics Real Design project was readily apparent. Through the design of the exhibition it should have been imperative that the designers and curators attempted to understand how to position ergonomics in a manner consistent with the audience's current understanding, thereafter structuring the engagement of the exhibition in a manner sympatheticto, or exceeding the audience's expectations of interacting with it. As a design approach to support public engagement with science, this would have seen the design team position ergonomics in a manner that individuals might be self-determined to approach or intrinsically motivated to engage with.

Another way of conceptualising these insights in relation to design, or for that matter, marketing, would have been to position ergonomics as fundamental in supporting individuals' personal autonomic, competence and social relatedness needs. Arguably attempting to present Ergonomics, or any other subject matter in this manner would potentially align it as primary in facilitation of user's basic motivational needs.

In relation to industrial design, interaction design and service design it is easy to see how the innate needs that Deci and Ryan identify might fuel consumer behaviour. For example, an individual's sense of autonomy might be enhanced by their ability to interact with a product or their ability to effectively and intrinsically simplify the

complexity presented by a product or experience as they use it (Norman, 2010). Maeda (2006) offers a further exposition of the value of simplicity as a design philosophy, and by implication, the role of the designer in promoting autonomy by virtue of their ability to visualise and conceptualise complexity in a manner that makes it simple for others to interact with.

Simplicity of design, both as an aesthetic construct and as a functional one, is imbued throughout Modernist approaches to design, is further exemplified in the Industrial Design of Dieter Rams at Braun and Jonathan Ive at Apple. Relatedness and Self-Competence also speak for themselves as concepts that designers will be experienced at designing to support, with 'web 2.0' concepts and social networks being a designed series of systems and 'social interfaces', the primary selling point and monetisation of which is reliant on the fact that these 'relatedness systems' increase the social relatedness of their users as they interact with what would otherwise have been solitary experiences. A conscious design-intent in supporting and reinforcing such notions as competence and relatedness is therefore a more recent post-modernist development, but, particularly with reference to web-enabled devices and the notion of an internet of things (Arnall, 2009), one that designers are already capable of conversing about, visualising and designing to consciously influence.

These three distinct concepts of autonomy, relatedness and competence and the extrinsic affordances that designers can create to support them will be explored in more detail throughout this review of the literature. Whilst the Self-Determination Theory Model is consistent with Modernist approaches to design and the interaction and user-centred design paradigms that have followed it. This thesis will now explore a contrary notion, namely the critical design concept of discrepancy and pursue the question of whether this latter concept represents a more useful, and more engaging model to support motivational design and to support designers motivate and engage the users of the products, systems and services they develop.

2.6.3 DISCREPANCY AS A CONCEPTUAL MODEL OF MOTIVATION FOR DESIGN?

A fundamental factor for consideration in designing for motivation, is the distinction between what a given designed plan or goal action sequence of behaviour demands of a user, and how the user intrinsically interprets or simplifies that in relation to their own personal desires or needs. In other words do we as active participants within the design process, whether user or designer, seek to rationalise complexity and seek simplicity, as Maeda (2006) and Martin (2009) can be interpreted as suggesting. Or do we as active participants gain more motivational energisation from encountering and interacting with something that is purposefully discrepant to us, or with our surroundings? This is also related to how users proceed to behave in practice and how reliably and autonomously they can enact the behavioural schema they have constructed. As Heckhausen states when considering motivation it is a case of asking "not [just] to what end an action goal is pursued, but **how** a goal adequate action sequence is possible, what kind of functions might be involved and **how** [such] processes are regulated? (cited in Hacker et al, 1980)" [emphasis added].

2.6.3.1 DISCREPANCY REDUCTION AS A CONCEPTUAL MODEL FOR MOTIVATION WITHIN DESIGN

To varying extents, designers make efforts to understand users' existing patterns of behaviour or cognitive self schema through a variety of processes, from observation and ethnographic techniques on one hand to laboratory based or controlled trials and product tests on the other. These approaches to understanding users allow designers to identify implicitly or explicitly the factors that may motivate their users and allow them to interpret what new design features, products or services could be introduced to reduce the discrepancy between their users' stated desires and their actual behaviour. A focus on giving the customer what they want can thus be considered a motivational process of discrepancy reduction; the discrepancy between user expectation and user behaviour. As Martin (2009) outlines, such design interventions can be radical in the case of products or services developed to enable users to fulfil previously impossible need fulfilment and gratification. Such design interventions can also be incremental in that they might support users to more easily and seamlessly fulfil needs that otherwise would have demanded greater energy expenditure (motivation) or physical or cognitive capacity.

Ergonomics Real Design Case Study Reflection 14

The success of design in influencing motivation within the context of the *Ergonomics Real Design Exhibition*, arguably lay in enabling individuals to translate rules of engagement into familiar, skilled or innate behaviour they perceive as relevant to the current task or environment (extrinsically motivated), or which they already themselves aspire to undertake (intrinsically mediated). The better the designer in assimilating the behaviour demanded of users, with what they are already capable

of, or aspire toward, the more motivating the experience will be.

The behavioural specification a designer might demand of the user, such as their ability to see a displayed artefact within a museum exhibition and read an accompanying caption, must support them to adapt their behaviour and to internalise the situation and the information it affords them. The discrepancy in this instance is that the designer and curators have an artefact and a caption that they would like the user to see and read, and by doing so, they intend them to acquire an enhanced appreciation of ergonomics. The designer's assumption in this instance and the behaviour they demand of their user, involves the user physically seeing the artefact and successfully reading the caption.

A designer must understand the physical or cognitive discrepancies they create within the environment, and how they might reduce or familiarise these from the perspective of their users, to ensure the user can embody the desired behavioural specification and successfully redress the discrepancy demanded of them. The success of the user in doing this, or the designer in enabling the user to do this could be considered design to support engagement and is one area where designers can support and deliberately influence the motivation of their users. The success of the designer in deliberately creating dissonance (amotivation) on the otherhand, if

appropriate, can also be considered the role of design to support amotivation. These approaches are referred to as motivational goals and anti-goals respectively throughout this thesis. These definitions adopted for the purposes of exploring the concept of motivation within the field of design research are similar to those identified by Carver (2004) in the field of motivational psychology.

The energy users expend in reconciling a motivational goal or an amotivational goal is the motivational energisation elicited by the engagement process (Reeve, 2008). In relation to the design of the *Ergonomics Real Design Exhibition*, if the user could not or did not wish to see artefacts or read captions they would become increasingly demotivated, assuming that they held the motive or ambition of in fact understanding the subject of, in this case, the *Ergonomics Real Design Exhibition*. If on the other hand they could not see or read the caption but also did not want to, i.e. they did not possess the specified goal, they might be considered amotivated. It is not unfair to suggest that large number of individuals exposed to PPE potentially fall into this category. However, due to the fact that this PPE exhibition was taking place inside the Design Museum, London, there just as equally would be a number of individuals motivated to engage with the exhibition independent of the subject matter, for the simple fact that it did reside within the museum. Alternatively, as in this latter case, if a user arrived with the expectation of reading, observing and interacting

with the exhibits, as part of the engagement process, then there would be very little discrepancy between the designers' and the users' behavioural intention and the resultant behavioural specification, providing of course that the user was physically capable of completing the intended task. In these circumstances, where designer and user's behavioural schemas are easily reconciled, it is more likely that visitors will leave an exhibition space having expended their energy in appreciating the exhibits and information contained in the text description, rather than expending it in an attempt to self-regulate physically or cognitively their capability to do so.

Thus, just as there exists two types of identified conversation of relevance to the notion of developing a motivationally engaging public engagement exhibition about Ergonomics, as explored in section 2.2, there are by definition also, two types of goal action sequence possible; one where the user wants to be motivated - where the goal action orientation (consensus) already exists and one where the user either doesn't want to be motivated towards the goal (anti-motivation) or doesn't know that they can be motivated (amotivation, apathy or learned helplessness). Developing this observation further, and building heavily upon the goal action theories of motivation and the cybernetics and conversational theories explored thus far in this literature review, it is possible to construe that one primary way in which a designer might motivate behaviour is in

creating a discrepancy that provokes a user to pursue a goal action sequence, by for example, creating a physical design or phenomenological experience that is intrinsically motivating and generates a consensus of phenomenological interest or enquiry on the part of the user. The alternative role of the designer in motivating behaviour is to capitalise on the latent or pre-existing interest or motive i.e. where consensus already exists amongst users and potential users, either in the mind of the potential user or as part of a collective social consensus that has already created or currently mediates a 'goal action sequence' or behavioural norm. The designers' role in this instance is in simplifying or streamlining the experience, **reducing discrepancy**, to facilitate fulfilment of this already established, and more likely, presently socially or technologically mediated goal action sequence.

The argument, asserted by this thesis, that designers are either the constructors of hitherto undefined goal-action sequences, or simplifiers of existing ones, presents designers, and the concept of design for motivation, with a paradox. If the mark of successful motivation is expenditure of as little motivational energy as possible, namely; to facilitate the simplification of complexity and to empower users to fulfil pre-determined goal action sequences or to successfully interact with new ones, how can designers measure their success in doing this? Should measurement focus on users' prior expectations, or should it measure a positive or negative quality depending on whether users are motivated to do or avoid doing something? In many respects this approach epitomises the prevailing norm within disciplines such as service design, that arguably seek to model and simplify the latent or pre-existing

aspirations users might have of an idealised or higher quality user experience as the basis of design solution that then resolves such discrepancy to ensure a seamless experience or the meeting or exceeding of user expectations. There have also been more recent attempts to use the same methods to 'redesign' novel contexts, i.e. those where no prior behavioural goal action sequences or expectations of service quality exist.

In this designing for service, or user-experience design context, articulating tasks demanded of the user, as a matter of potential discrepancy and motivational regulation, offers value to the design process as it forces designers to reflect on their users' starting point and explore whether each user decision is approach oriented or avoidance oriented. This presents designers with a simple logic to goven their design decision making, but one that nonetheless which has complex implications for the measurement and evaluation of the motivational impact of design upon an end user's experience.

2.6.3.2   DISCREPANCY REDUCTION AS A CONCEPTUAL MODEL FOR MOTIVATION WITHIN DESIGN

One extreme perspective adopted by designers seeking to influence the motivational engagement of their users may focus on idealising a user's experience as if it were entirely free of discrepancies, an approach typical of the designer who considers idealised end user-experience as the goal toward which to structure and focus their design process. Design research techniques appropriate to discrepancy reduction in this manner include blueprinting (Shostack, 1982), experience prototyping (Buchenau and Fulton-Suri, 2000) and the service design technique of future evidencing (Moggeridge, 2006). These design tools or practice techniques also encourage designers to consider how they can, and do, add value to the experience they are involved in shaping. In the case of the public engagement with science exhibition, such blueprinting and prototyping approaches in their current form consider only the functional or aesthetic processes involved in conceptualising user experience. In the case of the worked example used throughout this section of the literature, faced with the task of enabling, or motivating users to clearly see an artefact in a museum context and read the accompanying caption; design approaches such as service blueprinting or service prototyping do not consider the motivational energisation expended as the user seeks to do so. A discrepancy focus as outlined above encourages designers to consider other available modes of interaction, such as in an exhibition context, enabling users to touch the artefact and listen to the caption being read out loud, for example as designed approaches that might have a differing impact on both user motivational energisation and the energy they require to engage with the museum exhibit. As such, the design challenge becomes less emphatically about specifying functions required by the designer to assist and support the user, and more broadly about alternative approaches the user themselves might take to fulfil their end goal or purpose. This pivots how the designer might conceptualise the user experience and opens up an array of creative possibilites for how the designer can support the user to interact and engage with the exhibit rather than be the more passive recipient of the

designed or specified user-experience. This approach to considering how to support the user, rather than simply design for the user can be considered a capacity building perspective to design.

Ergonomics Real Design Case Study Reflection 15

One simplistic and indicative solution for designers in articulating tasks they demand of users in terms of discrepancies would be to respond by adhering to 'Fitts Law' (Fitts, 1954) and make the artefact and text larger. This increases the salience of the task demanded of users by making the required task stand out, in turn increasing the discrepancy of the task from other environmental stimuli and thereby increasing the likelihood of users successfully engaging with it. This increasing physical salience and cognitive discrepancy reduction approach demands that designers develop a clear understanding of the tasks they wish users to undertake and visualise and conceptualise a range of ways of them being able to fulfil these.

2.6.3.3 DISCREPANCY CREATION AS A CONCEPTUAL MODEL FOR MOTIVATION WITHIN DESIGN

One alternative to the simplistic 'make the carrot larger' (Fitt's Law) motivational approach previously exemplified above, would involve designers affording their users a more exploratory or phenomenological approach as part of the process of motivationally engaging them with a given exhibition or service-user experience. In other words, this increased phenomenological, or increased generative capacity would constitute an increase in users' self-representation and empowerment within the product/service eco-system with which they are interacting. Discrepancy creation, in this sense might involve presenting users with an attractive goal or ideal towards which to strive; a metaphorical 'make the carrot juicier' approach that affords users a number of possible means or modes of experiential interaction through which to achieve their goal. Or which, as discussed earlier in this thesis might present them the possibility of alternative goals that users had otherwise not previously considered as within their interests or personal capabilities.

Ergonomics Real Design Case Study Reflection 16

In the case of a museum exhibit, such an approach would involve enabling users to see, read, touch or listen, without the designer being explicit about the exact manner in which users should fulfil the goal or task. In other words, offering users a wide range of possible mediums through which to interpret a consistent underlying point or message or alternatively, an approach that enabled the user to narrate or define the experience. To reference the ongoing example used throughout this section to explore the concept of discrepancy as it relates to the design of a museum exhibition. Rather than the designer specifying the text

of the caption to accompany, as would constitute a typical approach to the design and curation of a museum exhibit, an alternative discrepancy creation approach could potentially see users being invited to narrate or write their own captions or reflections upon an exhibit that they would then leave to inform future visitors to the exhibition. This would generatively and creatively result in many different definitions of the artefact in question, rather than the single, static and deterministic caption that might otherwise have been provided by the designer of the exhibition.

As Carver and Scheier (1982; 1990; 1998) outline, the notion of a plan or goal action sequence is not necessarily static; this promotes the idea of individuals as 'active decision makers'. This view of individuals as implicitly and deliberately capable of modifying and restructuring their plans and intended behaviour in response to environmental cues and feedback, shares much in common with phenomenological and existential perspectives on child and skill development, discussed previously at the outset of this chapter as integral to the development of intrinsic motivation (White, 1959). Such active decision making perspectives also philosophically share much with Suchman's Theory of Situated Action (1993) and potentially provide further avenues for enquiry for designers interested in utilising discrepancy creation as an approach to increase or enhance the motivational engagement of their users, particularly, as has been outlined throughout this chapter, within the context of a museum exhibition.

Such generative and situated-action perspectives, when considered from a motivational psychology standpoint, are commonly considered within Self Regulation Theory or Corrective Motivation (Campion and Lord, 1982). These theories of motivation attempt

to reconcile or theoretically outline the manner in which individuals generalisably adapt and reconfigure cognitive plans, alongside their understanding of the range of emotions humans elicit in response to better or worse than anticipated progress towards fulfilling such plans, goals and tasks demanded of them by, in the interest of this thesis, the designers of the products, systems and experiences that they interact with. Theories of Self Regulation explore how emotions signal or reinforce their underlying behavioural intention, and facilitate or prevent collaboration and association with other individuals as they do so. There are also some conceptual similarities here with theories of risk homeostasis (Fuller, 2005).

In designing for motivation therefore, the critical focus is how emotional responses to stimuli, previously considered within design research by Jordan (2000) amongst others, increase the probability of an individual engaging or disengaging with an activity. Expectancy-value models explain this with the claim, like schema theories of human behaviour and engagement, that a human constructs implicit or explicit models or plans of behaviour "in order to explain choice between action alternatives, the intensity and persistence of behaviour as well as the cumulative outcomes" (Heckhausen, 1980). Design for motivation, could arguably be supported therefore by attempting to ellucidate some of these implicit or explicit goals, insofar as they can generalisably be considered as of utility to designers interested in the motivational engagement of their users and in designing more motivationally engaging products, systems, services and experiences.

2.6.3.3 GOAL ACTION THEORIES AS A CONCEPTUAL MODEL FOR MOTIVATION WITHIN DESIGN

The formation of plans of behaviour (Miller, Galanter and Pribram, 1960) and the goals that direct them (Locke & Latham, 2002) result from individuals' attempts to adopt idealised modes of behaviour, adopt an idealised physical state or use, or respond to artefacts that help them conform to idealised behavioural and social states or recognition. According to Reeve (2005, p200) "people are aware of the[ir] present state of behaviour, environment and events" thus they hold in mind a plan of their current circumstances. Motivation arises if this plan is different from their idealised image of behaviour, and motivation represents the energy they exert to transform their behaviour from a current plan to an idealised plan. Doing so requires breaking down the behaviour into a series of linked or related goals, that if executed completely, will represent completion of the plan – the so called TOTE (Test, Operate, Test, Exit) Model (Miller, Galanter & Pribram, 1960).

The TOTE Model, alongside the notion of visualising complex ideas and environments as plans or blueprints, relates readily to established models of the design process, and, as noted previously, established processes within the field of design research that emphasise this process-oriented and temporal perspective on user experience and in conceptualising user behaviour. For the purposes of this research it was important to articulate the role of emotion insofar as it relates to the abilities of designers to influence and direct motivation.

2.6.4 DESIGN FOR EMOTION A CONCEPTUAL MODEL ANTITHETICAL TO DESIGN FOR MOTIVATION?

Emotion is acknowledged here as a potentially valuable by-product of the reflective process discussed in the previous section. With a view to narrowing the inquiry of this thesis, emotion does not form a central part of this work or the assembled Motivational Design Framework that emerges from this review of the literature. That said, it is discussed here in view of the explored rolel of emotion as a regulatory component within human motivational energisation, and as a result of the fact that many designers might claim to be designing for emotion or affective engagement of their users (McDonagh et al, 2003; Norman, 2004; Jordan and Macdonald (1998), Jordan (2000) and Desmet (2002). Emotion is in fact little more than a behavioural by-product of the regulatory processes that underpin motivation and human behaviour. On one hand emotions "play a central role in cognitive and social processes and all aspects of human life" (Damazio et al, 2009) and are helpful in the process of being able to identify breakdowns in implicit and explicit human behaviour including that of intrinsic and extrinsic motivation. It could be argued that emotion is just a symptom of the 'better than expected' or 'worse than expected progress' in a user's goal seeking or goal avoidance behaviour (Carver, 2004).

Ergonomics Real Design Case Study Reflection 17

Emotions and the affective engagement that underpins them are not a direct cause or regulating component of motivated or engaged behaviour, nor necessarily a reliable indication of successful engagement with Ergonomics beyond a subjective and phenomenological response of individual visitors to the exhibition. Such a superficial metric of engagement as emotion is therefore not considered a sustainable way to track or evaluate the level of engagement of visitors to the *Ergonomics*

Real Design Exhibition. Affective response is, however, potentially useful in identifying whether the motivational energisation of behaviour is approach-oriented or avoidance-oriented; that said it reveals little of reliability about the extent to which users have engaged with the information contained in the exhibition as opposed to simply react to the aesthetic and phenomenological aspects of the presentation of this information.

Consequently the working contention within this thesis is that design for emotion is ultimately unsustainable as it focuses a designer's efforts in generating a behavioural by-product rather than refining the behavioural specification, or building or generating the users' or the systems' capacity for growth. This thesis asserts that design for emotion is the metaphorical equivalent of designing a combustion engine to produce as many emissions as possible as opposed to designing for improved engine performance or fuel efficiency. There are of course times when designing for greater emissions whether in the form of noise or sensory experience is entirely appropriate and desirable. However, Carver (2004) argues that emotion insofar as it relates to motivation can take two distinct forms; if a user's goal action sequence is focussed upon approaching a goal or goal action the emotional by-product will be one of elation or eagerness if the task is going well and one of sadness or depression if it is not. If the user's goal action sequence is avoidance oriented, the emotional by-products will be ones of relief or calmness if the process is going well and be ones of fear and anxiety if it is not. Evaluating these emotions as indicators of motivated behaviour present an interesting opportunity for future design research but such indicators also polarise the perspective of a motivational approach to design to one that differs in its focus to approaches to design that are interested in elliciting emotional engagement or impact.

Ergonomics Real Design Case Study Reflection 18

Carver (2007) goes some way to shedding light on the contention of the *Ergonomics Real Design Exhibition* project instigators that the public are rarely wowed by the work of Ergonomists. By this analysis and through consideration of Ergonomics, as outlined previously from a goal-oriented motivational perspective, such a 'lack of wow factor' may be due to the fact much of the work of ergonomics is focussed on avoiding or preventing problems or serious accidents (avoidance orientation) in safety critical circumstances. Arguably therefore the best ergonomists could hope for by way of positive emotional acknowledgement or engagement from members of the public would be relief or calm as the generalisable by-product of successful avoidance-oriented goal action sequences that much of the safety critical work of ergonomists constitutes.

One possible consideration for public engagement with ergonomics might then be to emphasise this more clearly and design a series of 'avoidance motivation' contexts, as these might be deemed the best way of representing the value and ethos of Ergonomists. That said, there are of course Ergonomists who are preoccupied with generating more positive user experiences, so such an approach might not be hugely representative. Public Engagement with ergonomics, might then present the opportunity to present the other side of the ergonomics with a focus on exhibits that create positive user-

experiences and that ellicit positive emotions when users interact with them.

Emotion is, by its very nature, an extrinsic process to signal and regulate behaviour rather than a behavioural end unto itself; it is outwith this exploration of how design can influence intrinsic motivation and engagement. To explore further the relationship of design for motivation and design for emotion and such an exploration does not represent an answer to the earlier cited challenge that underpins this work, of Krippendorff (2004) who stated his belief that designers and design research need to embrace greater understanding of intrinsic motivators of human behaviour and through their work influence more intrinsic drivers of human behaviour in the design of products, systems and services. This literature review will therefore turn its attention to exploring more proactive, rather than reactive signals and signifiers of human behaviour and motivational engagement, in the hope that by identifying and synthesising some of these it might be possible to develop a more motivational approach to design.

2.6.5 CREATIVITY AS A CONCEPTUAL MODEL OF MOTIVATED BEHAVIOUR FOR DESIGN?

As Reeve states "incongruity is a fundamental motivational principle" (2005, p.202). As discussed, emotion might signal such discrepancy but as far as designers should be concerned and as Bandura (1991), echoing Carver & Scheier (1982; 1990) argues, there are two types of discrepancy regulation: discrepancy reduction and discrepancy creation. These behaviours seek to address the discrepancy either positively or negatively, rather than just signify a response as emotion does.

Discrepancy regulation is the motivational process of attempting to respond to extrinsic feedback (environmental, social or technological) that otherwise indicates an individual is not performing in a manner compatible with their own behavioural self-schema, or indicates that they are not performing in a manner compatible with the user-schema of the designer who designed the product, system or service they are using. Discrepancy creation is the intrinsic creation, by the individual, of an idealised state or outcome that they might aspire and work towards. Discrepancy reduction is the process of motivational energisation involved in responding to such feedback from the interaction with products, systems and services.

Design for motivation, insofar as it relates to designing to support user self interest, is conceptualised, in this review of the literature, as the process of supporting the individual's aims, plans or goals and supporting or increasing their capacity to fulfil them. This has been discussed in terms of how designers might wish to strategically motivate or demotivate users, and therefore consider the motivational concept of discrepancy to anticipate and accommodate a number of responses and behaviours they could elicit, motivate or support within a user's internalisation of the designed, technologically or socially mediated environment around them. Whilst emotion might be useful for signalling and identifying such discrepancies, the argument advanced here is that designers concerned with regulating users motivational state rather than

simply identifying discrepancy, whether positive or negative, should concentrate instead in supporting users to generatively and creatively self-regulate their response to such discrepancy. The contention of this being that further to simply empowering the user to participate in a generative and creative experience the user will also be more intrinsically motivated by the experience.

Ergonomics Real Design Case Study Reflection 19

The question of whether it is in the best interests of public engagement with science to adopt a discrepancy creation approach or a discrepancy reduction response to engagement posed the design team many conceptual challenges. Informed by the work of Carver (2007), this macro-motivational perspective would dictate whether audience members left the exhibition space feeling 'eager or elated', as opposed to 'relieved or calm', should the engagement exhibition be effective.

If the design team wished the exhibition to elicit calm from users, it is hypothesised here that the preferred motivational design strategy would be one of discrepancy reduction. If the design team wished visitors to the exhibition to express elation and eagerness as a positive response to the exhibition, the preferred motivational strategy would be one of supported discrepancy creation.

Simon's (2010) principles of engagement in a museum context suggest engagement can be achieved by asking questions of the visitors to the museum:

> Discrepancy creation involved questions that challenged visitors' assumptions and baseline understanding or practice of ergonomics

> Discrepancy reduction as an interpretive approach, sought to answer users' doubts or questions about the value of Ergonomics

Both constitute valid engagement approaches referenced by both the public engagement with science literature and design literature. However, each demands a rich understanding of the starting point from which, as designers, the *Ergonomics Real Design Exhibition* was engaging its participants, and from a motivational perspective, these two approaches have drastically different hypothesised implications for how users will experience or interpret the message of the museum exhibition.

Within generative design research, Finke et al (1996) articulate the notion of creative cognition within software design, as being foundational to a subsequent process of creative visualisation, creative intervention and conceptual synthesis. The Motivational Design Framework is itself a creative visualisation indicative of the wider conceptual synthesis articulated by the literature reviewed in this thesis. The outline generative process framed by Finke et al forms the conceptual basis for the design process adopted by the *Ergonomics Real Design Exhibition*. At the heart of such arguments lies the presumption that humans are inherently creative beings and

that such creativity is to some extent related to the concept of motivation, particularly that of intrinsic motivation.

2.6.6 DESIGN AS THE PROCESS OF RECONCILING INTRINSIC MOTIVATORS AND EXTRINSIC INFLUENCES ON MOTIVATION?

The three foundations of Ergonomics and Human Factors are Physical, Cognitive and Organisational Ergonomics (IEA, 2009). These three facets are, insofar as they relate to the development of a Motivational Design Framework, a useful tool for designers in articulating the breadth of possible influences upon motivation. As broad descriptive concepts, they can be mapped relatively compatibly with Deci and Ryan's three-layer conception of Intrinsic Needs.

The reference to these established fundamentals of Human Factors also acknowledges the substantial role played by existing human factors research, particularly in relation to physical and cognitive ergonomics and human factors, such as those described in relation to the discrepancy creation and reduction in section 2.6.3. Designers and design researchers utilise this research to understand, integrate and direct the behaviour of the users of products, systems and services they design. The proposed conceptual Motivational Design Framework in this thesis and literature review integrates the entire body of ergonomics research and practice that falls under these three headings. In doing so this, highly abstracted perspective clearly hypothesises and integrates the role of ergonomics and human factors in influencing and directing human motivation. Within such a broad generative schema the framework also exposes myriad further questions and opportunities for further research exploring the relationship of ergonomics and human factors in motivating and engaging users of products, systems and services.

Ergonomics Real Design Case Study Reflection 20

The extrinsic components of the Motivational Design Framework sit well with research work conducted as part of the *Ergonomics Real Design Exhibition* development process. Illustration of the role of human factors and

INTRINSIC
FACTORS

EXTRINSIC
FACTORS

INDIVIDUAL

PHYSICAL

ONOMY

SENSORY

COGNITIVE

ORGANISATIONAL

TENCE

SOCIAL
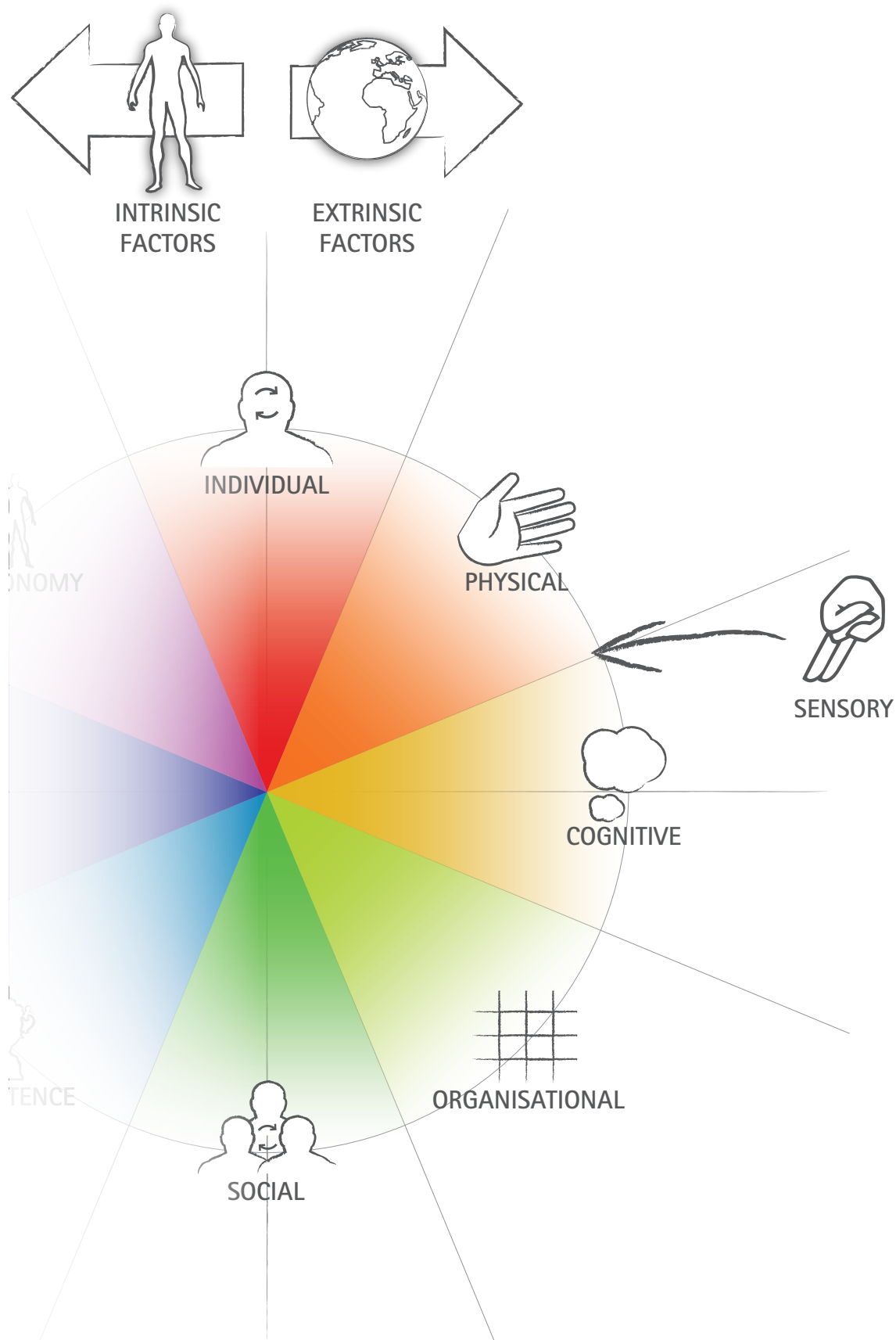
FIG. 19 SYNTHESIS FROM DONG ET AL (2004) DEFINITION OF INCLUSIVE DESIGN & THE ROLE OF DESIGN AND DESIGN RESEARCHERS IN SHAPING AND REFINING PHYSICAL EXPERIENCE & THE LATTER'S FOUNDATIONAL ROLE IN HUMAN MOTIVATION

ergonomics in the energisation of human behaviour, and the impact of this on the individual and society, was the essence of what the *Making Things Better Partnership* hoped to engage the public with, and evaluate their response to in the form and through provision of the phenomenological experience of a museum exhibition.

A conceptualisation of human factors as extrinsic, originating from the environment or an empirical study of behaviour, rather than as generative phenomena within the human, also integrates in a similarly broad and generative manner with models of Inclusive Design (Dong et al, 2004) see. For the purposes of assembling a holistic and generative framework that supports designers' understanding, visualisation and advocacy for the role of motivation within design, Ergonomics and Human Factors and Inclusive Design are considered as a loosely coupled conceptual whole, together with that of Deci and Ryan's conceptualisation of human intrinsic needs (1985; 2000).

Ergonomics Real Design Case Study Reflection 21

Emphasising the role of ergonomists in inclusive design research in assisting designers in making their products more inclusive and engaging become a central focus of the *Ergonomics Real Design Exhibition*. A model that incorporated Inclusive Design within it, and integrated the aims of inclusive design with those of ergonomics, was integral to justifying the role of inclusive design within the exhibition. In summary and based on the review of the literature conducted so far, the suggestion made here is that as a scientific discipline and body of research, the practice of ergonomics and human factors is to make explicit, i.e. extrinsic, what otherwise might

be implicit in human interaction with sociotechnical systems.

2.6.7 THE RELATIONSHIP BETWEEN PHYSICAL EXPERIENCE AND MOTIVATION: A CONCEPTUAL MODEL FOR DESIGN?

Physical design or physical ergonomics, as articulated within the Motivational Design Framework, are approaches to research and analysis of physical forms, designed or natural, static or dynamic, that designers might have cause to shape or utilise to greater motivate or demotivate user behaviour. Physical forms in this context refer to the sort that physical ergonomists have traditionally helped designers to measure and manipulate, thereby supporting safe human use and interaction. Sensory, as articulated in the Motivational Design Framework, can be considered an intermediary motivational construction between a physical form or artefact and an individual's cognitive representation of that form or artefact, on account of the fact that sensory responses within a human's interaction with an artefact requires an introjected degree of internalisation of the experience on the part of the individual (fig. 15).

A physical form only becomes a sensory experience if the individual is capable of internalising it to some degree (see fig. 19), and as such, it will rarely be entirely consistent in its formation between two individuals. Yet physical affordances still retain significant extrinsic (ecological) and generalisable physical and cognitive attributes that a designer is able to conceptualise, evaluate, create or manipulate to elicit a range of relatively consistent internalised user responses. The fact that these responses are ecological in their foundation, rather than intrinsic to the individual, is what sees them positioned on the extrinsic dimension of the framework.

Design, and designers, will inherently play an extrinsic role within the motivational process; therefore the challenge to designers is that of ensuring their designs integrate as closely as possible with the autonomic, socio-relatedness, or competency oriented needs of the individuals that use them (see section 2.5). A designer has the ability not just to make their designs relevant to users in this manner, but also to support an individual's development of their personal sense of autonomy, social relatedness or

self-competence. This will directly impact on a designer's ability to develop a more motivational design or motivating experience for participants.

The user does not have to be conscious of this process for it to be effective; however, the issue of whether it is more effective if they are, i.e. if the process of physical or sensory exploration and skill development on the part of the user is deliberate (Ericsson, 2009), is discussed further below and itself represented an interesting area for further inquiry and designed experimentation. In summary, in terms of influencing the motivational engagement of users, it is argued that deliberate consideration of the impact of such physical affordances on motivational engagement by a designer will have a significant impact upon the effectiveness of the design to elicit motivated or engaged behaviour from those who interact with it or participate within the product or service delivery process. Such manipulation of physical form represents a significant way in which designers can support and facilitate a basic means of user interactivity and generative discrepancy creation and experimentation, something that this thesis has identified as integral to developing user motivational engagement.

2.6.7.1 THE EXTRINSIC CAPACITY OF DESIGN IN SHAPING HUMAN PHYSICAL EXPERIENCE; THE LIMITATIONS OF DESIGN IN PROMOTING INTRINSIC MOTIVATION?

To expand the distinction outlined previously of conscious versus unconscious influences upon motivation any attempts a designer makes to exert influence on users' motivation are inherently extrinsic, at least at the point of their instigation. Deliberate design to support intrinsic motivation is in fact a paradox and exploring this paradox is acknowledged here as absolutely fundamental in the establishment of a robust philosophy of motivational design.

Intrinsic motivation has, by its nature, to occur unconsciously and autonomously from the user's perspective and to occur from within the user's locus of control (Lefcourt, 1982). In this sense, it could be conceptualised that anything designed by anyone other the user themselves would represent an extrinsic influence or constraint on that individual's behaviour. It might also be posited in light of this observation that the conscious design intent to develop user autonomy might be the single biggest thing designers can do support intrinsic motivation. The growth of user-centred, human-centred and increasingly participatory approaches to design, could be considered indicative of designers acknowledging this fact, although rarely in these disciplines has the manipulation of user engagement been a conscious design intent, or the concept of greater user autonomy been outlined explicitly as the overriding aim or justification of the designer or design process.

Elaborating this discussion further, Sorrentino notes:

> "Although non-conscious behaviour does indeed occur, conscious thought can also strengthen, weaken or change the very nature of behaviour...conscious thought does not [however] occur in a vacuum; it is often the product of non-conscious forces. It can also occur by association or by environmental cues" (1996, p.640).

Motivational design, as a philosophy, can leverage much from the ergonomics and human factors literature, and from user-centred and interaction design subsets of design research. These sub-disciplines and research specialisms can evidence or articulate their ability to support designers to understand, acknowledge and make explicit the impact on behaviour of their designs. A designer, particularly one focussed on creating more motivating designs or designing more motivating and engaging experiences for users, can provide extrinsic motivational cues and affordances for users to unconsciously or consciously interpret and interact with. Taking ownership of, reconfiguring, assigning and incorporating these cues as part of their self-schema and cognitive representation, enables them as users to become more intrinsically motivated themselves in their interaction with or reflection upon the use of designed products, systems and services.

This notion of a designer providing the user with cues and affordances, and allowing them to configure or choose which of those best suit their own preferred learning style or intrinsic motives, is one consistent with Vargo and Lusch's (2004) claim that all value is co-created between supplier and consumer, or in the case of design, co-created between designer and user.

Ergonomics Real Design Case Study Reflection 22

In the case of the *Ergonomics Real Design Exhibition* this argument adds support to the view that the value people perceive of ergonomics should be co-created with them, not simply presented in the self-evident, epistemological truth-asserting manner of the legislating museum (Casey, 2003). The value of ergonomics should not be presented as a notion that is esoteric or beyond questioning and comprehension. Presenting in such a manner would impair the abilities of the

visitors to the museum to discern to what extent they might wish or otherwise be capable of internalising the value of ergonomics and contributing to it. If the value of ergonomics is presented in an otherwise opaque manner, it may result in a demotivating experience for visitors, as it will not support their innate ability or need to participate in the creative, or skill development process this experience might otherwise offer them, what has, in this thesisbeen developed to be understood as the individuals' innate tendency fo discrepancy creation. Ultimately, if a visitor is unable to perceive the value of ergonomics as relevant to themself, the *Ergonomics Real Design Exhibition* would not be successful in advancing public engagement. Such an acknowledgement affirms, not for the first time within this thesis, the importance of designers being able to evidence the motivational engagement or impact of their decision-making and the effect that this has on their users' internalisation of their design.

It is of limited motivational benefit to assume that by placing an artefact, or a series of artefacts as exemplar case studies of ergonomics, will make the value of ergonomics self-evident to a visitor to the museum. As Vargo and Lusch's (2004) theory of Service-Dominant Logic, and the question of unconscious versus conscious influences on motivation discussed earlier in this chapter highlights, the process of motivating individuals with the value of ergonomics is an active one and one that to

be most effective should be considered as part of an on-going process of conversational engagement and phenomenological experience. This stance is perhaps contrary to more deterministic, interpretative and expert-designer led approaches reminiscent of realist approaches to design and curation. These perspectives would argue that value of ergonomics in everyday life, in the case of *Ergonomics Real Design Exhibition*, is inherent within the objects themselves and the information accompanying them.

This polarisation poses designers with a dilemma: do you design your exhibition to assert a universal or expert-led truth to visitors to the exhibition, or do you engage visitors in the process of defining that truth for themselves, in the process perhaps redefining the concept of truth for all parties. Section 2.7 contains further discussion of the differences between expert-led and participatory-led approaches to design, specifically in terms of how they relate to designing for motivation and engagement.

A meta-motivational evaluation of the *Ergonomics Real Design Exhibition*, detailed in Chapters 3 and 4, will explore some of these claims and proposes a methodology and future research agenda to support further design research and reflection upon the value of designing for motivation. This is offered to help elucidate the differences in motivational engagement between the

polarised approaches outlined above; the distinction between, and potential integration of co-deterministic as opposed to self-deterministic design methodologies.
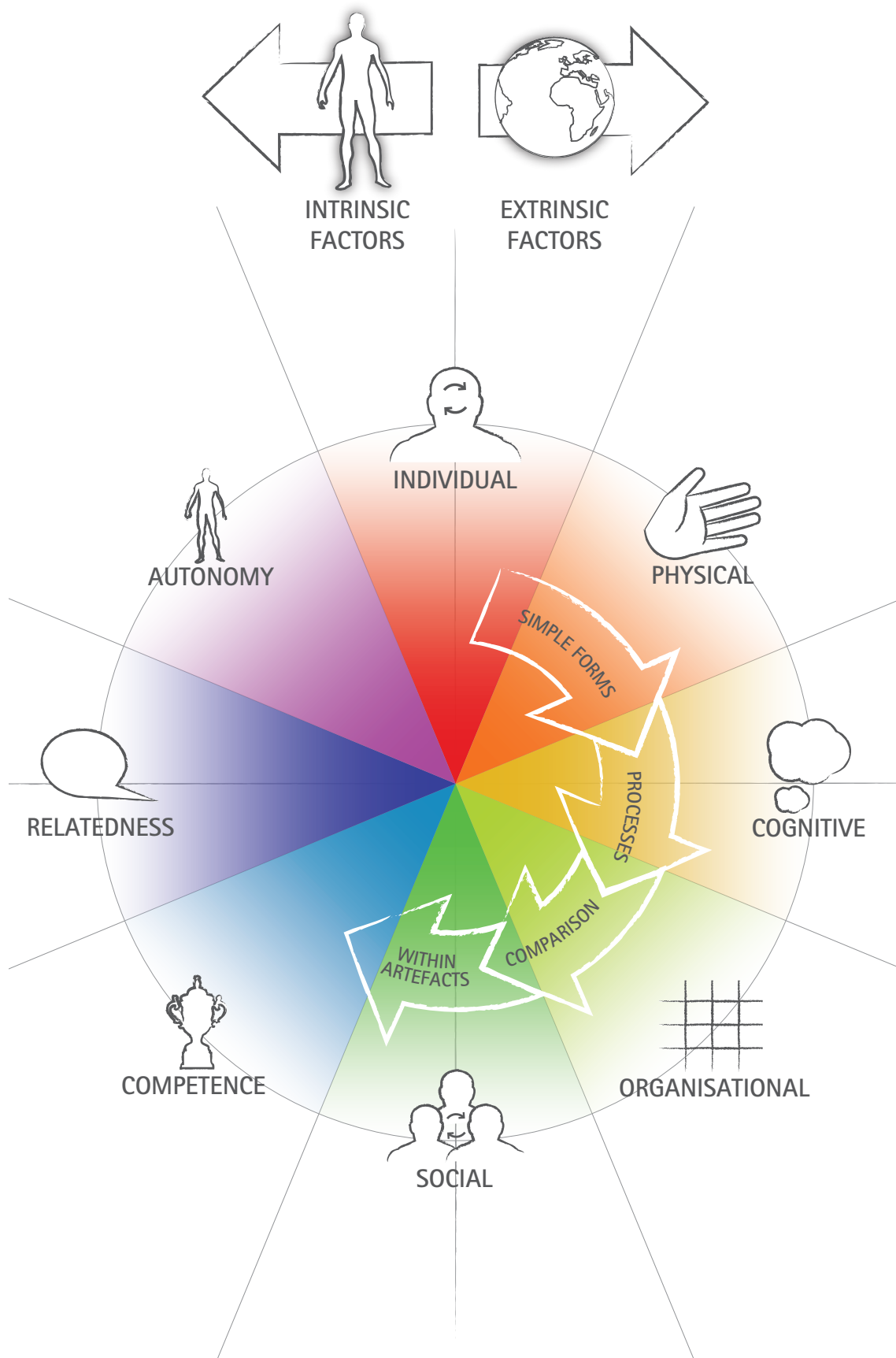
FIG. 20 SYNTHESIS OF RUST'S (2000) KNOWLEDGE TRANSFER THROUGH ARTEFACTS

2.6.8 MOTIVATION AS THE DEVELOPMENT OF SKILLED BEHAVIOUR; A CONCEPTUAL MODEL OF MOTIVATION FOR DESIGN?

Motivational design can be linked to skill development and other praxiological forms of designed enquiry (Cross, 1999). Skill is the implicit development of otherwise explicit behavioural rules, norms, processes or patterns of behaviour; the process by which an actor performs within the environment without conscious behaviour (Rasmussen et al, 1994). Skilled behaviour can thus be considered autonomous behavioural engagement; the search for greater autonomy having been identified earlier in this chapter as a key source of intrinsic motivation. Humans, in the process of conducting everyday interactions with the world around them, are engaged with a constant process of motivating and demotivating themselves to ensure homeostasis as a result of achievement of goals or need-oriented objectives. In contemplating the myriad decisions and regulatory processes this demands of an individual, or indeed the demands of a designer wishing to support that individual, it is clear that supporting motivational development is incredibly complex.

The emergence of increasing complexity within design research, along with the growth of cognitive systems approaches to design in recent years, has arguably belittled the importance of, and distracted designers from, focussing on the influence or importance of the physical design or the physical components of such systems in supporting regulation of behaviour. The physical component of human experience is the foundation upon which others are based, and is therefore inseparable from other less tangible forms of design such as interaction design, service design and social design. The focus on physical components of design can be seen in the sub-disciplines of human factors and ergonomics itself, specifically in the study of anthropometry and physical human factors. These subsets of ergonomics seek to explore and organise the design of physical and sensory experience as a primary and fundamental stage in the design of sociotechnical systems. As Rust et al's (2000) Knowledge Transfer Through Artefacts Framework (fig.20) indicates it is only through such simple forms that it

becomes possible to abstract more complex patterns of behaviour and interaction. This line of argument is also supported by that of the earlier cited Suchman's evolution of the focus of the social sciences (in Segelstrom, 2009) which affirms that more gradual transition within social scientific disciplines away from a focus on the physical and the physical mediation of information and knowledge. An richer exploration of this transition and the concept of knowledge transfer more generally is therefore developed in the following section, to explore what the implications of this transition are for designers interested in designing to support the motivational engagement and autonomous empowerment and behaviour of their users.

Ergonomics Real Design Case Study Reflection 23

As the earlier explorations of physical literacy and skill development in this literature review affirm, the first step to successfully designing for motivation is ensuring that the design is physically accessible and that users are able to interact with it autonomously. In the context of the *Ergonomics Real Design Exhibition*, or the design of any other sociotechnical system, considerations should be given to the physical and sensory components of engagement and the contributions these make to the effective phenomenological and higher order processing or learning of participants.
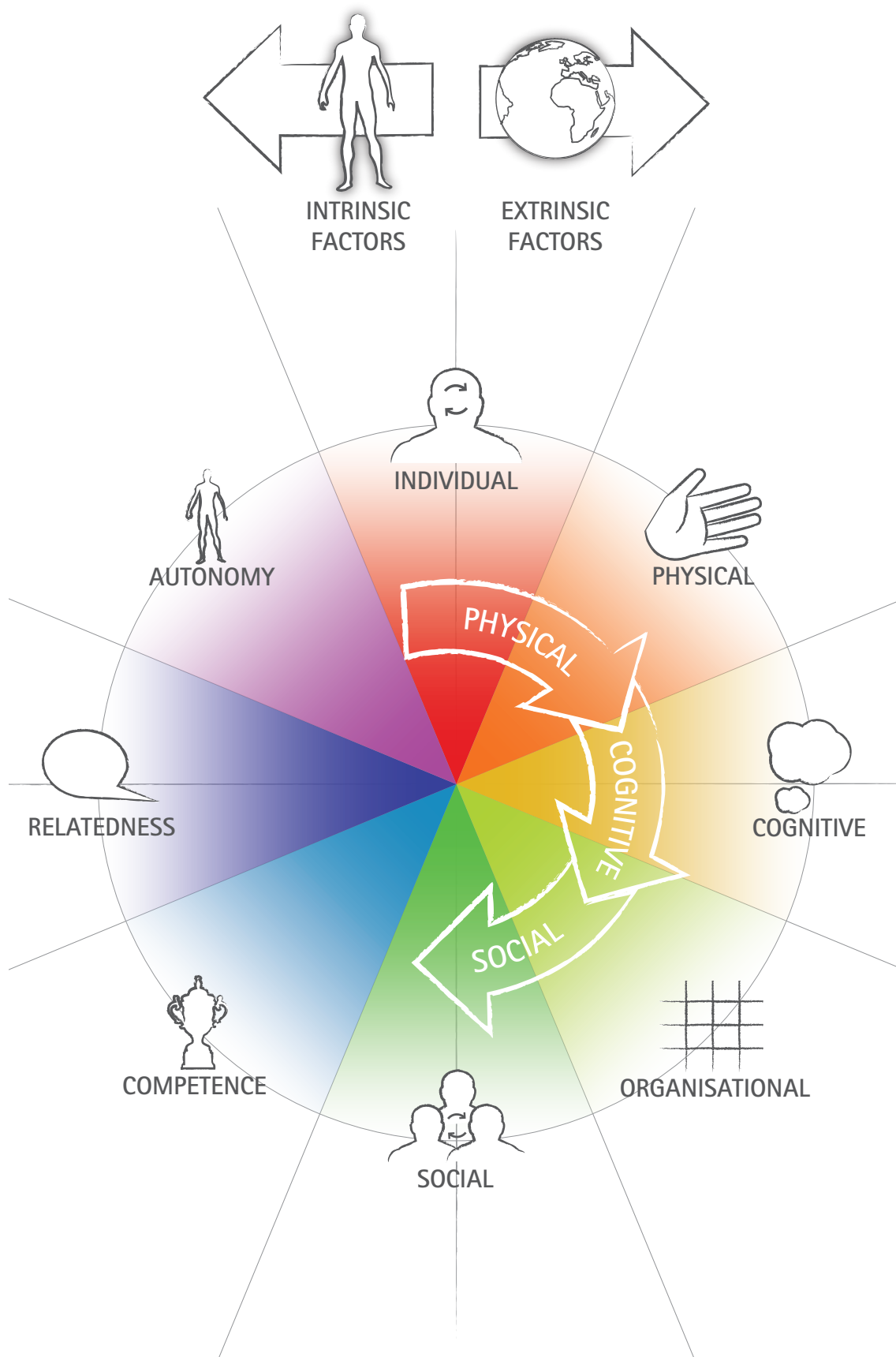
FIG. 21 SYNTHESIS OF SUCHMAN'S EVOLUTION OF THE FOCUS OF THE SOCIAL SCIENCES ARTICULATED IN SEGELSTRÖM ET AL, (2009).

2.6.9 MOTIVATIONAL ENGAGEMENT AS THE PROCESS OF ELICITING KNOWLEDGE AND UNDERSTANDING FROM ARTEFACTS AND SYSTEMS; A CONCEPTUAL MODEL OF MOTIVATION FOR DESIGN?

Knowledge may be found in or through physical artefacts; therefore, the way that knowledge is contained in artefacts occurs as a result of interaction, conscious or subconscious responses to artefacts that exceed the user's existing physiological, perceptual or cognitive thresholds (Rust et al, 2000, see fig. 20). Exceeding a threshold challenges the way an individual organises and structures their knowledge and patterns of interaction in relation to that artefact, or in the construction of their behavioural schema of that artefact.

An example of the impact that the formulation of a behavioural schema such as this might have on motivation can be found in considering the process of locating the power switch for an electronic device. A user might explore each of the possible buttons on the device, physically interacting with them one by one until they had determined the correct button by trial and error. Through this process of developing ad-hoc rules or heuristics from their physical interaction with each button, the user constructs knowledge.

Construction of knowledge in this manner would require that the user had the physical capability, the skill, to press the buttons in question and the ability to form a schema by remembering the rules that emerge from such sensory exploration and action. Each step of the trial and error process involves some degree of visualisation, followed by a step in the TOTE model routine discussed earlier in this thesis; this transition from expectation to action and back to expectation is the process of motivational self-regulation, no matter whether the expectation or anticipation phase of the process is positive or negative.

A designer might in this example be able to fast track sensory exploration through manipulation of sensory affordances such as colouring the power button, perhaps specifying a different colour such as red or green, or by printing or embossing a familiar power logo or icon onto the button. The user, by recognising the rules associated with such an icon or colour from previous interactions with electronic devices or by the increased sensory awareness that the colour of the button elicits would be able to know through semiotic representation, which button is the power button and thus effectively bypass the trial and error, sensory exploration phase.

Rust et al (2000, p.30) classify such processes of transferring knowledge and understanding through artefacts as follows:

"Knowledge Transfer through:

SIMPLE FORMS - An artefact demonstrates or describes a principle or technique. For example only containing one button, the power button.

PROCESSES – Artefacts arising from a process make the process explicit, this can include models of processes or indications of the underlying transition between states that occur as part of a process. By indicating through, for example, a glowing button or status light whether or not the power is on or off, the process of powering on and off the device will be assisted. Such an affordance will also support decision making about whether or not it is necessary to power the device on or off in the first place, based on assessment of the power indicator in relation to any wider environmental affordances such as, in the case of a torch, the onset of darkness.

COMPARISON – Artefacts are instrumental in advancing research by communicating ideas or information. Giving people a range of different power buttons and evaluating

which of the artefacts and buttons are easiest for people to operate or use most easily – if the user in question is seeking to evaluate the usability of the buttons.

WITHIN ARTEFACTS – Artefacts provide a stimulus or context that enables information to be uncovered. Perhaps, continuing the example, the artefact could inform the user of how quickly they located the power button, thus informing them more specifically of the quickest or more reliable way of powering up the device. In relation to the previous diagram this would help classify the efficiency and reliability of the rules and knowledge that people form around their use of artefacts and their interaction with sociotechnical systems."

When viewed using the Motivational Design Framework, the respective influence of each of these modes of artefact driven engagement and knowledge transfer can be hypothesised. At its simplest, such a synthetic inquiry concludes that designers seeking to influence engagement in a direct and personal manner, would be best placed by resorting to the use of simple forms whilst those seeking to provoke deeper understanding, reflection and conversation or social-relatedness around the artefacts in question might be better placed in adopting a process led or comparative exhibits of the artefacts. Designers seeking to ensure social interaction and consensus through artefacts would have to design or assemble the artefacts to provide knowledge transfer and feedback within the exhibit of artefacts themselves, perhaps as a response to user interaction and engagement.

Ergonomics Real Design Case Study Reflection 24

In relation to the *Ergonomics Real Design Exhibition*, these theories of knowledge transfer and skill acquisition highlight the role within the exhibition environment of simple forms, comparison of artefacts, communication of processes and the comparison of processes and the

INTRINSIC FACTORS

EXTRINSIC FACTORS

INDIVIDUAL

AUTONOMY

PHYSICAL

THE PHENOMENOLOGICAL

CONVERSATION FOR ACTION

THE PRAGMATIC

RELATEDNESS

COGNITIVE

THE RATIONAL

CONVERSATION FOR POSSIBILITY

COMPETENCE

ORGANISATIONAL

SOCIAL
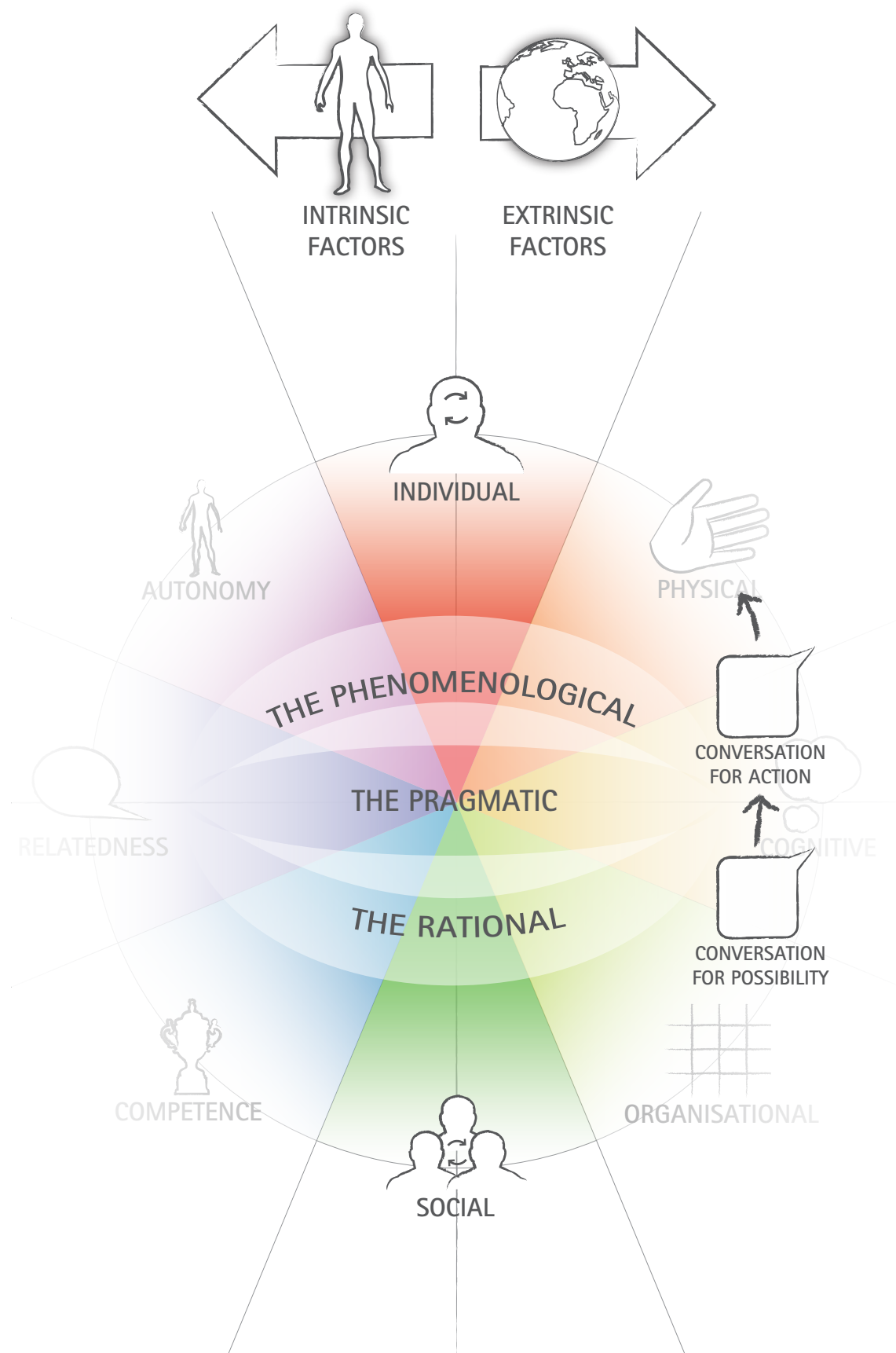
FIG. 22 SYNTHESIS OF JONES & DUBBERLY'S TYPES OF EXPERIENCE (2010)

importance, to knowledge transfer and motivational regulation, of feedback.

The ability to classify such rules in formally articulated knowledge structures and layers of abstraction also helps individuals to effectively share and communicate, in other words, socially mediate, the knowledge elicited by artefacts.

Ergonomics Real Design Case Study Reflection 25

In the context of a public engagement exhibition, the phenomenon of social mediation highlights the significance of not just the artefacts that are being exhibited but also the way those artefacts are grouped, organised and classified.

Social mediation will more readily occur if the designer has considered the role it plays in helping people engage with the artefacts in question. Social mediation, building on Rust et al's (2000) classification, can be considered the highest order by which individuals might test or affirm the way in which they structure their knowledge and interaction with the artefacts in question, otherwise known as social learning (Bull et al, 2008).

2.6.10 PHENOMENOLOGICAL APPROACHES TO DESIGN RESEARCH AND PRACTICE; A CONCEPTUAL MODEL OF MOTIVATION FOR DESIGN?

The distinction of the modes of knowledge transfer and the multi-faceted view of artefact driven engagement presented is further affirmed, within the literature, by the classification of design research offered by Frayling (1993) and Cross (1999). Artefact driven engagement such as this, typical of most museum environments, is considered within the context of established design research as phenomenological inquiry, less concerned with affording the user an insight or understanding of a broader psychological construct, than allowing them to form their own interpretation of the value or meaning of the artefact itself.

Rust et al's (2000) classifications also highlight the recent transition of focus in the social sciences from inquiry of physical function and orientation of artefacts, through to inquiry into cognitive function and orientation, to yet further, its current innovative focus exploring the social context of use (Suchman, 1993; Grudin, 1990 cited in Segelström et al, 2009). Segelström proposes that designers should also focus on motivational engagement and energisation.

The foundational approach designers can adopt to instigate users' motivated behaviour intrinsically is to do so through manipulation of physical and sensory affordances, that in turn encourage users to interact with products in an intrinsically motivated manner "with the energy and inquisitiveness reminiscent of an infant at play" (White, 1959).

Ergonomics Real Design Case Study Reflection 26

In relation to the question of how this framework could support greater, and conscious, motivation of visitors to an exhibition, the above conceptualisation of how artefacts can engage individuals and the classification of the different forms that this can take sits in interesting parallel to the fundamental tenets of motivation and motivational processes discussed above. These highlight the importance of the users' phenomenological and basic interaction with the exhibition as being fundamental to their successful engagement with it.

The clear mapping of physical, cognitive and social factors and their impact on, and within, motivational psychology, design practice and design research further supports the suggestion that designers can play an influential role in directing and regulating motivation. It is proposed that the Motivational Design Framework is a synthesis of the reviewed literature and offers a lens through which designers can consider the literature. In this way it can help designers conceptualise the means by which they might greater motivate and engage their users in a generative, but evidence informed manner.

Ergonomics Real Design Case Study Reflection 27

This motive benchmarking approach, facilitated by the Motivational Design Framework, allowed the curatorial team to highlight and rationalise whether or not the motive behind the design of the artefact was in fact ergonomic. The framework allowed for greater integrity and authenticity than might have been the case had the curatorial decision-making been purely deterministic and at the discretion of the lead curator, an approach that would not have lived up to the participatory ideals discussed earlier in this literature review.

A more pragmatic approach to exhibit identification and selection was also a strong likelihood in the case of a collaborative project such as the Ergonomics: Real Design Partnership where some team members did not have an expert understanding of ergonomics. The Motivational Design Framework provided a means of assessing the validity of the exhibits against the core values of ergonomics but also with reference to the intrinsic dimension of the model; it provided the designers with a number of perspectives from which to consider the manner users might engage with and internalise the value of ergonomics, be motivated and energised to engage with them.

The Motivational Design Framework supports a phenomenological interpretative approach signified by physical autonomy (first tier of the framework). It encourages designers to consider the social-relatedness and cognitive feedback processes that

are, or that a designer might speculatively anticipate as being associated with the project the designer is instigating.

The Motivational Design Framework also helps designers consider the epistemological and competence-oriented processes, the second-order, regulatory processes symbolised in the third tier of the framework. These second-order processes it is argued, represent the conscious element of the motivation required by a user's repeated and sustained engagement with a product, system or service in question. It is consideration of this latter tier of the Motivational Design Framework of organisational, management led and social aspects of design, insofar as they support or should be heeded by designers consciously attempting to influence the motivation. It is to an investigation of the role of these emergent management-led and social approaches to design and their impact on motivation of users that this literature review now turns its focus.

2.7 THE RELATIONSHIP OF MOTIVATION TO DESIGN PRACTICE

The earlier sections of this literature review explored the role of designed artefacts in shaping phenomenological experience. The review, and the accompanying conceptual synthesis in the form of a Motivational Design Framework, explored at a broad level of abstraction the role that designers can play in engaging and motivating people, specifically referencing the role of artefacts as knowledge transfer objects in the development of a public engagement with science exhibition and the foundational role of physical experience in shaping and directing motivational engagement of users. The impact of designed artefacts in motivating and energising human behaviour was discussed, along with the role of designers in aiding the construction of mental schema throughout the sensory exploration and skill acquisition process and the role of motivation in regulating this. The role of artefacts in providing the foundations for phenomenological and sensory interpretation and subsequently higher order cognitive feedback, social learning and user-engagement as users interact with products, system and services, was also explored.

This literature is now evaluated in relation to changes within design research and practice that have seen a shift away from investigation and manipulation of purely physical forms, towards more interactive, social and competence-oriented forms

of design. The role of design to support motivation in this broader sense, and the implications for designers from other disciplines such as instructional design and interaction design is considered.

Cognitive and organisational human factors, second-order cybernetic systems, are explored in relation to designing for motivation. They are juxtaposed with the basic drivers of human intrinsic motivation: the needs of relatedness, competence and autonomy (Deci and Ryan, 1985; 2000; Reeve, Deci and Ryan; 2004). Designers are increasingly addressing intangible forms of design, such as the design of services; they are therefore increasingly aware of the need to consider measurement of intangible sources of value within the design and use of their products, systems and services (Krippendorff, 2004). Greater consideration and understanding of intrinsic sources of motivation, or implicit motivational drivers, represent an important area of influence and consideration within the design process (Ferguson et al, 2008).

This chapter explores the significance of social relatedness and participatory approaches to design and their relationship with an individual's sense of competence; the implications of this for design approaches to consciously motivate interest, interaction and appreciation of products, systems and services are discussed.

2.7.1 TRANSITIONING DESIGN: FROM PHYSICAL ARTEFACTS TO EMPOWERING SELF−REGULATING ECO−SYSTEMS; FACTORS TO BE CONSIDERED BY DESIGNERS DESIGNING WITH A MOTIVATIONAL INTENT?

The shifting focus of design from products to services has led to the role of the designer transitioning from designing purely tangible products and user-experiences to intangible services and information systems (Young, 2008). These transitions present challenges and have resulted in a number of questions about the role and responsibilities of the designer in designing to support motivated and engaged behaviour as they design increasingly intangible product-service eco systems.

Inspired by the Scandinavian participatory design approaches of the 1970s (Ehn, 1988; Holmlid, 2009), faced with increasing complexity as they become involved in some of society's most intractable challenges such as social care, education and environmental design or redesign, designers have enthusiastically embraced co-creative and transformative approaches (Burns et al, 2006). The literature reviewed presents a clear evidence base for the relationship of physical interaction and motivation in the form of self-regulatory and reflective processes adopted by humans in sensory exploration and phenomenological experience.

What follows, an examination of the human behaviour that social motivation and motivational systems research considers, leads to clear implications for designers who adopt a less deterministic interpretation of user capability in their design processes. Designers' attitudes can be conceptualised on a spectrum. At one end are those who perceive that all engagement can and should be designed, the expert-led deterministic viewpoint. At the other, those that perceive in the face of complexity and social challenges in the implementation and use of design, the focus should be on equipping individuals with the resilience, skills and competencies to face such complexity themselves, the participatory perspective.
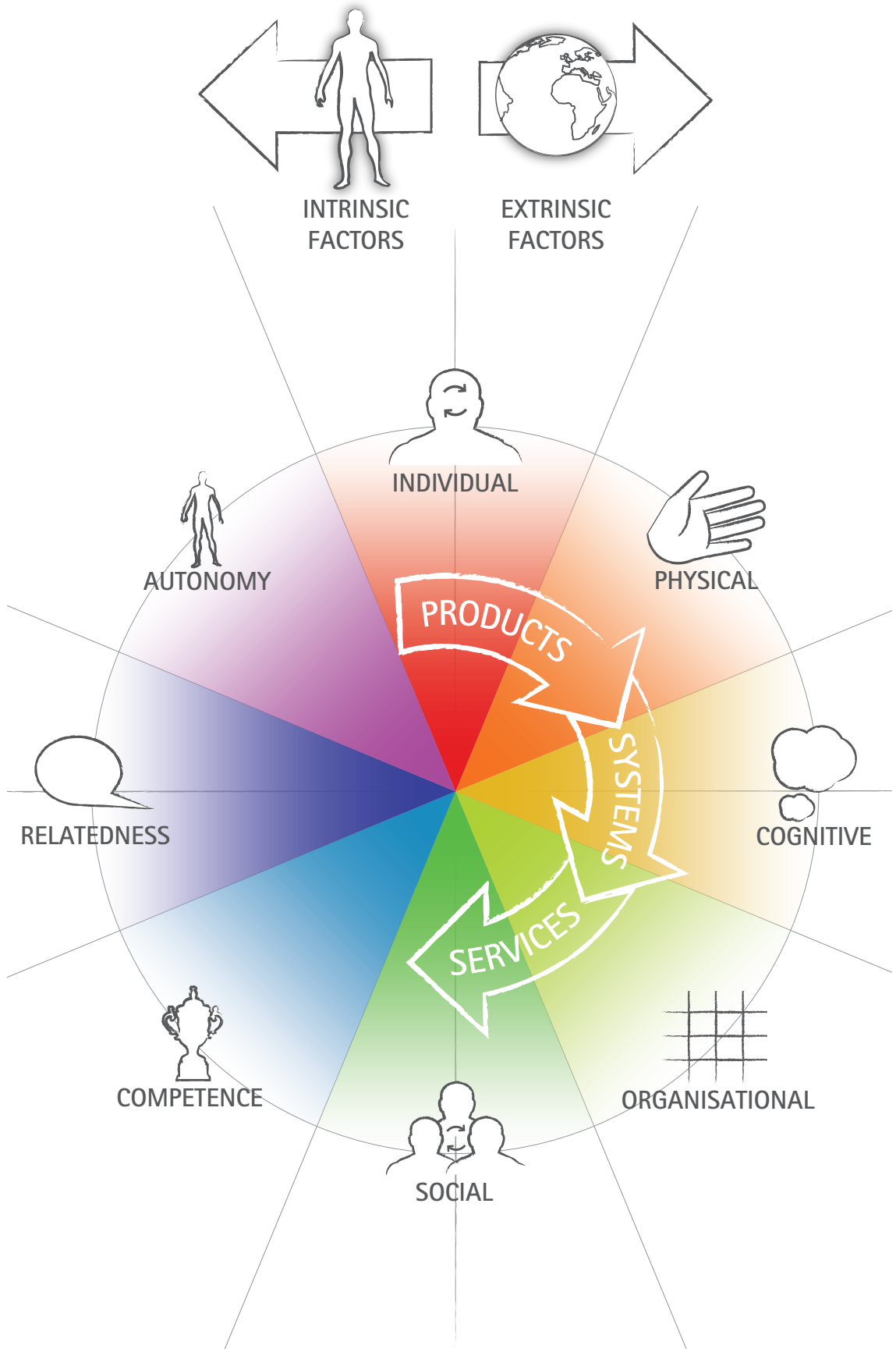
FIG. 23 THE TRANSITION FROM PRODUCTS TO SERVICES FROM (YOUNG, 2008)

The participatory perspective seeks to capitalise on the skills, competencies and experience of users in informing the design specification, to ensure more saleable products or more democratic design. As discussed in the previous chapter in reviewing individualistic motivational psychology literature, expert-led design versus co-creative and participatory design can be framed as two distinct design philosophies, of extrinsic control of users versus intrinsic empowerment of users.

Alongside considering the socialisation and democratisation of the design process; designers must also consider the increased technological complexity, intelligence and miniaturisation of consumer products. Considerations can be found in the disciplines of Interaction Design (Winograd 1986, 1994; Ehn and Löfgren, 1997; Holmlid, 2009), Cognitive Psychology (Norman, 1988), Usability Testing and Engineering (Nielsen, 1994) and the Lifecycle Perspective (Mayhew, 1999). The complexity of this overlapping landscape is simplified and summarised in fig. 24 (Sanders et al, 2008):

Ergonomics Real Design Case Study Reflection 28

Ergonomics is an expert-led design discipline, therefore it is apparent that encouraging people to engage with or participate in understanding the products and process of the applied scientific discipline of ergonomics, may be antithetical and inauthentic to the foundations and ethics of ergonomics itself (see Hancock and Diaz, 2002; Liu, 2003; Hignett and Wilson, 2004).

Ergonomics' expert and research led approach to design is representative of a technologically deterministic and extrinsically mediated approach to the design of products, systems and services. Consequently, to maintain authenticity to the discipline it sought to communicate

Expert Mindset

"users" seen as subjects
(reactive informers)

Research–Led

Design–Led

Human Factors
+ Ergonomics

Usability
Testing

Critical Design

Cultural
Probes

User–Centered
Design

Contexual
Inquiry

Design + Emotion

Applied
Ethnography

Lead–User
Innovation

Participatory
Design

"Scandinavian"
Methods

Motivational
Design

Generative
Tools

Generative
Design Research

Participatory Mindset

"users" seen as partners
(active co–creators)

FIG. 24   THE LANDSCAPE OF DESIGN RESEARCH (SANDERS ET AL, 2008)

and engage the public with, the *Ergonomics Real Design Exhibition* was inherently expert-led and extrinsically mediatory in its view of motivation and in its mindset and approach to engagement. This was combined with the fact that The Design Museum, a key partner and host of the exhibition, itself tends to adopt a Gestaltsist, non-didactic approach to exhibition design as opposed a clear linear narrative or epistemological approach to the design and curation of its exhibitions (Cross, 1996). Given these differences in approach, philosophical orientation and precedents there were inevitable limits to the extent to which the exhibition could be genuinely participatory or social in its orientation.

The Motivational Design Framework, as illustrated in fig. 21, can help designers to conceptualise the myriad possible starting points of individual project partners and to synthesise the philosophical limits of their respective skill sets within collaborative projects. Identifying and accepting such starting points and limitations within the design process could ensure more straightforward collaboration between partners with disparate views, experiences and attitudes to empowerment and motivation. Such observations, whilst straightforward in their implication and potentially self evident for many designers, can be considered prerequisites to ensuring successful and sustainably motivating social and participatory design approaches. In many respects, utilising the Motivational Design Framework in this manner simply deals with the issue of approach and avoidance motivation on a broader more holistic level than the personal, individualised level in which it was discussed previously in this thesis.

Every organisation or wider stakeholder group within the design process has their own objectives, goals and prior experiences that make designing to support motivation a challenge, at an individual, organisational and social level. Competence as a motivational construct is similarly scalable in its manifestation within the design process; it can be utilised by designers as a mechanism to support consideration or reference to the individual competence orientation of a given user or stakeholder, or it can be used to support designers to consider and address the much broader motivational and socio-cultural concept of organisational competence and professional practice.

Ergonomics Real Design Case Study Reflection 29

The Motivational Design Framework was assembled to support reflections on the challenges, and opportunities to add value, within the design and development of the *Ergonomics Real Design Exhibition*. The framework supports these reflections by providing a common language and conceptualisation of the motivational components to be considered. It presents an opportunity to take a balanced approach to identify which aspects of the design challenge lie within the design team, or users' locus of control, which lie within the locus of control of other project partners, and/or which lie outwith the control of the design team completely. This understanding enables the design team to remain motivated and focussed on the elements of the design that they can actually address.

The framework was developed in part as a response to some of the challenges faced within the Ergonomics

Real Design project, most of which were the result of institutional philosophies and organisational perspectives beyond the control or influence of individual project team members. That said, it could equally well be a prompt for focusing on competencies within the design team.

2.7.2 THE ROLE OF SELF-REFLECTION IN SUSTAINING MOTIVATION; FACTORS TO BE CONSIDERED BY DESIGNERS DESIGNING WITH A MOTIVATIONAL INTENT?

One approach to considering the role of motivation within the design and the use of a product, system or service is to consider the tasks that require motivational energy of their participants as separate from other task or capability demands imposed upon them by the broader environment. Self-reflection on the part of users is one way in which in a participatory design process users might be encouraged to consider the motivational impact of the design upon their behaviour or understanding. Consequently, design for motivation might be consistent with the process of affording individuals more capacity within their use of products, systems and services to reflect on their personal aims, efforts and achievements. This self-determinist participatory proposition stands in contrast to the generalised industrial era conception of designers, which adopted a simple, generalised model of the user and their capabilities (Dunne, 1999).

Ergonomics Real Design Case Study Reflection 30

Self-reflection in the development of the *Ergonomics Real Design Exhibition* would have involved affording users and project stakeholders the opportunity to identify the defining principles and characteristics of Ergonomics as a discipline. An even more pragmatic co-creative and participatory perspective would involve engaging visitors to the Museum, and professional ergonomists, to reflect upon what they consider to be the principles and characteristics of ergonomics.

This brings the literature review full circle on itself and back to the conclusions from the opening sections of this chapter that underlined the importance, in public

engagement, of understanding where your audience is starting from. This may be considered an established procedure within all forms of design and public engagement, talking to your client or customer. However, what this review of motivational psychology literature has revealed, certainly with respect to the parallel, case based analysis of the Ergonomics Real Design Project that accompanied it, is that the processes by which those conversations can influence users' motivations are inherently complex and in some cases even paradoxical.

A conscious design intent is required to ensure insights generated from early conversations with one's users can be synthesised and visualised by designers to ensure that the design developed, a public engagement exhibition in this case, effectively motivates or where appropriate demotivates its users. This will be addressed in the next sub-section of this literature review. This literature review has also ascertained the significance of conversations and self-reflective feedback and the role they play in assisting designers to ensure motivating design. They should enable designers to understand how best to facilitate discrepancy reduction or discrepancy creation in a participatory and socially mediated manner, it being these discrepancies either positive or negative and either physical, cognitive, organisational or social, that generate engagement and the regulation of motivation. Effectively utilising and harnessing information gained from feedback and self-reflective loops in

users' behaviour across this schema, could furnish designers with insights to ensure that users can interact autonomously with the designed experience.

Designers can play a significant role in consciously motivating and engaging their end users and enabling those users to participate in a more social approach to engagement and knowledge and skill acquisition, by adhering to objectives of empowering self-reflection through enabling effective autonomous interaction. In the case of the *Ergonomics Real Design Exhibition* this meant using conversations with key stakeholders to understand what discrepancies occurred in their understanding of Ergonomics, in turn, motivating members of the public, design students and ergonomics practitioners to engage and self regulate their understanding with the applied scientific discipline of ergonomics by comparison with their prior conceptions and experience.

Designers can be inspired by the philosophical and inherently empowering participatory perspective that is now adopted by many in the fields of social design and service design. These approaches encourage and facilitate users self-reflection and exploration of the phenomenological aspects of their experience of using and interacting with products, systems and services in order that they might elect, and more effectively regulate, which products, systems, and social affordances are important to them within the experience.

Further discussion of these approaches is found in Schon's (1983) The Reflective Practitioner. Schon recommends privileging the feedback loop as the key mechanism,

not only of understanding the world around us, but through which evolution occurs. Such notions can also be observed as integral to the fields of Cognitive Psychology and Cybernetics that explore the rational principles and self and system schemas at the heart of socio-technological systems. These fields of research attempt to elucidate the rules that govern and regulate sociotechnical systems and the human behaviour, motivation or amotivation they elicit.
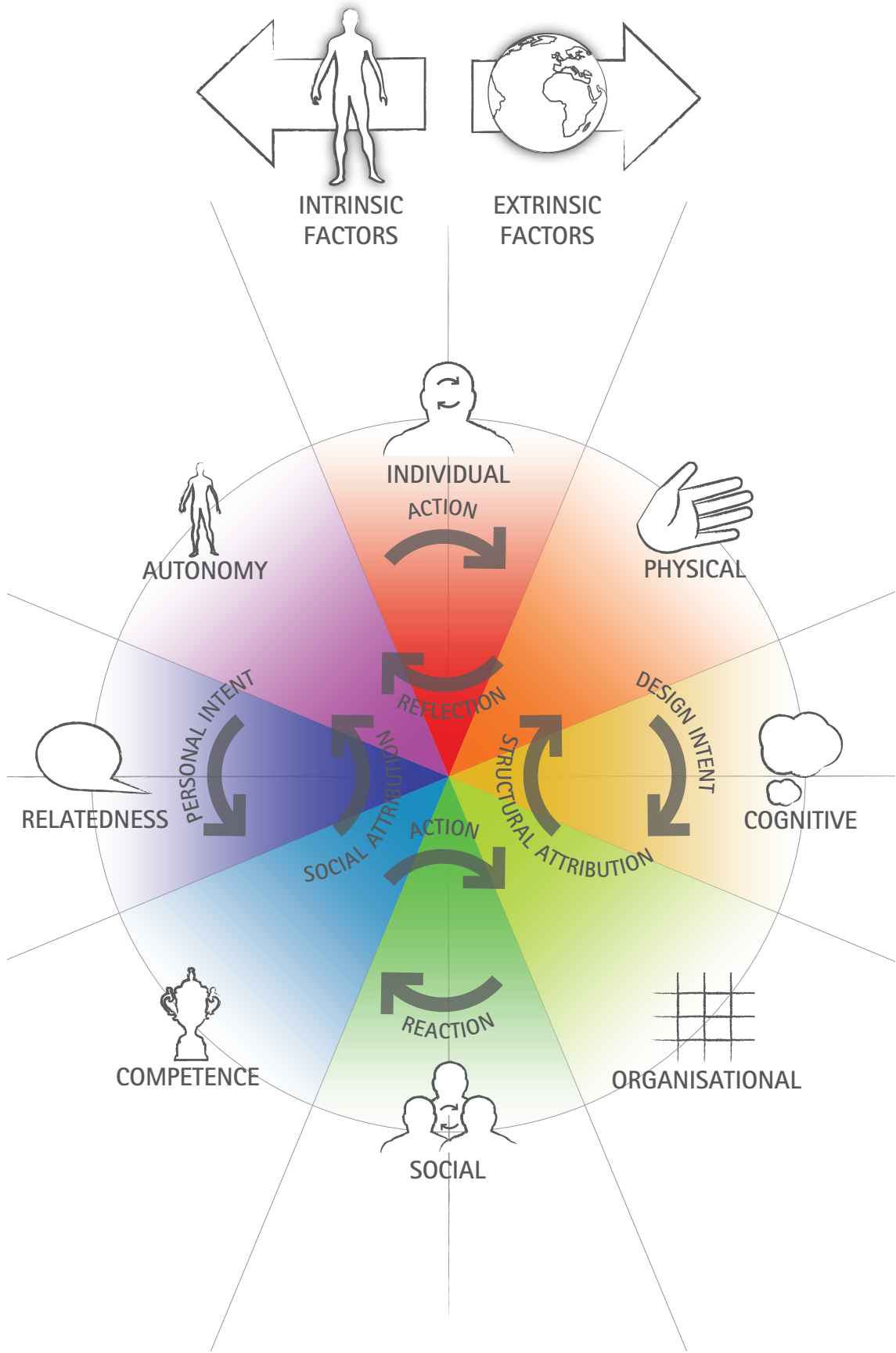
FIG. 25 MODEL OF THE INTERACTION OF INTRINSIC MOTIVES AND EXTRINSIC AFFORDANCES INSPIRED BY SCHON'S REFLECTIVE PRACTIONER (1983)

Ergonomics Real Design Case Study Reflection 31

The concept of feedback can explain or hypothesise the foundational motive or philosophy behind the *Ergonomics Real Design Exhibition*; to address the claim that most people only notice ergonomics when it is missing or when it goes wrong (Young and Haslam, 2008). Citing examples such as rail crashes and bad product usability it was the belief of key project stakeholders that people were generally motivated to invest in, and see the value that ergonomics provides, only when an event (or feedback) had occurred that had otherwise demonstrated existing deficiencies in the design of a product, system or service.

This argument suggests that the usual motive for investing in ergonomics was when human interaction with sociotechnical systems occurred that was inconsistent with safety regulations or conditions acceptable for human health and safety. It has been argued elsewhere in this thesis that discrepancies of perception and reality, such as in this case the discrepancies of perception of the value of ergonomics and the reality of the value of ergonomics, are prime influencers of motivation and motivated or demotivated behaviour. Therefore the greater challenge to the *Ergonomics Real Design* team, and ergonomists themselves more generally, is how to provide feedback of the benefits of ergonomics to visitors to the exhibition.

First and second order cybernetic systems may well be useful constructs for designers to consider and utilise as tools to better understand how users rationalise and regulate discrepancies, and in turn to ascertain how to anticipate these processes as the experience scales with increased participation and social interaction.

Ergonomics Real Design Case Study Reflection 31

With respect to the *Ergonomics Real Design Exhibition* the notion of first and second order systems can be used to distinguish between the two levels of design of the exhibition. First order systems can be considered analogous to the physical design of the exhibition, and the role of the designer in physically supporting individuals to engage with the exhibits and to phenomenologically interpret them and their own role within those systems or broader environment.

Second-order systems refer to the role of the designer in supporting the competency of the individual to discern something of the value of ergonomics from this process, either by relating it to their own prior experience or to the experience of others. From a motivational perspective, these personal and social factors can be considered analogous to the innate autonomic, social relatedness and competence oriented needs explored earlier (Deci and Ryan, 1985; 2000; Reeve, Deci and Ryan, 2004).

For first and second order systems to be useful in ensuring motivation and engagement with ergonomics, would require the designers of the *Ergonomics Real Design*

Exhibition to structure the exhibition design as a series of learning goals, or to relate the value of ergonomics in terms of how it supports fulfilment of user-needs (Carver and Scheier, 1982; 1990; 1998). This systems approach also demands designers consider the three layers of physical, cognitive and social interaction and reflection that users will engage in as they experience the exhibition, its exhibits and its surrounding environment.

In this context, an individual's motivation to engage with ergonomics can be assessed in terms of the extent to which they perceive they have gained new insight or understanding from the experience. How they articulate this perception can therefore serve as some indication of their growth and acquisition of a revised or new understanding of ergonomics.

It is suggested that the more closely designed artefacts support our intrinsic needs as humans for autonomy, relatedness and competence, the more motivated we will be to use them.

Ergonomics Real Design Case Study Reflection 32

Therefore in relation to the *Ergonomics Real Design Exhibition*, the more directly ergonomics can be presented as a science and professional discipline that increases humans' ability to develop autonomy, alongside developing their individual sense of self-competence, the more motivating it will be as an exhibition. Such an assertion needs to acknowledge the existing level of

perception that people have of ergonomics and present this new, theoretically more motivating perspective, to them in a manner that supports their engaging with it and subsequent development of a new or revised understanding.

The development of a motivational design philosophy has much in common with the established fields of instructional design and theories of skill development and knowledge transfer. The following section explores existing models of skill acquisition, learning and behavioural change that support designers' conceptualisation of motivation. This was conducted with a view to supporting designers to more consciously influence and direct their users' motivation and translate conversational or behavioural expressions into tangibly engaging experiences. Models of human factors, instructional design, skill acquisition, learning and motivation are all synthesised and incorporated into the development of the Motivational Design Framework.

2.8 DESIGN FOR MOTIVATION AND ENGAGEMENT AS DESIGN TO SUPPORT LEARNING

The social cognitive perspective to design considers motivation explicitly within the design process, placing a particular focus on competence and socially oriented drivers of intrinsic motivation to develop and regulate learning and users' creativity (Zimmerman and Kitsantas, 2005). Cybernetics and cognitive systems approaches to visualising design processes were suggested to support designers to conceptualise and visualise the motivational impact of these processes. This section concludes the review of literature and relates it to the pragmatic means by which designers can visualise, implement and evaluate a motivational approach to the design of products, systems and services and ensure that users engage and learn from such active experiences.

2.8.1 MOTIVATIONAL DESIGN AS A PROCESS OF INSTRUCTIONAL OR PEDAGOGICAL DESIGN; FACTORS TO BE CONSIDERED BY DESIGNERS DESIGNING WITH A MOTIVATIONAL INTENT?

Without the possibility for learning, that is to say our desire to become more autonomous, competent, or increase our social relatedness, our experience as users of products, systems and services will be sterile and lifeless; put another way, the experience will not be motivating or fun and our desire or ability to continue to interact with said products, systems and services will become untenable or unsustainable as our motivation to engage degenerates (Deterding, 2009). This is consistent with the principles of organismic growth (Deci and Ryan, 1985; 2000; Ford, 1993; Fromm, 2003; Troncon, 2010) otherwise expounded up to this point in this literature review.

It is also acknowledged that motivation is multi-dimensional; which is to say, it does not just have direction (toward and away from something) but it has intensity, for example, the velocity with which an individual approaches or avoids interaction with a designed system (Reeve, 2008). These two dimensions of intensity must be considered as part of a consideration of motivation and engagement within design, alongside the notion of persistence. Persistence being how readily an individual will return to something, having initially been repelled by it, or the opposite, how quickly individuals will lose interest in something that previously they had been drawn towards.

The lack of a defined process by which to systematically visualise or model users' existing perceptions and motivational engagement with the design of a given subject matter, product, system or service, presents a considerable barrier to the development and implementation of a philosophy of motivational design, particularly one that can conceptualise persistence or intensity of engagement and motivation. This is a particularly complex barrier given the review of the literature has hitherto ascertained such motivational regulation consists of a vast array of first and second order

regulatory processes, that constitute and contribute to the motivational energisation exhibited or perceived as users anticipate, interact with, and reflect upon their use of products, systems and services.

Each of the phases of the process of self-regulated learning have different value, or utility and result in differing levels of motivational energisation within the design process. These phases also map readily to similarly structured approaches to design, particularly generative approaches highlighted by Finke (1996) and Oxman (2006).

2.8.2 MODELLING SKILL ACQUISITION, MOTIVATION AND PHILOSOPHIES OF DELIBERATE PRACTICE; FACTORS TO BE CONSIDERED BY DESIGNERS DESIGNING WITH A MOTIVATIONAL INTENT?

A number of ways to visualise and reflect upon the pragmatic and temporal means of assessing or valuing the role of motivation within the design process have been explored. Conceptual modelling was used to convert the complexity of the motivational psychology literature into a more accessible and applicable tool for designers. As Love (2000, p.295) notes:

> "All aspects of research into design involve conceptual abstraction and symbolic representation... Abstractions and representations are fundamentally grounded in human values (Guba, 1990; Kitchener & Brenner, 1990), metaphors (Altschuller, 1984; Coyne, 1990), or conceptual frameworks (Nideau, 1991)".

2.8.2.1 MODELS OF PERSONAL, PHYSICAL, COGNITIVE AND SOCIAL ENGAGEMENT IN A LEARNING CONTEXT

The ways in which it is possible to engage people or, to adopt a self-determined and generative design perspective, for people to engage themselves in the process of learning, is broad in scope. Bisset and Lockton (2010) explored a three-stage conceptualisation of how users are motivated to interact with complex systems and services. This, building on earlier work by Lockton (2010), develops three stereotyped ideas of users as Pinball Users, Shortcut Users or Thoughtful Users, the latter heavily substantiated with reference to the work of Ford (1992).

These models of users, or user personas, can be positioned on a spectrum from passive or disengaged at one end, to pro-actively engaged and self-reflective at another, with the thoughtful user seeking out active engagement with an experience. This model begins to afford designers the ability to conceptualise how individuals might hypothetically internalise and engage with the artefacts, systems and services that they design, at any stage of the design process or throughout the product or service lifecycle. These are illustrated in relation to the Motivational Design Framework in fig. 26.

At the very least, this model allows designers to consider and generatively respond to how users might simplistically internalise facets of the experience that designers create for their users. Whilst highly reductive, this model views the user's motivational energisation and behaviour as proactive and malleable, something that this literature review identified more conventional industrial-era conceptions of users and user behaviour are less accomplished in supporting and communicating.
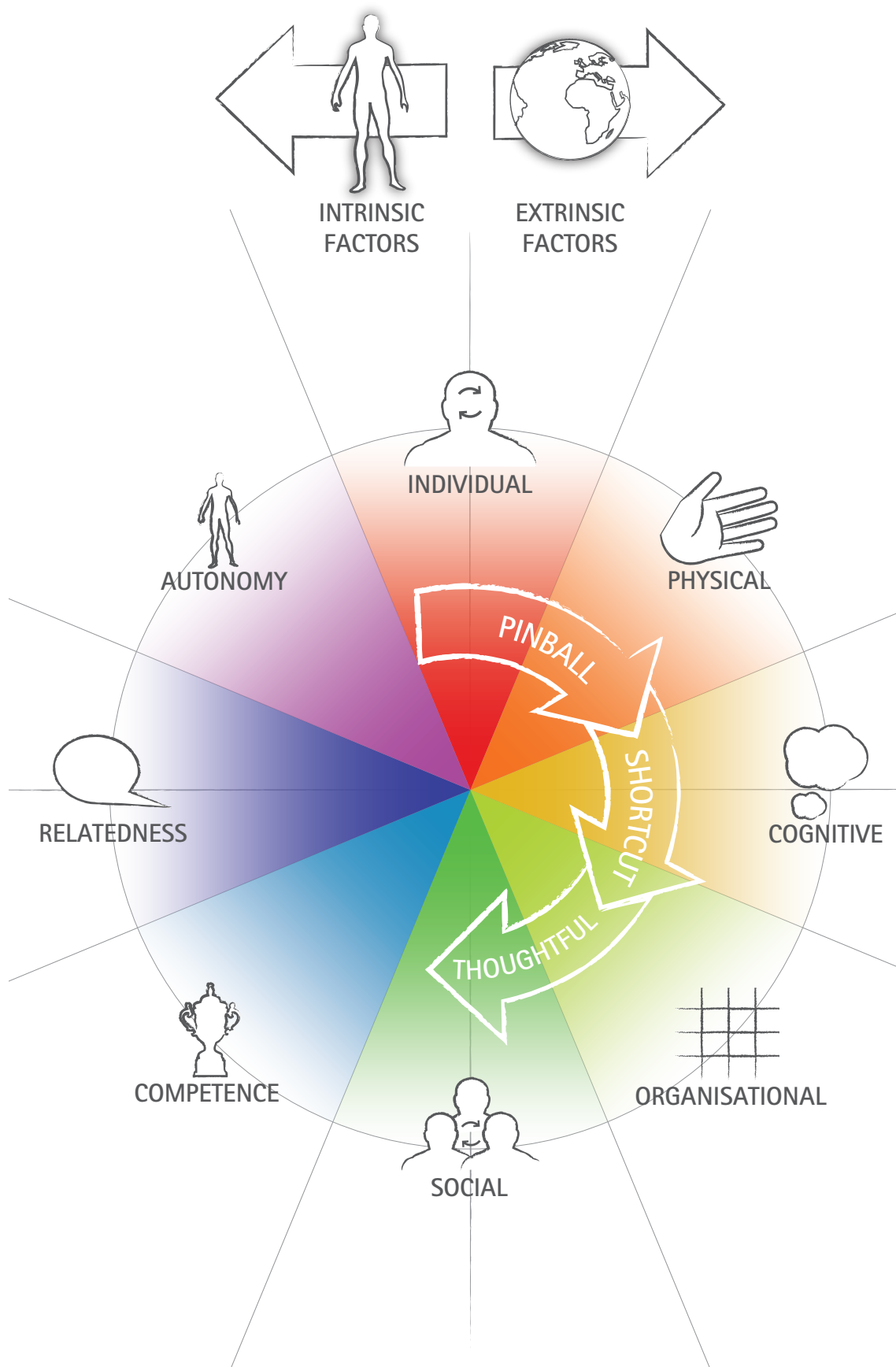
FIG. 26 PINBALL, SHORTCUT AND THOUGHTFUL USER MODEL FROM BISSET AND LOCKTON (2010)

Ludic engagement, a fundamental facet of human learning and development, has been formulated as a set of design patterns to help designers more clearly anticipate and accommodate the behaviour of their users (Lockton, 2010). The notion of play and creativity as a source of user motivation within the design and use of products, systems and services has been discussed previously in this literature review, but is returned to here for its apparent pertinence to the design of engaging and motivating learning experiences. A ludic pattern language suggests that to engage people with tasks, or for a designer to successfully promote user engagement with objects or artefacts, there are many possible approaches depending on the organisational or personal outcomes that form the priority of the designer. Lockton's exploration is not constructed deterministically, rather it is intended to aid designers initiate the process of engagement. This will in turn aid designers to better motivate people by encouraging themselves to reflect on the behaviour a specific design will elicit from its users as early in the design process as possible (Bisset and Lockton, 2010).

The Motivational Design Framework when juxtaposed against Lockton's three-stage conceptualisation of the possible users of a system (fig. 26), bears resemblance to Casey's (2003) interpretation of five key personas that designers and museum curators can broadly expect to engage in the course of a public exhibition.

INTRINSIC
FACTORS

EXTRINSIC
FACTORS

INDIVIDUAL

AUTONOMY

PHYSICAL

AWARENESS

RELEVANCE

RELATEDNESS

CONFIDENCE

SATISFACTION

COMPETENCE

ORGANISATI

SOCIAL
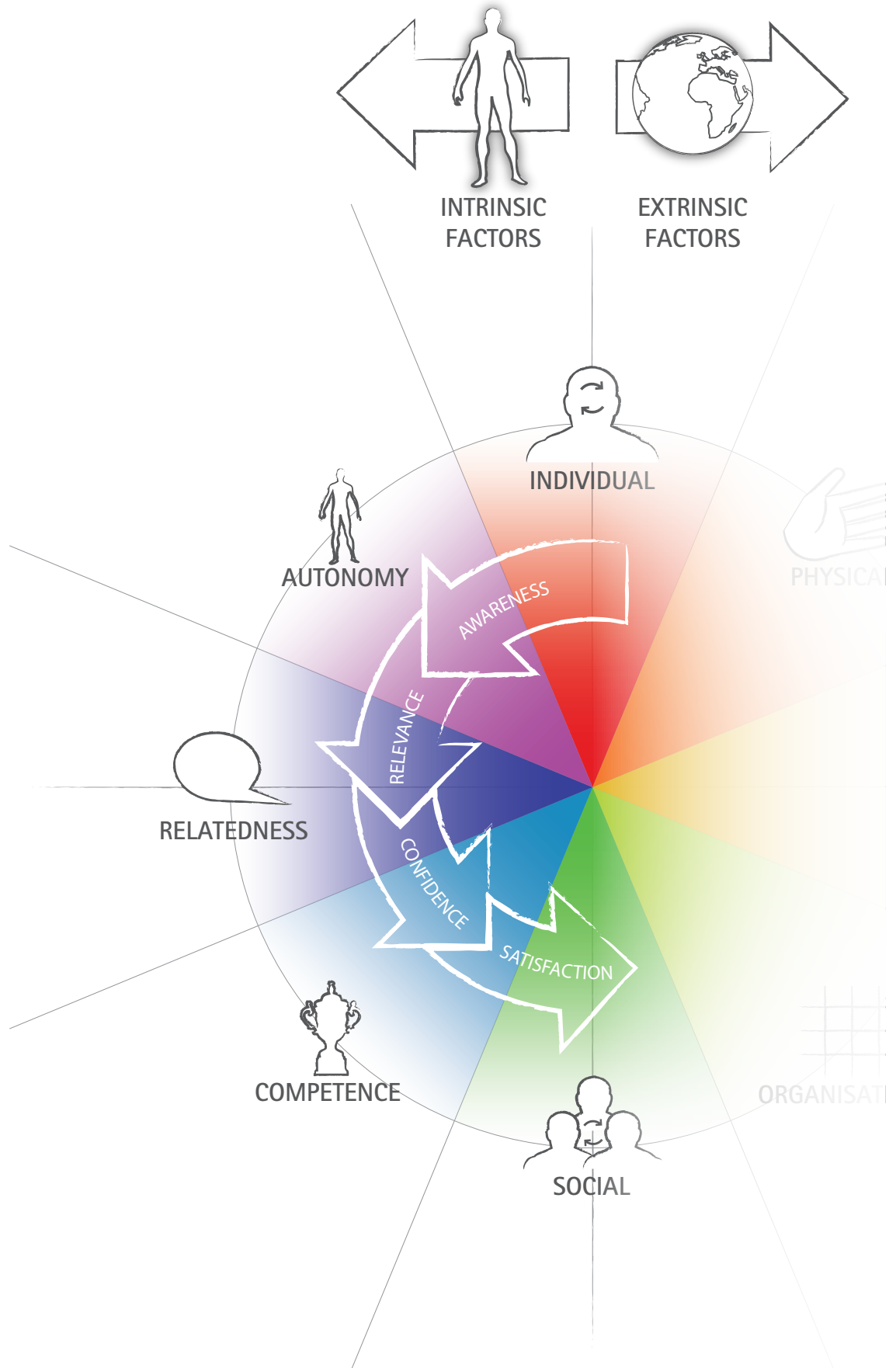
FIG. 27 MODEL OF THE KELLER'S (1983) ARCS MODEL IN JUXTAPOSITION WITH THE
MOTIVATIONAL DESIGN FRAMEWORK

2.8.2.2 ENGAGEMENT AND ARCS MOTIVATIONAL DESIGN FRAMEWORK

Another alternative model to support designers in taking a generative, structured but open approach to conceptualising and visualising their users' motivational engagement with the design process is the ARCS Model (Keller, 1983; Arnone 2005). The ARCS model is an approach to motivational design that has been used to underpin the didactic and educational content and evaluation of public engagement initiatives including children's television programmes (Arnone, 2005).

In the context of designing to engage people with educational or instructional objectives, ARCS works by transitioning them from awareness of the issue, through perceived personal relevance, to confidence in assessing and articulating the need or values of the subject matter in hand, culminating with their satisfaction at, and in some augmented models, reflection upon one's personal advocacy within the engagement activity. The ARCS acronym comes from each of these distinct phases in the engagement process: awareness, relevance, confidence and satisfaction. ARCS classifications are looser, less prescriptive and more easily applicable to a greater range of products, processes and facets of human behaviour. There is also greater synergy of motivational processes and influences, exemplified within the synthesis of the Motivational Design Framework across the individual stages of the ARCS Model (fig. 27).

Awareness in the ARCS model is referring to sensory and/or cognitive perceptual awareness; relevance is another way of referring to the patterns of rule based behaviour that cybernetic models of human behaviour suggest humans form in the process of structuring their knowledge of their environment. Consolidation or repeated testing of such rules leads to what ARCS refers to as the Confidence and Satisfaction phases, that determine a human's ease of interaction and motivational self-regulation within a sociotechnical system. When juxtaposed against the Motivational Design

Framework and discussed in comparison to Lockton's Framework highlighted in the previous section, Keller's framework suggests that awareness of users occurs much earlier in the interaction and engagement process than the 'pinball' construct of Lockton supposes. Keller's conception therefore appears to argue for a more active notion or representation of the user with the engagement process.

With reference to the schema theories discussed in section 2.4, *awareness* and *relevance* relate to schema acquisition, confidence and satisfaction to the internalisation of schema in concordance with the individual's self schema, a process Deci and Ryan (2004) refer to as introjected regulation of an environmental affordance or of a socio-behavioural heuristic see (fig. 15).

Ergonomics Real Design Case Study Reflection 33

The ARCS model suggests an engagement strategy that directs users to internalise the goals and values of an exhibition. The *Ergonomics Real Design Exhibition* would, when prototyped or evaluated in accordance with the skill and motivational progression directed by ARCS, aim to increase users' awareness and perceptions of the personal relevance of ergonomics to them. It would also harness the motivational energies associated with perceived concordances and discrepancies between a visitor's existing and emergent perceptions of ergonomics. An ARCS engagement and motivational design and evaluation strategy would demand a clear understanding of the audience's existing understanding of ergonomics, and what it is reasonable for them to acquire by way of understanding, throughout the engagement process.

Whether artefacts and contexts were presented in accordance, or discordance, with the visitor's existing self-schema and perceptual awareness determines whether the form of motivation energised by the designer is one of approach or avoidance (Elliot, 2007). The differing impact of an approach or avoidance motivational strategy is complex and an area that would warrant further investigation in relation to design for motivation and exhibition design. That said, it is clear that amotivational approaches will ensure greater short-term engagement but less sustainable long-term motivation or engagement with a task (Carver and Scheier, 1982; 1990). As discussed above, Carver (2004) highlights the individual affective response associated with amotivational or motivational approaches to the design of products, systems or services. These differences of response will impose upon users' sense of satisfaction as part of the ARCS evaluation process and will impact upon whether users leave an exhibition feeling concerned or calm in the case of an avoidance approach to engagement, or feeling enthusiastic or frustrated in the case of an approach, or goal-oriented exhibition design strategy (Carver, 2004). These responses clearly represent the polarised ends of the spectrum, but the ARCS model attempts to conceptualise and support assessment of engagement, ensuring internalisation or the degree of knowledge transfer that may have occurred as a visitor interacts with a designed product, system or service.

Ergonomics Real Design Case Study Reflection 32

Within the Ergonomics Real Design project awareness is associated with the stage at which designers meet visitors in the exhibition. Building on Dubberly and Jones' (2010) model of conversation, the awareness and relevance exhibition phases represent the conversation for consensus phase of the motivational process, the latter two stages of an ARCS process represent the conversation for action phase.

What is implicit in this model is the transition from exploratory processes of awareness of ergonomics and its definition, through to consolidatory processes of engagement, from awareness and engagement to confidence and satisfaction. These tangible modes of engagement reassure people of their personal interpretation, their physical literacy of ergonomics, as well as their newly acquired, interpretation or their established knowledge and understanding of the contexts and methods of application of ergonomics. An exhibition designed in this way should provoke questions and exploration of ergonomics, while also seeking to answer such questions and define a variety of paths to enable visitors to pursue such exploration and internalisation of ergonomics in a manner they feel comfortable with.

When viewed in relation to the Motivational Design Framework, the ARCS model is inherently an approach that encourages the designer to internalise the question of what transformative effect the design will have on the intended user at all stages of the design development. Whilst challenging, particularly in terms of measurement and validation, this approach goes further than the other models of engagement discussed here, in ensuring that the design is as intrinsically motivating as possible.

Ergonomics Real Design Case Study Reflection 33

The *Ergonomics Real Design Exhibition* identified ARCS as a suitable model through which to structure the empirical assessment of the level of motivational

engagement of visitors. If it had been utilised earlier, as the defining conceptual approach to the design and layout of the exhibition, it is likely that the engagement data would have been a more valuable measure or test of the hypothesis behind the development of the ARCS model itself; that [public] engagement [with science] is more effective if it seeks to make personally relevant the work of scientists to the audience. Due to pragmatic constraints in the conceptual design and development of Ergonomics Real Design it was only possible to test the outcomes of the exhibition using this model; the design of the exhibition took a more organic, and less structured approach, to communicating ergonomics and engaging the public with science.

This latter notion of ARCS being most conducive to supporting intrinsic motivation and many of the inferences within the models of design, behavioural change and skill development discussed in this section, supporting designers in conceptualising the challenge that the Engineering and Physical Science Research Council (EPSRC) warn those participating in Public Engagement with Science projects to be particularly mindful of, specifically, to '…not assume that your public wish to learn about what you have to tell them…'. Put another way, and when viewed from a Motivational Design perspective, designers should not assume that motivation is inherent as a component or as an outcome of a particular designed intervention, but as has been argued elsewhere in this thesis, something that has to be consciously considered, visualised, and this thesis argues, generated within the design process. Motivation, this literature review opened by supposing, was something that most designers never consciously sought to influence, or if they did seek to, did so by utilising industrial–era 'carrot and stick approaches' to considering, visualising and evaluating motivation (Pink,

2010). The ARCS Model as a framework for design, and design research represents a way of designers being able to focus their energies on designing to support and regulate user's internalisation and intrinsic drivers of behaviour.

2.8.3 SUMMARY AND SYNTHESIS OF THE LITERATURE REVIEW; FORMULATION OF THE RESEARCH QUESTIONS AND EMPIRICAL ASSESSMENT OF THIS THESIS

It is intended that the extensive and expansive review of the literature contained in this chapter might readily support designers to appreciate and develop their own understanding and breadth of influence in being able to consciously direct and influence users' motivation. The initial research objectives of this thesis investigate what conceptual frameworks can be used to design and develop a motivating public engagement exhibition in a museum environment, what constitutes human motivation and the role it plays in design, and finally, what factors need to be considered, or processes adopted by designers intending to consciously influence the motivation of their users? The literature review also explored how such motivational factors can be implemented and measured by designers, as well as considering a number of structured approaches pertinent for designers keen to adopt a more motivational design philosophy. Following this review a number of the facets of these separate research areas were deemed pertinent to further empirical investigation through synthesis and integration with the design process adopted as part of the *Ergonomics Real Design Exhibition.*

This thesis will seek to expand and validate some of the key conclusions of the literature review in relation to work conducted and data gathered in conjunction with the *Ergonomics Real Design Exhibition.* This builds on the case-based reflective study that supported this literature review, with a view to presenting and critically evaluating a range of techniques adopted throughout the concept development, design implementation and concept evaluation phases of the Ergonomic Real Design project, in terms of their impact and utility for designers in motivating and engaging user behaviour. Specifically the research questions to be detailed and in some cases empirically assessed in the following chapters of this thesis are:

RQ1: The degree to which conversation and dialogue are tools designers can use to ensure the motivational design and engagement of their users interacting with a given product, system or service?

This question is founded in the earlier research reviewed in section 2.2 that highlighted the importance of dialogue in helping develop individual conceptions of conscious or unconscious skill development. As such learning and skill development has been argued as similar to the process of intrinsic motivation, it seems rational to investigate how, on a number of levels conversation can support designers to both generate motivational insights about their users, but also generatively integrate these insights within the design concept to ensure greater motivational engagement of their users, through, as the literature highlighted as important, ensuring that their designs meet users' existing expectations and accommodate their current levels of understanding and motivational engagement. Put succinctly, this could be considered the contribution of this thesis in exploring how conversation can be adopted and utilised by designers to highlight areas of positive and negative motivational discrepancy around which the engagement of their product, system or service can be constructed.

RQ2: To what extent is the design process conducive to ensuring, or capable of being adapted to ensure the motivational and generative engagement of the resultant product, system or service?

Related to the initial research question highlighted previously, this research question seeks to explore the process of design and specifically the process of designing a public engagement with science exhibition in a museum context to elicit the motivational engagement of users and empower them as skilled participants and contributors within the design process. This question will explore, through a series of case-based reflections and through documenting the design process from an applied museum exhibition design project a series of practice based reflections on the process

of supporting users motivational engagement, skill acquisition and learning. This will be done by profiling a number of approaches to 2d and 3d conceptual and physical modelling undertaken by the design team to engage various participants and stakeholders in the design process and to secure the donation and curation of a range of exhibits to populate the exhibition. The visualisations adopted on this project as part of this modelling process were integral to the design and development of the exhibition, but in addressing this research question, this thesis will also record a number of reflections on how these visualisations were both generated from initial end-user engagement and may have impacted on the overall engagement and learning of visitors to the exhibition itself.

RQ3: What value can be derived by designers from measuring the motivational engagement of visitors to a museum exhibition? It will reflect on the process of measuring such engagement for what it can tell designers about the design and structure of exhibitions or other context-driven multi-user, multi-touchpoint service experiences.

The results of answering each of these three research questions and their corollary follow-up questions will elicit a number of recommendations for future research and design practice.

3. METHODOLOGY

Following the review of the public engagement with science, museum design, motivational psychology and design research literature it is possible to identify a number of assumptions about how designers can take account of motivation within the design of products, systems, services, and in the case of the case-based and empirical analysis of this thesis, exhibitions. The case study reported throughout this thesis is used as a resource and designed context in which to test some of the researched assumptions that arose from the literature reviewed. The findings from this case study, alongside the model developed in response to the review of the literature, the Motivational Design Framework, addresses the second and third research objectives. The first research objective is specific to the design challenge in engaging human behaviour and motivation within an exhibition or museum environment, in response to a public engagement with science brief.

3.1 CHOOSING THE RESEARCH DESIGN

A case study approach was considered appropriate to facilitate reflection upon the author's experiences as researcher and member of the *Ergonomics Real Design Exhibition.* These reflections support the aims of this thesis to provide insights into the role of designers in influencing the role of motivation in design. Case study methodology enables further insight into the findings from the literature about the approaches designers can use to positively influence the motivation of users of the products, systems and services they develop, and the philosophical and ethical questions of a designer's practice that this provokes. Using a case study approach supported and enabled a reflective approach to researching and evaluating the motivational impact and implications of the design decisions made as part of the *Ergonomics Real Design Exhibition* Project design and development process.

A case based reflection on the *Ergonomics Real Design Exhibition*, a multi-stakeholder, multi-touchpoint user experience, enabled a representation and articulation of the implications for design research. The exhibition was a designed experience, instigated as a form of public service announcement on behalf of the applied scientific discipline of ergonomics. Hosted within an established museum environment, it represents a relevant, controlled environment in which to conduct a subjective and empirical assessment of the role of motivation within design, and the role of designers in directing and informing design. It builds on the work of Casey (2003) who conducted design research within the museum environment. The parallels between designing to support public engagement with science within a museum environment and the challenges associated with designing, or conducting design research to evaluate public engagement within other contexts are related. By adopting an action-research oriented perspective and relating the observations to the experience of designing to support public engagement with science as part of the *Ergonomics Real Design Exhibition*, this research discussed the implications for design practitioners and researchers interested in engaging and motivating end users and wider project stakeholders.

3.2 CASE STUDY METHODOLOGY

A case study approach was considered the most appropriate methodology to use. It was deemed particularly useful for pragmatic reasons, including the role of the researcher as a designer and member of the *Ergonomics Real Design Exhibition* team. Yin states that case studies are useful when: "A how or why question is being asked about a contemporary set of events over which the investigator has little or no control" (1994, p.9).

A case study methodology was an ideal choice as little prior research had taken place into the role of motivation in design and this research sought to build on extensive literature and theory from other disciplines. Using the case study method enabled an exploration and reflection upon the process of designing the exhibition, rather than simply focusing upon reflection of the motivational implications of the completed end product. This approach is in keeping with case studies being considered well suited to the discovery of new information, not simply confirming existing knowledge. Eisenhardt (1989 cited in Rowley, 2002, p.16) states that case studies are:

> "Particularly well suited to new research areas or research areas for which existing theory seems inadequate. This type of work is highly complementary to incremental theory building from normal science research. The former is useful in early stages of research on a topic or

when a fresh perspective is needed, whilst the latter is useful in later stages of knowledge (pp.548-549)".

Using a case study approach allowed for analysis of the data collected to explore two areas: 1) an extensive examination of the role of motivation in design with reference to existing literature, alongside 2) an in-depth exploration of the role motivation plays within the development of the *Ergonomics Real Design Exhibition*, a specific case example. The case study sets out the challenges faced by the design team in reconciling and addressing the role of motivation and engagement in the design of the exhibition. To support the relevance and greater contextualisation of the literature for design practitioners and designer researchers, insights and reflections have been illustrated in the series of yellow standout boxes throughout the literature review.

These case based reflections were recorded simultaneously to the process of reviewing the museum design, public engagement with science and motivational psychology literature. Reviewing the literature resulted in the proposition of a framework to support designers in consciously influencing the motivation and engagement of the users of their products, systems and services, the Motivational Design Framework. Its development aided critical reflection upon the literature and will support wider critical reflection on the work contained in the discussion.

The exhibition case study was used to test the assumptions outlined above that emerged from the literature review. These assumptions were tested through three elements of the exhibition:

> Contextual research conducted prior to the exhibition's design, see section 3.3.
> Concept development that uses the information gathered in the contextual research, alongside the literature, to prototype approaches for the exhibition, see section 3.4.
> Concept evaluation that examined the motivational impact of the design of the exhibition on two discrete samples of visitors, see section 3.5.

3.3 CONTEXTUAL RESEARCH

The contextual research phase sought to examine the role that engaging end-users, through conversations in an early phase of the design development, plays in creating a motivational experience for them. A range of research methods were utilised in this stage, each of which are reported below. The literature review identified the role that discrepancy can play in motivating users, and the importance of starting where your users are, that is eliminating discrepancy at the earliest stages of a user's interaction with a product, system or service. The contextual research sought to examine this further in relation to design practice, through semi-structured interviews, unstructured interviews and the use of tag cloud analysis.

The contextual research phase, documented in the first phase of empirical data gathered, sought to examine the utility of conversational processes being integrated within the design process. Their role in supporting designers to design to deliberately reconcile or exacerbate discrepancy is examined.

Data during the contextual research phase was collected in parallel to the early stages of design development of the *Ergonomics Real Design Exhibition*. This enabled a baseline of public engagement with ergonomics to be established to support the wider exhibition evaluation. In terms of this research it also enabled assumptions about

user involvement in design to be explored, their levels of motivational engagement. This work, completed with colleagues from the *Ergonomics Real Design Exhibition* team, has been the subject of a number of published papers, see Young et al (2010a, 2010b) however, this analysis of the data from those studies is unique to this thesis.

The wider baseline study reported in Young et al (2010a, 2010b) sought to assess an individual's baseline understanding of the term ergonomic and their understanding of the applications of ergonomics. The research reported in this thesis uses the same data, but analyses it uniquely, considering the motivational ramifications of this baseline from a discrepancy motivation perspective.

3.3.1 SEMI-STRUCTURED INTERVIEWS WITH PUBLIC VISITORS TO THE DESIGN MUSEUM

Semi-structured interviews were conducted with a representative sample of public visitors to the venue of the planned exhibition, The Design Museum in London, interviewed in the same context and at the same time of day, and of the year that the Ergonomics Real Design Exhibition would eventually be held. For these purposes the visitors to the design museum, represented the notion of members of the public at whom this public engagement exhibition would be targeted. These interviews ascertained visitors' existing perceptions of ergonomics, prior to the development of the exhibition. These perceptions were contrasted with an analysis of recent ergonomics literature defining and modelling ergonomics, see section 3.3.3. Semi-structured interviews were chosen to provide respondents with support to articulate their perceptions of ergonomics.

Data were collected to assess the baseline level of awareness of the role and value of ergonomics. It was also used to highlight any discrepancy in the value ergonomists claim ergonomics offers the general public and, as represented by these interviews, the Design Museum visitors' perceptions of that value. The review of the literature concluded that a motivational design approach seeks to exploit this discrepancy as a source of potential energisation of human behaviour, in this case the energy of the public to engage with the discipline of ergonomics.

Interviews were conducted on a Saturday afternoon in the café at the Design Museum. This approach was chosen to give a good cross section of public visitors to the museum, although it is acknowledged that school groups are not represented in the sample. Most visitors were happy to be interviewed by the researchers, so there is minimal concern about bias related to the selection of the sample (Grant and Williams, 2010).

A summary of the sample demographics is given in the following table:

Age bracket	Males	Females	Total
Under 18	-	-	-
18-25	1	-	1
26-35	3	2	5
36-45	-	1	1
46-55	1	1	2
56-65	1	1	2
Over 65	3	1	4
Unknown	-	1	1
Total	9	7	16

TABLE 1 – SEMI–STRUCTURED INTERVIEW RESPONDENTS – MEMBERS OF THE PUBLIC

The outlines for the questions to visitors to the museum (members of the public) were as follows:

1. What does ergonomics mean to you?

2. What are some examples of good or bad ergonomics?

3. In what context is ergonomics most important?

Many of the interviewees reported some kind of design experience, especially architecture. Most reported no particular experience of ergonomics.

3.3.2 UNSTRUCTURED INTERVIEWS WITH EXPERT ERGONOMISTS

Unstructured interviews were conducted with expert ergonomists later in the week of the semi-structured interviews. The data from these interviews were used in juxtaposition to those collected from the semi-structured interviews with public visitors. This process enabled a baseline of current perceptions of ergonomics to be established. It also enabled any degree of discrepancy between ergonomist perceptions and those of the public to be discerned. This approach was chosen to best energise engagement from both key user groups in the design process.

Unstructured interviews were chosen to enable the ergonomist respondents to retain control over the language and structure of their contribution. Unstructured interviews are considered an ideal method for developing theory rather than testing a hypothesis and for informing design and implementation (Patton, 1990). The unstructured conversational nature enabled the interviewer to build on the ergonomists responses and probe for further information when required. Unstructured interviews were also chosen as the method for experts as they are considered ideal for acquiring knowledge while retaining authenticity (Gubrium and Holstein, 2001).

This contextual research sought to establish how ergonomics was perceived by this sample of the professional Ergonomics community and to pinpoint discrepancies and consistencies, both within and between the responses of the individuals questioned, with purpose of generating creative and hypothetically motivating concepts and exhibits. In this instance the unstructured interviews had two intended areas of conversational focus:

1. Why ergonomists had chosen the career that they had?
2. How the expert ergonomists defined or described the value of ergonomics?
3. How the ergonomists explained their work to friends, family and non-ergonomists?

The researcher used a note card with reminders of the questions, as above, to ensure that interviews remained unstructured and his role and involvement was balanced and consistent across the interviews. Demographics of respondents are shown below:

Age bracket	Males	Females	Total
Under 18	-	-	-
18-25	-	1	1
26-35	-	-	-
36-45	1	1	2
46-55	1	-	1
56-65	3	-	-
Over 65	-	-	-
Unknown	-	-	-
Total	5	2	7

TABLE 2 – SEMI–STRUCTURED INTERVIEW RESPONDENTS – EXPERT ERGONOMISTS

The sample was an opportunistic cross-section of professional ergonomists, with a range of backgrounds, professional and academic experience. The sample was drawn from keynote speakers at the Ergonomics Society Student Conference 2008. They were approached initially by email in advance of the conference, with each participant being given further information about the purpose of the interviews prior to the start of the conversations.

3.3.3 TAG CLOUDS DEFINITIONS

The semi-structured and unstructured interview data contained a number of definitions of ergonomics. These were objectively benchmarked against a review of the UK Ergonomics and Human Factors literature that identified papers specifically addressing questions of the definition and contexts of application of ergonomics. Papers providing accessible models of the purpose of ergonomics or that discussed definitions were identified. A number of papers and models were published in the period 5–10 years prior to the contextual analysis. This period had seen the 50th anniversary of the foundation of the national bodies for Ergonomics and Human Factors in the UK and the USA. These papers were used, together with the contents of the previous three years of proceedings from the UK Ergonomics Society Annual Conference, and the contents listings of the Contemporary Ergonomics book series for the years 2008-2009.

A keyword analysis of these papers was conducted to form a tag cloud. This method is commonly used for summarising the content of websites and effective for quickly summarising large bodies of text based content (Kaser & Lemire, 2007). The methodology of creating the tag cloud involved copying the contents lists into TextStat (http://neon. niederlandistik.fu-berlin.de/textstat/), an open source concordance analysis software tool (Diniz, 2005; Wiechmann and Fuhs, 2006). TextStat analyses the frequency of words in a body of text, producing a list of the words with a numerical indication of their respective frequencies.

This data were input into the open access Wordle tag cloud engine (www.wordle.net) to help visualise the results. One of the key papers identified in the contextual review of the literature, Dempsey et al's (2000) taxonomy of ergonomics, was also visualised using Wordle. Wordle provides a quick and effective way to visualise and summarise the core concepts, context and definitions of ergonomics. It also enabled the themes

inherent within Dempsey et al's paper to be compared to those identified throughout the unstructured and semi-structured interviews.

Identification of themes using tag clouds and Wordle afforded the researcher, as it would designers conducting similar exercises, a visual means to identify discrepancies or consistencies inherent within the definition of ergonomics. When considered as part of a structured design process, this approach facilitates the consideration and anticipation of motivational energisation or hooks for engagement that designers need to consider when seeking to measurably support and anticipate public motivation and engagement with products, systems and services.

This thesis continues to document the structured design approach highlighting the process of concept development undertaken as part of the *Ergonomics Real Design Exhibition.* The methods behind this phase of conceptual development are detailed next.

3.4 CONCEPT DEVELOPMENT

This section reports on prototype models identified from the literature that were explored when designing to address the identified discrepancies and consistencies between perceptions of the value of ergonomics reported in the interviews introduced above. This section details the process used to translate the interview data into a range of synthetic design concepts supporting visualisation of the structure and interpretative approach of the exhibition itself.

Designing to consciously consider and provoke users' sense of consistency and discrepancy requires the interpretive design of the exhibition to start where the users are and progress towards a deliberate and enhanced understanding. This synthetic process was used as a designed approach to incrementally manage the levels of discrepancy identified between what the professional ergonomists determined as the definition of ergonomics and the prior level of understanding of ergonomics offered by the public visitors to the Design Museum.

3.4.1 ITERATIVE PROTOTYPE MODELLING

A designer faced with a large number of variables in the design process, in this case a number of discrepancies or synergies in the definition of what constitutes the value of ergonomics, needs to structure the available information to enable effective discussion; one such approach to this problem is the design process of prototype modelling (Goodwin, 2009).

Models of potential structures, together with an exhibition narrative, were constructed following the interviews and semantic analysis detailed earlier. These were designed to ensure the effective motivational design of the exhibition through identifying tangibly the areas where the public's definition of the value of ergonomics coincided with the views of the ergonomists (convergence) and where there was a discrepancy. This approach was crucial as design for effective and sustainable engagement relies on deliberate consideration of the role of discrepancy in the design process.

The prototype models, informed by the contextual data, presented the possibility of substantiating the narrative structure of the exhibition with contexts and conceptual synergies defined by those interviewed. The designers of an exhibition, equipped with the insights gathered from the conversational and analytic processes, could chose to define the narrative structure of the exhibition by forcing the juxtapositions or disparities of perception and conceptualisation confirmed by this phase of contextual analysis.

The process of conceptual and narrative development was iterated at every further interaction with project partners (lenders of exhibits, physical and graphical designers) to ensure the aims of the exhibition remained tantamount throughout. This iterative process allowed a clear overview of the project, in terms of decisions throughout its

development and the remaining capacity within the exhibition space for the design or curatorial team to source or reconcile as an exhibit.

When viewed from a second-order perspective, the responsibility for the design and curatorial team to fill otherwise vacant exhibition space, is representative of a process of discrepancy reduction on the part of the wider project team. The primary objective, to design and construct an engaging exhibition about ergonomics, could be conceptually considered as their motive or purpose as professionals employed to work on the project, from a motivational perspective of discrepancy reduction.

The process of prototyping and modelling an exhibition space, modelling and visualising the discrepancies and synergies to advance the narrative and concept of the *Ergonomics Real Design Exhibition* are considered the intangible interpretive design of the exhibition. The distinction of separating the designing of tangible touchpoints of the exhibition, and intangible narrative and interpretive processes that tie them together, is an approach consistent with many in the development of designing for services or Service Design (Stickdorn and Schneider, 2010).

Synergising and juxtaposing the conflicting personal definitions of the value of ergonomics presented the design team with substantial complexity. Mapping the contexts identified by the interviewees was considered an appropriate way to evaluate generalisable characteristics between responses, such as tying their statements to specific and convergent contexts of application and experience. This process was repeated with reference to the contexts of ergonomics identified by the ergonomics literature reviewed in section 3.3.

This began the process of integrating the discrepancies and conceptual starting points of the users interviewed against the physical exhibition space. This reductive approach began the process of simplifying the conceptual design of the public engagement experience, in design research or practice terms, and identifying the points of

convergence and discrepancy within the experience design of the exhibition. Tying the conceptual notions of the value of ergonomics to the physical space in this literal manner supported discussion between project partners and prospective exhibition lenders about the identified discrepancies and synergies in definition of ergonomics. The outcomes of this conceptual mapping process also supported the project team's awareness about the available space and physical orientation of the exhibition space.

Documenting users' existing perceptions and engagement with ergonomics in a tangible manner was a useful tool for identifying discrepancies within the exhibition development. This helped motivate, facilitate and direct discussions within the design team and supported the gathering of input from the wider *Ergonomics Real Design* project management team and advisors. This approach enabled the exhibition to be designed to motivate and engage its users, informed by contexts they already understood as ergonomic, and with clear pathways of understanding and skill development guiding them through the less familiar.

Mapping pathways and progressions against the physical space pragmatically supports a quick and effective transition from concept development to detailed design. This research evaluates the motivational impact of the narrative structure of the exhibition.

This two dimensional low cost, prototyping approach enables the contextual and spatial mapping of users' existing perceptions and engagement, which in turn increases their engagement and enables designers to develop a motivational approach to design that develops their understanding from that point. Illustrating the user's existing perceptions in this manner is not conceptually dissimilar from the process of acquired metaphorical conceptualisation, as exhibited by Currie (2009). Concept mapping, in relation to learning has additionally been proposed by Beitz, (1998) and to previous attempts to promote participatory ergonomics by McNeese et al (1995).

3.4.2 CONCEPT MAPPING AND ICON DEVELOPMENT

The next stage in the development of the *Ergonomics Real Design Exhibition* was to map concepts onto the available exhibition space. "A concept map is a picture of our understanding of something. It is a diagram illustrating how sets of concepts are related." (Dubberly, 2010) Plans of the space allocated to the exhibition were therefore acquired and input into Adobe Illustrator. A series of icons representing the contexts of 'understanding of ergonomics' identified by users in the interviews were chosen to support this stage of development. These icons were positioned in task progression consistent with moving the user from the familiar to the unfamiliar, as identified in the interviews recorded earlier. The user interviews identified ergonomics, as far as they were concerned, about the design of household everyday items. Adopting the suggested approach would see an icon representing household items placed at the entry to the exhibition space, the literal and metaphorical starting point for users.

The adoption of this approach in practice would translate into a design concept that took visitors on a journey through the exhibition. The first area of the exhibition would be the starting point of household ergonomics and the exhibition would then progress through contexts that increase in scale and complexity. Icons were developed in a manner consistent with the project brand guidelines, developed at the outset of the project, to ensure a consistent and non-subjective aesthetic throughout the development process. They were used in the diagrams (blueprints) that supported the iterative development of the exhibition plans. This approach to blueprinting the museum experience, conceptually as a multi-touchpoint user experience and physically as a plan view schematic of the physical service space, has its conceptual basis in the methodology of service blueprinting (Shostack, 1983) and blueprint+ (Polaine et al, 2009).

3.4.3 THREE DIMENSIONAL MODELLING

To support the exhibition design development process, the iterative prototype model of concepts was input into a scale three dimensional computer generated model of the exhibition space developed in Google Sketchup and Autodesk 3D Studio Max. The three-dimensional models were chosen as a research approach as they enabled accurate and representative consideration of the physical space and elements of detailed design, enabling the designers to consider how the context of ergonomics, and the learning and skill progression of the visitor, would be tangibly and physically supported, in richer detail than 2D approaches or than would be possible without tangibly constructing the models in 3D. Three-dimensional modelling of the exhibition was introduced as a tool to enable simultaneous and iterative discussion of the content of the exhibition with individuals less comfortable or experienced in designing environments.

Three-dimensional modelling provided an increased level of detail to the design process to support motivational energisation and engagement within the design of the *Ergonomics Real Design Exhibition.* This approach to motivational design constitutes discrepancy reduction at a micro-level of scale, greater than that conducted and detailed in section 3.4.1. In this case the three dimensional modelling supported designers to identify quickly and cheaply the physical barriers or discrepancies within the exhibition environment that would be significant to motivational design, either those that promote or prohibit sensory exploration and physical engagement as users interacted with the exhibits and the exhibition.

The two dimensional conceptual mapping detailed earlier considered the holistic, organisational and psychological barriers to effective engagement. This three-dimensional modelling supported a process of physical modelling and prototype production that enables designers to consider the more fundamental physical and

sensory barriers to successful discrepancy reduction or creation on the part of users iteratively, in turn promoting or inhibiting successful engagement with the exhibition as a whole.

The role of three-dimensional physical and virtual prototyping is well understood within design and design research as a process of enabling greater clarity, and refinement of, the functional requirements and specification of products, systems and services. Three dimensional modelling is a method that can be employed by designers to greater understand, anticipate and test the physical and sensory barriers to motivational engagement and to support them to visualise these barriers or enablers within the exhibition design.

3.4.4 STAKEHOLDER PERSONAS

Stakeholder personas are an established methodology in Interaction Design and Service Design practice (Cooper, 2007; Goodwin, 2009; Stickdorn and Schneider, 2010). They were used within this research as a valuable and well established design research approach to help stakeholders in the project team, each with different views and experience of ergonomics, to empathise with the expected level of prior engagement with ergonomics of the anticipated visitors to the exhibition.

Stakeholder personas were developed by synthesising, contextualising and visualising the data collected through the semi-structured interviews with public visitors a number of literature-informed models of skill progression and generalised user behaviour. This was combined with measures of visitor footfall, repeat visits, and economic and social status data collected in an earlier study commissioned by the exhibition venue to help them understand and market to their existing audience. Personas were also developed for other key stakeholder groups including design professionals, human factors professionals and design students.

This approach honours Krippendorff's call for "recognition of the reality of embodied human experience" (2004, p.44). Personas help articulate an idealised or representative embodied experience in an attempt to encourage all project team members to consider alternate and conflicting views that their audience might possess, in turn challenging some of their own personal assumptions about the appropriateness of the design or interpretive approach. The personas focussed on representing the skills, attitudes, behaviours, aims and goals that visitors to the museum were likely to possess in relation to ergonomics. These served as a further lens or empathic tool through which to anticipate potential areas of discrepancy or creative convergence within an approach to motivational design.

To support the development and authenticity of the student persona, questionnaires were circulated to design students at Brunel University. The data collected through these questionnaires were used to test and clarify the assumptions of the student persona, testing for discrepancies as the design team constructed them. See Goodwin (2009) for further discussion and an overview of the process of creating personas.

Personas were one tool used to keep users central to the design decision-making process. They are proposed as a method that designers can use in their practice to support motivational and engaged responses to the products, systems and services they design.

3.4.5 ABSTRACTION HIERARCHY

The interview data collected identified a range of applicable contexts of ergonomics, as perceived by potential users and ergonomists. The design team had to summarise this detail and the contextual richness it provided to a level that it was possible to:

a) explore within the constraints of the exhibition venue

b) reasonably to expect individuals to be able to absorb or interpret about ergonomics

c) enable ergonomists to provide detailed and tangible examples from the contexts in which they work.

An Abstraction Hierarchy (AH) was adopted as a means of summarising the differing levels of abstraction and engagement proposed and agreed throughout the exhibition space, in a succinct manner that could be easily interpreted at a broad level of detail during the planning process. An Abstraction Hierarchy is a valuable approach to conceptualising the How-Why relationships between complex sociotechnical interfaces. Whilst this is the first recorded instance of such an approach to conceptualising the design of a museum in this manner, it is not without precedent in conceptualising a multi-user, multi-touchpoint sociotechnical system such as a casino (Burns and Hajdukiewicz, 2004). The Abstraction Hierarchy was used to map the flows of engagement and motivational energisation between layers of abstraction enabling the researcher to identify and consider the motivational energy, feedback and reflective capability, or dynamic behaviour and decision making demanded of visitors in engaging with the exhibition. It also proved to be a critical tool in communicating the overall development of the exhibition to date, at the point the three-dimensional and graphic designers joined the project team.

The *Ergonomics Real Design* team chose to not adopt a full ecological interface design approach to the design of the public engagement experience. Instead we

opted to utilise the Abstraction Hierarchy phase, one fundamental component of ecological interface design (EID) and Cognitive Work Analysis (Jenkins et al, 2009; Rasmussen et al, 1994, Vicente, 1999). Abstraction Hierarchy is the first stage in the EID process and has been used to inform the design of training programmes, software and interfaces (Jenkins et al, 2009).

The Abstraction Hierarchy (AH) provided a framework that enabled the design team to build upon and incorporate the phenomenological experience of ergonomics shared by the members of the public, together with the higher order cognitive and epistemological perspectives and more general purposes and values of ergonomics that the exhibition sought to engage visitors with. Reconciling bottom-up generative and top-down determinist approaches to engagement, as the literature review determined, would be key to the successful motivational design of the exhibition, as it would demand reconciliation of the competing intrinsic driver and extrinsic determinants of engagement and user motivation. The AH provides a valuable framework for de-conceptualising the designed experience in this manner, at the same time keeping it contextualised within the overriding purpose and aims of the *Ergonomics Real Design Exhibition.*

It was felt that the AH was a valuable tool in de-conceptualising the broad topic of ergonomics and pursuing the design challenge associated with developing the various multifaceted exhibits that constituted the exhibition. The abstraction hierarchy facilitated this by providing a snapshot overview of the entire exhibition in one page in a manner that enabled each context identified in the interview data to be detailed with recursive detail. The AH provided an indication of the overall purpose of the exhibition and the individual manner in which that would be experienced at any one point in time as a visitor to the exhibition interacted with it and experienced each individual context.

3.5 CONCEPT EVALUATION

This section reports the methods used to collect follow-up user engagement data to assess the meta-motivational impact of the final design of the *Ergonomics Real Design Exhibition* upon two groups: ergonomists (practising professionals and academics) and design students. These groups were considered two key audience stakeholder groups throughout the design and implementation of the exhibition.

3.5.1 SELF–REPORT QUESTIONNAIRES

Self-report questionnaires were used to collect feedback data from ergonomists and design students. For each of the themed context areas of the exhibition, they were asked to assess the impact of that section in relation to:

a) increasing their awareness of ergonomics

b) their perception of the relevance of that section to their existing mental model or self schema of ergonomics

c) their confidence in being able to explain that section to another person, as well as finally

d) their overall satisfaction with that particular aspect of the exhibition.

Self report measures in the form of a questionnaire were adopted largely for their ease-of application, which acknowledgement of their limitations in terms of bias and manipulation of participants (Singleton et al, 1993). The criteria adopted for the questionnaire were directly informed by Keller's (1983) ARCS Model of Motivational Design reviewed in the literature review. The ARCS Model underpinned the design development concept, and was judged to support assessment of a range of self-reflective feedback loops, through which designers and users can gain insights into the levels of engagement and motivational regulation elicited by their experience of interacting with the exhibition. The four points of reflection in the ARCS Model (awareness, relevance, confidence and satisfaction) relate to the underlying transformational processes that underpin human motivational self-regulation. Therefore in this context they relate to the participant's motivation and perceived discrepancies in their interpretation of ergonomics, relative to their self-assessed levels prior to entering the exhibition environment.

Participants were requested to rate their perceived prior awareness, perceived relevance, confidence in repeating the key messages from, and overall satisfaction with and of each exhibit. They rated these values one to ten on a Likert scale, ten being a high-recorded level and one a low-recorded level. This process was completed once for each of the five contexts of the exhibition, as participants walked round it.

The demographics of the participants of this evaluation are detailed below:

Age bracket	Males	Females	Total
Under 18	-	-	-
18-25	-	-	-
26-35	1	1	3
36-45	1	-	1
46-55	1	-	1
56-65	-	1	-
Over 65	-	-	-
Unknown	-	-	-
Total	3	2	5

TABLE 3 – SELF REPORT QUESTIONNAIRES – EXPERT ERGONOMISTS

Age bracket	Males	Females	Total
Under 18	-	-	-
18-25	14	5	19
26-35	-	-	-
36-45	1	-	-
46-55	-	-	-
56-65	-	-	-
Over 65	-	-	-
Unknown	-	-	-
Total	15	5	20

TABLE 4 – SELF REPORT QUESTIONNAIRES – DESIGN STUDENTS

3.5.2 EXPERT STAKEHOLDER QUALITATIVE FEEDBACK

In addition to completing self-report questionnaires, additional qualitative feedback on the exhibition was gathered from the expert ergonomists. They were invited to spend 30mins viewing the exhibition in advance of a discussion to provide feedback on the exhibits, held in a room adjacent to the exhibition.

A qualitative approach to gathering feedback was adopted to ensure a free-ranging exchange of views and feedback and to enable, in conjunction with the previously outlined questionnaire based approach, that the feedback and analysis of the exhibition represented a mixed-methods approach and wasn't purely constrained by the questions asked of participants (Greene et al, 2001).

Upon entering the adjacent room to the exhibition participants were given green and red post-it notes. They were asked to record their thoughts and reflections on these, indicating exhibits they perceived as positive on green post-it notes and those they perceived negative, in terms of the application of ergonomics the exhibit represented or the manner in which it was presented or communicated, on red post-it notes. The post-it notes were then stuck onto a two dimensional plan-view representation of the exhibition space with each exhibit indicated by an icon.

The characteristics of the participating ergonomists were as follows:

Age bracket	Males	Females	Total
Under 18	-	-	-
18-25	-	1	1
26-35	-	-	-
36-45	1	1	2
46-55	1	-	1
56-65	3	-	-
Over 65	-	-	-
Unknown	-	-	-
Total	5	2	7

TABLE 5 – SELF REPORT QUESTIONNAIRES – PARTICIPATING ERGONOMISTS

Three of the participants in this process had seen the exhibition prior to the feedback session; five had previously completed the self-report questionnaires.

3.5.3 FUTURE ENGAGEMENT MODELLING

The final methodology used in the empirical evaluation of this case study was future engagement modelling. Five expert ergonomists were invited to participate, alongside members of the Ergonomic Real Design project team, in a number of co-creative evaluation exercises. These exercises were conducted at the end of the exhibition period and they sought to provide an opportunity for participants to reflect upon the discrepancies created or exacerbated by the exhibition, and reflect upon any discrepancies the exhibition had successfully reconciled. These reflections began a process of generating ideas forming generative design of future engagement with ergonomics.

The tools developed for the future engagement exercise included blank templates for newspapers, mobile phones and internet browsers intended to represent how people might interact with ergonomics in ten years time. These Tomorrow's Headlines approaches are consistent with those suggested in IDEO Method Cards (2002) and the future evidencing processes described by Moggeridge (2006) and Stickdorn and Schneider (2010).

These feed-forward approaches to concept development and ideation were used to encourage reflection and to support a generative response from participants that outlined the possibilities for engagement with ergonomics beyond the physical, phenomenological and temporal limits of a public exhibition. Much like the design process of the Ergonomic Real Design Exhibition itself, participants were invited to consider future engagement in terms of its physical manifestation and the level of interpretation, or value that in ten years time might conceivably underpin future engagement. The expectation mapping exercise saw participants being challenged to consider what newspaper headlines relating to ergonomics would be in ten years time and to consider how people might interact with ergonomics. Further exploration of

the concept of Expectation Mapping and Customer Journey Mapping is available in Stickdorn and Schneider (2010).

3.6 DATA ANALYSIS AND VISUALISATION

The aforementioned methods resulted in considerable data to test the assumptions about designing for motivation in relation to the *Ergonomics Real Design Exhibition.* This section reports the data processing, analysis and visualisation. The results and implications of this are discussed in chapter five.

Miles and Huberman (1994) define the process of analysing data collected by case study as three concurrent flows of activity: "(1) Data reduction, (2) Data display, and (3) Conclusion drawing/verification" (1994, p10).

This three-stage approach was adopted throughout this research; the process for data reduction and display is described here, the resulting discussions and conclusions are offered in later chapters.

3.6.1 ABSTRACTION AND CONCEPTUAL SYNTHESIS OF THE MOTIVATIONAL DESIGN FRAMEWORK

The approach taken for concept development integrates with existing design research, particularly that which sought to establish the manner and impact of designed inquiries (Buchanan, 2005; Cross, 1999; Frayling, 1993; Yee, 2009). Close parallels can be drawn with one facet of design research, inquiry into the role of tacit-knowledge within the process of design and design practice. Future research could focus on further exploration of this literature and application of the concepts of tacit-knowledge to that of intrinsic behavioural and self-regulatory processes.

3.6.2 THEMATIC ANALYSIS OF INTERVIEW DATA

Qualitative interview data were collected through semi-structured interviews with the general public, see 3.4.1 and unstructured interviews with ergonomists, see 3.4.2. These data were recorded, transcribed and coded using a thematic approach to analysis. The common themes identified through this analysis are reported in the results; for the visualised outcomes of this see section 4.4.3.

Analysis of the data identified a number of key contexts in which ergonomics and ergonomists operated. These were conceptually mapped by taking the transcribed interview data and identifying the context to which the respondent was referring. The majority of ergonomics use-cases and conceptual areas that respondents referred to were everyday, familiar contexts such as in their homes, use of transportation and their workplaces. These contexts were identified and grouped together with those explicitly identified in the ergonomic literature synthesis (section 3.3.3) and the expert ergonomist interview data (section 3.3.2).

These groupings were combined together into a diagram (fig. 29) reporting the original statement, when appropriate identifying the artefact in question, and highlighting the generalised operational context to which the interviewee had been referring. This approach was chosen as it supports Ford's assertion that "contexts are the anchors that organize and provide coherence to the activities within a behavioural episode" (1992, p.24).

Conceptually this process can be considered analogous to that of text-based concordance analysis; rather than manipulating literary artefacts and statements, it sought to manipulate and synthesise physical artefacts and contexts. It supported the designers to produce and develop motivational design, through reducing or creating discrepancy between the articulated contexts of ergonomics understood by the two

groups of respondents: the general visitors and the expert ergonomists. Analysing these data enabled the *Ergonomics Real Design* team to establish, early in the design process, the contexts in which they should seek to communicate ergonomics. These data would provide a strong, coherent structure to the exhibition. Having identified the contexts, it would then be possible to develop the level of detail and idealised behavioural responses that were most suited to experiential engagement.

This method of thematic analysis of user-elicited reflections and experiences, and its role within a research-led design process of motivational design, is a departure from traditional extrinsically mediated modes of defining engagement. Traditionally, identifying or designing contexts of public engagement would assert the discipline of ergonomics preference for cost and utility value models (Krippendorff, 2004). The thematic synthesis approach of the *Ergonomics Real Design* case study represents a new approach. It is also a change from traditional designerly or curatorial, phenomenological approaches to identifying contexts or subject matter of an exhibition. Designers would usually draw on the curator's or their own individualistic, internalised interpretation, instinct or intuition of the subject matter or context in question.

The approach taken for this study was explicitly developed to support a more participatory, democratic and accessible approach to energising participation and engagement of the visitors and stakeholders of the *Ergonomics Real Design Exhibition.* It was an unprecedented and potentially marketable feature of the exhibition, certainly relative to other exhibitions hosted in the chosen venue, and to previous public engagement with ergonomics initiatives.

Thematic synthesis and analysis was chosen as a method because it ensures a level of motivation, human-centredness and engagement amongst participants that outlasts the time they were in the physical space of the museum. Respondents were interviewed

immediately after having interacted with the exhibition and were therefore considered able to demonstrate measures of engaged behaviour and motivational self-regulation (this is assessed quantitatively, see section 3.5.1 and qualitatively in section 3.5.2).

From a pragmatic design perspective, this thesis documents and reflects upon the argument that emerged from the case-based reflections documented throughout chapter two. This was that by identifying clearly the contexts of ergonomics so early in the development of the *Ergonomics Real Design Exhibition*, the design concept would provide an environment that "audiences if they desire to – can learn from the experience of their visits" (Black, 2005, p181). From a motivational psychology perspective, this study demonstrates that by designers clearly articulating the contexts of engagement early in the design process of public engagement, they are able to consider motivational processes of discrepancy creation and discrepancy reduction, key to motivational engagement and therefore the motivational design of their users.

3.6.3 ANALYSIS OF PICTORIAL TAG CLOUDS

The tag cloud methodology described above in 3.4.3 was chosen to enable a large amount of data and information to be presented in an accessible manner. The tag clouds produced through this process can be found in 4.4.3. In terms of analysing these data, the word clouds produced were compared and contrasted and the presentation of content within the visualisation allowed for comparisons of the core contexts and themes. The word cloud data were also compared to the data that emerged from the thematic analysis of the interviews to establish discrepancies and commonalities between them.

3.6.4 QUESTIONNAIRE ANALYSIS

Data were collected via questionnaires on two occasions, during the concept development stage with design students to aid the production of personas as reported in 3.4.3 and in the concept evaluation stage where self-report questionnaires were used with design students and expert ergonomists, see section 3.5.1 and section 3.5.2. The questionnaires were designed in a structured way to answer specific questions and enable the standardisation of data to support analysis. The components of motivated behaviour represented in the ARCS Model were selected to further structure the design of the questionnaire and the resulting evaluation of the motivational engagement elicited of users by the exhibition.

The questionnaire data and the scoring responses on the Likert scales were entered into one data set. Exploratory data analysis and descriptive statistical tests were conducted and summary statistics explored, see 4.5.1 (Tukey, 1977). Descriptive information was collected, grouped and displayed in tables and mapped against the exhibition layout, see 4.5.2. The descriptive statistics helped identify ways in which designers and design researchers can measure or better evaluate the role of motivation in design.

3.6.4.1   DESCRIPTIVE STATISTICAL ANALYSIS

The first descriptive statistical analysis of questionnaire data focused on the role of motivation in relation to users' engagement with a designed multi-touchpoint user engagement experience, the *Ergonomics Real Design Exhibition.*

This analysis was repeated twice, once for the expert group data and once for the student group data. A further analysis was conducted on the combined expert and student data. These data were then visualised as tabulated data and as a box plot.

Following preliminary descriptive analysis and reflection upon the visualised representations of these data, further analysis was conducted. This analysis structured the data to ascertain the respective influence or relationships between individual respondents' scores for the contexts of the exhibition, in relation to the overall mean levels of awareness, relevance, confidence or satisfaction expressed by all visitors. In the case of the student group these scores were analysed in relation to an expressed general perception of the exhibition as a whole.

This analysis sought to descriptively model the motivational impact of the individual contexts of the exhibition on motivational engagement with the exhibition as a whole and to identify potential relationships between dimensions of motivational engagement that offer designers and design researchers potential for further investigation and designed enquiry.

4. RESULTS

A broad array of generative and descriptive data were collected, typical of that generated or considered by designers in the course of any design process. The results and broader reflections upon them, alongside the methods used, present a platform for designers interested in influencing the role of motivation within design to develop their own research or practical assessments and enquiries.

4.1 OVERVIEW

The methodology was chosen to highlight how designers can consider, anticipate and accommodate the role of motivation and motivational self-regulation throughout the design process of a public engagement exhibition. The results of this process enable designers to adjust the perspective through which they view the impact of their work, specifically, in the terms of the motivational impact and self-regulation the products, systems and services that they demand of users. The philosophy of motivational design proposed requires a change of perspective on the part of designers. The results highlighted in this chapter demonstrate that it is possible for designers to converse about (RQ1), embed within their design processes and approach (RQ2) and evaluate the motivational impact of their work (RQ3) in a way that adds value to their research or practice, but without demanding a significant praxeological departure from their existing design methodology or approach. The philosophy presented is a post-phenomenological one, as it demands a shift of psychological perspective in how designers view the world, their design process and their users, but beyond that does not demand that they adopt a different design approach or use different tools.

From the perspective of public engagement with science research, the methodology used and the results collected serve as a contribution to the field of design research. This study is practice oriented and provides designers, design researchers and curators

with findings relevant to engaging members of the public with a scientific discipline, in a participatory manner. The results demonstrate an applied participatory approach that involved users, putting their views on an equal footing within the design development process. The case study presented will aid discussions and reflections about practice and provides a conceptual framework, to aid understanding and comprehension of motivation. It also details a number of tools, which can be used for visualising, conceptually developing and empirically assessing the impact of design in terms of the motivational engagement it demands of users.

4.2 CASE STUDY

The results of the case study are highlighted in yellow throughout the literature review. This approach integrated and reflected on the research reviewed, drawing relevance to how it relates to design practice. This case-based reflection culminated by recording the results from the research through design practice developed by the researcher as part of his design practice as a member of the *Ergonomics Real Design* Project Team. These reflections are incorporated into the broader reflections of the role of motivation in design that suggest how common design tools can support designers.

4.3 CONTEXTUAL RESEARCH

Utilising the concept of 'conversations for consensus' identified earlier in the literature review of this thesis, this section details the results of the design process to establish the context in which the *Ergonomics Real Design Exhibition* was attempting to engage and motivate greater understanding and participation with ergonomics. This process involved a number of phases, the first; a series of semi-structured interviews or conversations with members of the public followed by similar conversations with scientists and expert practitioners, detailed in sections 4.3.1 and 4.3.2. This initial 'conversations for consensus' phase was followed by a further phase of design synthesis that reviewed a number of literature sources for similar context definition this detailed in section 4.3.3. Together these three approaches provide a consensus of the existing awareness of the participants of the public engagement process. This synthesis presented indications to the designers of how they could affirm the relevance of these contexts and create or reduce discrepancies in how these users might interact with this subject matter as the designers began the process of designing the public engagement experience. Such a discrepancy reduction and creation approach and the importance of user awareness and relevance in underpinning successful public engagement having been previously identified in the literature review of this thesis as critical for designers in engaging or motivating their users' further understanding of, and participation with, the science of Ergonomics.

4.3.1 SEMI–STRUCTURED INTERVIEWS WITH VISITORS

The full results of the semi-structured interviews are recorded in an appendix of the *Ergonomics Real Design* Project Report (Grant and Williams, 2010). The data collected were additionally analysed and are visualised in Section 4.5.1, to address the second research question of this thesis: how user insights can be integrated and synthesised as part of the design process to enable designers to understand and consciously influence the motivational engagement of their users. Semi structured interviews were identified as the most suitable method for this aspect of the research for the fact that they enable the 'free expression of views' within a loosely controlled frame of focus or context.

The data collected from the semi-structured interviews were used to assess the baseline level of awareness of the role and value of ergonomics, and highlight any discrepancy in the value ergonomists and the ergonomics literature claim ergonomics offers the general public and the Design Museum visitors' perceptions of that value. The results enable discussion and reflection upon the sorts of discrepancy they enable designers to identify, and how future iterations or adoptions of this process might further improve design and public engagement practice.

The thematic analysis of these interview data established a number of common themes and understandings detailed below; these present the baseline of engagement from which designers could then create discrepancy or seek to reduce discrepancy in users' understanding in the design of a motivationally engaging experience. These baseline data also served another significant purpose in the process of developing a motivational approach to design, by supporting designers to embed their design solutions in the context for which they are designing or in which users will use and engage with their designed solutions. Motivational researchers identify this baseline

contextual understanding as a key factor in the effective energisation and regulation of human behaviour.

4.3.1.1 DEFINING ERGONOMICS: THE PERCEPTION OF USABILITY AND DESIGNING FOR COMFORT AND SAFETY

Most interviewees attempted an explanation of ergonomics. The most commonly cited example of ergonomics was 'chairs':

"Furniture. Designs of different chairs"

"Sitting. Chairs and stuff"

Others made the link between ergonomics and usability or design with people or users in mind:

"Like that keyboard that came out in the 90s or that sort of thing"

Some interviewees mentioned comfort as a factor in ergonomics:

"Comfort in your own home"

and a few also mention health and/or safety:

"I would have said health and safety"

A small number of respondents were not able to state what ergonomics was, or were uncertain about it:

"I mean, not that it's an ergonomic thing, but the usability is so fantastic"

"[I wouldn't consider it ergonomics] in the sense that there's no difficult physical aspect in particular, as far as mindset goes"

4.3.1.2 RESPONDENT PERCEPTIONS OF THE RELATIONSHIP BETWEEN ERGONOMICS AND AESTHETIC OR KINAESTHETIC ELEMENTS OF DESIGN

Most interviewees focused on aesthetic or kinaesthetic elements of design, believing ergonomics was about the physical fit of an object, space or environment, rather than mentioning cognitive or emotional aspects, few making the link with the way a user might think about an object or space.

Some respondents mentioned the fit of an object or its tactile properties:

> "Maybe my kitchen tap actually, it feels very ergonomical [sic], but it is not ergonomically successful, it is not in a way that it moulds into my hand or anything but it has a very reassuring and pleasure-giving sense of touch and it's very easy to control"

Discrepancy creation in this instance might have constituted the deliberate manipulation of the size and fit of a number of common everyday products or the exploration of a range of alternative textures or materials that those users might be more familiar with. Discrepancy reduction could potentially have involved a number of products being identified as particularly bad examples of such kinaesthetic or tactile perception and users being engaged to suggest refinements or improvements to them.

4.3.1.3 HUMAN ADAPTABILITY AND THE INFLUENCE OF CULTURAL FACTORS ON ERGONOMICS

A number of respondents considered ergonomics of less importance to them due to their ability to adapt to situations or poor design:

> "Well, the funny thing is, I don't mind what I'm used to in design. It's like using a pen or a pencil; you learn to use it at the time... It's just a different piece, whether it's a PC or Mac."

One interviewee described how he felt that cultural factors can affect ergonomic design, citing his experience of public transport as an example:

> "Sitting on the bus on the way here, it's the leg space. And as I'm an Asian, I'm comfortable sitting there. But the European people, American people, I don't think the buses are suitable for them, actually. I see the people struggling and sitting, but I am comfortable."

Discrepancy creation and reduction as 'lens' from this interpretation of these responses by designers interested in utilising these insights might have emphasised the range of different cultural or product variants in these factors, perhaps encouraging visitors to reflect on situations where they need to adapt their behaviour or skill in order to use a product, system or service. It might have also encouraged users to contribute suggestions for how a number of everyday products, contexts or experiences may, in their opinion be redesigned or otherwise adapted to suit them as individuals.

4.3.1.4 ERGONOMICS AT HOME, AT WORK OR RELATING TO TRANSPORT

When asked for their examples of good or bad ergonomics respondents most frequently cited examples from their working or home life, or relating to transport.

> "Most people like cooking, but they give you the excuse, "If I had a better kitchen or a nicer kitchen, then it would change my lifestyle because I could cook more and buy less packaged food. I could do it myself."

> "I work at a firm where we moved to brand new offices. It had a huge impact on morale and things. The offices were really, really run down and lots of things didn't work. It just wasn't a very pleasant environment. The new offices were beautifully designed, it was really, really light, and everything was brand new. It was just really smart, and it made for a better environment."

> "The Tube. The overcrowding. The temperature. The lack of trains. The whole environment really"

Discrepancy creation in this instance might have involved the presentation of a number of situations where these cited examples of bad ergonomics were in fact well considered, so where one respondent claimed the tube was bad, finding an example of good ergonomics from the tube. Discrepancy reduction in this context could potentially involve examples of timeless ergonomics in the workplace that contradicted the notion expressed by the respondent that good ergonomics has to be new.

4.3.1.5 ERGONOMICS AND MOBILE PHONES

Another theme was personal mobile technology:

> "I get the same phone each time, I just get the upgraded model. So I know how it works and I know what it does. It's easy. I used to have a Sony Ericsson. That was OK, but then it wasn't as good as the Nokia, so I picked the Nokia."

4.3.1.6 FAMILIARITY OF PRODUCTS AND ENVIRONMENTS

As the literature suggested would happen (Keller, 1983; EPSRC, 2003) many respondents described the role of the value of ergonomics in terms of artefacts or contexts with which they were familiar or that play a prominent role in their lives:

> "I don't know if this is relevant, but one of my team had an accident some while ago and he cannot sit or stand too long at one time. So we had to get him a special desk, and he couldn't move about. So he might be on the phone and he'd be standing and looking at this computer, and then there's a little knob on the desk. You'd see him sitting down in a normal position and he adjusts it to the way. We got it for him, because it was important for him. Is that ergonomics?"

> "I bought an ironing board that I think is a reasonably good one and yet I can do anything from gouge piece out of my thumb when I'm putting it up to I can lose control of it when I'm putting it down. And really, we have been using ironing boards for generations surely, it's about time. There could be one even I find simple to use."

Most respondents appeared to prioritise ergonomics for objects they use or spaces they inhabit most frequently:

> "Seating. That's probably the best example. Especially in offices, where you sit down for eight hours a day"

> "I think the things we use on a daily basis. Something practical"

However one respondent used a different hierarchy, which may have been related to the alternative exhibition at the venue, a fashion exhibition. This respondent focused on clothing and fashion.

> "Clothes are the first thing that we're ergonomically connected to and then it's furniture. So, I'd say if I had to say a priority, it would be clothes and furniture"

4.3.2 UNSTRUCTURED INTERVIEWS WITH EXPERT ERGONOMISTS

These interviews were conducted to collect the expert's views about current perceptions of ergonomics. They also explored why people chose to work in that profession.

Responses to the question asking them how they feel the public perceive Ergonomics included:

> "...I don't think they do..."

> "the public would usually say 'designing chairs' and computer workstations, it's very kind of... ...well... at least they know what it is, but it's very limited in its scope – the public understanding of the variety... and the impact of human factors and ergonomics"

> "...in the UK, I think [public perceptions] are very much associated with physical ergonomics...it's about comfy chairs, it's about workstations... people wouldn't use words like anthropometry, but they'd use words about how comfy it is or how nice it feels"

> "...they'll think you said economics, not ergonomics..."

Many of the ergonomists reported that they had been attracted to ergonomics to satisfy an innate curiosity or fascination with how everyday products were designed, and could be improved.

> "I've always been interested in things, you know? I had a Meccano set as a boy and I've always been interested in gadgets... combine that with my interest in people as a psychologist and there you have it, that's Ergonomics."

> "I'm a quite hands on practical person, so I like Ergonomics because although I studied the theory I really like the fact that [in studying Ergonomics] you went into a lab and applied it... I'm much more applied and I really like that everything I do is very applied, you know, usability sorts of things and the practicality side of it"

Most demonstrated a curiosity or expressed a fascination in how to apply and understand the rules that governed their phenomenological experiences of everyday products, and their relationship with the environment of their everyday life.

Many talked of their natural curiosity with life around them and some gave specific examples, case studies or names of eminent individuals who, or which, had motivated their determination for a career as an ergonomist.

> "...what motivated me, I think, it was the fact that we are not all the same, there are differences between us and I guess it was the fact that these differences are everywhere..."

Several interviewees mentioned books such as Donald Norman's (1988) Design of Everyday Things, or university lecturers who had inspired them, indicating the variety of forms of engagement that had led them to develop an interest in and pursue a career in ergonomics.

4.3.3 TAG CLOUDS DEFINITIONS

The tag clouds reported here scale the word relative to the number of times in the whole body of text it features.
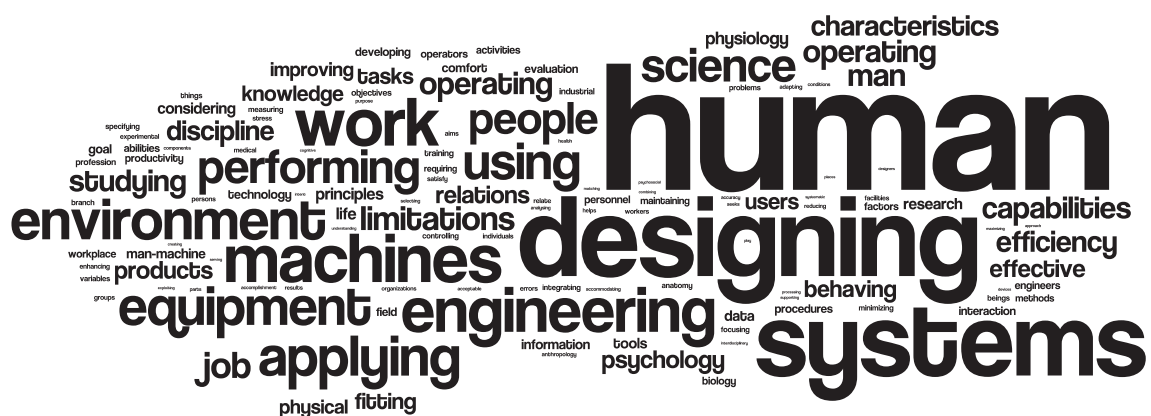
FIG. 28 TAG CLOUD FOR CONTENT WORDS FROM DEFINITIONS OF HUMAN FACTORS / ERGONOMICS AS IDENTIFIED BY DEMPSEY ET AL. (2000) IN (YOUNG, GRANT, BISSET, WILLIAMS, SELL, & HASLAM, 2010)

This first analysis deliberately excluded the word ergonomics, the most mentioned word was human followed by designing and systems.

The words environment, engineering, equipment and machines indicate the mechanistic, systematic characteristic of recent work of UK Ergonomists from 1950 onward. Performing, job, capabilities and limitations alongside words such as using and people suggest ergonomics emphasises understanding the limits of humans in their interaction with sociotechnical systems.

This synthesis, analysis and visualisation allows for meaningful identification of the discrepancies within and between these data and the data synthesised by the same process in sections 4.3.1 and 4.3.2. It also allows us to consider the research questions, which sought to identify how designers might use conversation as tool to identify discrepancies in users' understanding of a product, service, system or in this

context, public engagement with science and design to redress or exacerbate this as a means of elucidating motivational engagement and energisation.

This analysis excluded words not related to a specific product, process or context. It highlights a slightly distinct emphasis in the definition of ergonomics. It also allows identification of discrepancies between this analysis as a representation of the topics of interest to ergonomists in the two years preceding the exhibition, and the previous analysis.

This analysis emphasises the role of health and safety, as well as terms consistent with those in fig. 28 from Dempsey et al (2000). Research and study also have greater prominence; this is likely to be because the analysis was of conference proceedings rather than the highly refined and conceptually broader results analysed in the Dempsey interpretation.

There is also increased emphasis on construction, inclusive and technology. This reflects the increased prominence of these areas to ergonomics in 2008-2009 (fig.29).

The discrepancies between these two analyses represent areas of growth and recent developments. Consequently these are both areas that designers seeking to focus on discrepancy as a key principle, could choose to explore to stimulate engagement and interest in their design.

The one limitation of the way that the tag cloud analysis is conducted is the fact that paired words or phrases are split into separate entities, so human factors becomes human and factors. Even acknowledging this limitation, the results provide a clear innate picture of the processes and contexts of ergonomics, whilst keeping the complexity low. This representative, but low complexity approach to communicating the definition of ergonomics enabled the design team to begin the process of synthesising the conversations conducted with the members of the public and the expert ergonomists into tangible, rational design constructs and contexts.

The further contribution of coding this synthesis in terms of whether the particular word described a physical, rational or objective measure of ergonomics or the experience of interacting with ergonomics, builds on the research summarised in sections 2.1 and 2.2 of this thesis to synthesise an approach to using conversation as the means to support designers design for public engagement with ergonomics in an exhibition context.

FIG. 29 TAG CLOUD FOR COMBINED 2008 AND 2009 PROCEEDINGS FROM UK ERGONOMICS SOCIETY ANNUAL CONFERENCE

4.4 CONCEPT DEVELOPMENT

Following the previous phase in the design development of the 'conversations for consensus' there followed a phase of 'conversation for action' or design development. This included the visualisation and evaluation phases of the design concept and as such addresses the research questions two and three respectively. These questions investigating the role of visualisation or specifically visual synthesis in developing a visual and conceptual synthesis of the *Ergonomics Real Design* Public Engagement with Science Exhibition, and a novel approach to evaluating the motivational engagement and self regulation of behaviour of users as they interacted with this exhibition.

4.4.1 ITERATIVE PROTOTYPE MODELLING

The synthesis (fig. 27 and fig. 28) of the semi-structured interviews data was designed in a similar manner to the word-clouds formed from the reviews of the ergonomics literature detailed in section 4.4.3. It exemplifies an outcome of a process that allows designers to work at a high level of abstraction when considering how best to engage and motivate the public. Synthesising user insights and feedback in this way enables the designer, or design team, to work at a high level of conceptual abstraction. This ensures that the design solution can be informed by users, which will result in a design that appears contextually and personally relevant to its users. In the case of the *Ergonomics Real Design Exhibition*, the end exhibition is both relevant and meaningful to the audience of the museum.

The opportunistic sample of visitors to the exhibition venue used, detailed in section 3.4, had their views situated alongside holistic integrative models explored in the literature review (Wickens, 2004 and Pheasant, 1986). A number of those interviewed mentioned these models as influential for their understanding and appreciation of ergonomics. This process of synthesising consistencies within the various data sources enabled the design team to gauge existing perceptions and definitions of ergonomics to ensure a suitable benchmark for measuring subsequent levels of engagement with ergonomics. In the *Ergonomics Real Design Exhibition* this benchmark was established to contrast with two further studies reported in Grant and Williams (2010).

This process of synthesis provides an important benchmark for further reflection and investigation of the impact on end user motivation and engagement, of designers gathering and reconciling users' requirements and existing understanding within design processes.

What does 'Ergonomics' mean to you? – "Conversations for consensus"

"We have a BMW Mini and it's just very well designed. When you drive it, for an average person everything is just under your hands. Everything is the right size and in the right place. It's how you would expect it to be without having to think. The indicators are where you sort of look. It has the sort of feel as if it were designed for you"

"Train, plane and bus seating..."

"The tube, the overcrowding, the lack of trains, the temperature, the whole thing really..."

"Street design, obviously. In terms of the badly laid out in the way of street furniture, that it's not all user-friendly in a place where it should be user-friendly."

"I work at a firm where we moved to brand new offices. It had a huge impact on morale and things. The offices were really, really run down and lots of things didn't work. It just wasn't a very pleasant environment. The new offices were beautifully designed, it was really light, and everything was brand new. It was just really smart, and it made for a better environment."

"Most people like cooking, but they give you the excuse, "If I had a better kitchen or a nicer kitchen, then it would change my lifestyle because I could cook more and buy less packaged food. I could do it myself."

"The example is the software I have got on my laptop because I am not in the same era as it is for you, It is a little bit too complicated for me. It makes me feel a bit inhibited"

"The example is the software I have got on my laptop because I am not in the same era as it is for you, It is a little bit too complicated for me. It makes me feel a bit inhibited"

"I get the same phone each time, I just the upgraded model. So I know how it works and I know what it does. It's easy. I used to have a Sony Ericson. That was OK, but then it wasn't as good as the Nokia, so I picked the Nokia."

"Tools for right handed people that don't work for left handed people...lecture tables for right handed that don't support left handed people."

"I don't know if this is relevant, but one of my team had an accident some while ago and he cannot sit or stand too long at one time. So we had to get him a special desk, and he couldn't move about. So he might be on the phone and he'd be standing and looking at this computer, and then there's a little knob on the desk. You'd see him sitting down in a normal position and he adjusts it to the way. We got it for him, because it was important for him. Is that ergonomics?"

"I've always thought that beanbags were terribly badly designed as human structures. It just seems to be a bit of a novelty from a comfort point of view. It's not actually comfortable. "

"It is a bit like I just met you, and let's say I think you are a great guy, and I want to be like you. So, I wear grey tee shirts and orange sleeves. In the process, I learn something about me by wearing a grey tee shirt and orange sleeves. But, there is going to be a relationship between the clothes and the person"

"Sitting on the bus on the way here, it's the leg space. And as I'm an Asian, I'm comfortable sitting there. But the European people, American people, I don't think the buses are suitable for them, actually. I see the people struggling and sitting, but I am comfortable."

TRANSPORT

BUILT ENVIRONMENT

HOME

WORKPLACE

ELECTRONICS

CHAIRS

CLOTHING

CULTURE

FIG. 30 DIAGRAM VISUALISING THE DEFINITIONS AND PERCEPTIONS OF ERGONOMICS AS ARTICULATED BY SEMI-STRUCTURED INTERVIEWS WITH AN OPPORTUNISTIC CROSS-SECTION OF VISITORS TO THE DESIGN MUSEUM, NOVEMBER, 2008.

"I mean, not that it's an ergonomic thing, but the usability is so fantastic"

"So it's more than pretty clothes..."

"...people would say 'the chair I'm sitting in rather than the flow of traffic at Gatwock'"

WHAT IS IT?

"And of course they have those Ergonomic chairs, they were supposed to be comfortable and functional"

COMFORT

"It's the visual things and that's obvious, some people find some things so much easier when they are visual and obvious I know I do"

VISUAL

"I'm the person who is going to be reading a paper book when no one else is, flipping through those things because I like the feel. I like the kinaesthetic feel of books and paper"

KINAESTHETIC

DEFINITIONS

"If they look good, sometimes you are willing to put up with something that is not really very comfortable. You know that you only have to wear them for a few minutes"

"If it was an airline had seats that were more comfortable, I would be much more likely to use it, even if it cost me a little bit extra. Not a lot extra, but a little bit... In the same way that if first class were a little cheaper then I would use it because it's much more comfortable"

"The things that are closest to people can take priority...Clothes are the first thing that we are ergonomically connected to and then it's furniture. So if i had to say a priority, it would be clothes and furniture."

INFLUENCE

Tension between FORM and FUNCTION

Influence on PURCHASING - tradeoff in terms of USABILITY

ORNAMENTAL versus RIGOUROUS Ergonomics.

DISCREPANCIES

FIG. 31 DIAGRAM VISUALISING THE DEFINITIONS AND PERCEPTIONS OF ERGONOMICS AS ARTICULATED BY SEMI-STRUCTURED INTERVIEWS WITH AN OPPORTUNISTIC CROSS-SECTION OF VISITORS TO THE DESIGN MUSEUM, NOVEMBER, 2008.

The model of existing perceptions of ergonomics (detailed in fig. 27 and fig. 28) presents an iconic, symbolised and synthesised representation of the contexts mentioned within the interview data outlined in section 3.3. Chairs, Home, Electronics, Transport and Workplace contexts were the key themes that were included in the exhibition; these are indicated in colour. Exhibits identified in the interview data that did not make the final curatorial shortlist are represented with light grey icons, including the Built Environment, Clothes and Culture.

A number of definitions from the data are also represented, such as comfort and kinaesthetic sensation, alongside some of the discrepancies or paradoxes they identified in their understanding of ergonomics. This contributes to a motivational approach to discrepancy reduction or creation as the basis of the design development process of future public engagement with ergonomics.

The decision making about which contexts to include or exclude in the final exhibition, which should be considered as consistent or discrepant with the audience's existing perceptions and understanding, was the cause of much debate and discussion throughout the *Ergonomics Real Design Exhibition* project. Some selection decisions were made for pragmatic reasons, such as not being able to source suppliers of suitable exhibits, other contexts were excluded because they were not considered to be consistent with the definition of ergonomics held by the majority of members of the project team.

The decision making process in the exhibition case study at some points privileged maintaining consistency with the project team's own definition of ergonomics, rather than taking an approach that deliberately created discrepancy or consistency with the user definition. Therefore the conceptual synthesis is very relevant in light of the observation from the literature that design decisions informed by principles defined by designers themselves are inherently extrinsic in their nature, and thereby limit

FIG. 32 AN EXAMPLE OF EARLY 3D MODELLING THAT BEGAN TO ITERATIVELY BRING TO LIFE THE CONTEXTS IDENTIFIED AS A RESULT OF THE CONVERSATIONS WITH MEMBERS OF THE PUBLIC & EXPERT ERGONOMISTS IN THIS CASE THAT OF 'CHAIRS'

the users' development of intrinsic motivation. Alternatively, the design team could share the evidence by which they made such extrinsically mediated design decisions to ensure that the experience is not a demotivating one for end users. In this case it would mean that they explained why they chose to leave out certain contexts of ergonomics that the users had otherwise indicated as significant.

The iterative, two dimensional conceptual design process was utilised to consider a number of ways in which contexts and artefacts could be developed to support their interpretation and communicated to the audience. These include macro-interpretive progressions that could support designers of multi-touchpoint user experiences to better structure their design intent from a motivational perspective.

In the exhibition case study, a macro interpretive approach supported designers to consider the overall exhibition concept and narrative structure of their design proposition. This enabled them to consider, as early as possible in the design process, the manner in which users will interact, engage and motivationally regulate their behaviour in relation to the concept of the exhibition, as well as in relation to its physical structure. This macro interpretative approach involved the broad conceptual synthesis illustrated in fig. 27 and fig. 28 alongside the micro-context interpretative approach that visualised and conceptualised how an end user might interpret, psychologically 'chunk' (Petty et al, 2001) and appreciate the value of ergonomics, within each contexts identified.

4.4.2 THREE–DIMENSIONAL MODELLING

The three-dimensional modelling was utilised to aid the design team to provide balance within an iterative, collaborative design development process. It enabled them to consider the holistic definition of the content and subject matter of a public engagement with science exhibition, the psychological or information design development, alongside the tangible exhibition design that considered how the experience looked, felt, and would be physically navigated by visitors.

Early in the design process confronting head-on the commonly held misperception that ergonomics is all about chairs, as visitors entered the exhibition, was discussed. This rendering, figure 29, prototyped how this could be structured. It featured chairs from a range of contexts, as well as an exploded view of a ergonomic office chair, designed to literally represent one of the aims of the expert ergonomists in the design team, to explode the myth of ergonomics solely being about the design of chairs.

Three dimensional modelling was also used to develop prototypes detailing the design development of exhibits. These were regularly updated with proposed text and diagrams so the relevant members of the project team could review them, and so that all members of the project team were able to see the position and content of the text and images in context.

Framework					
General Target Persona — Data from Design Museum Audiences London Report (May 2008)	**General Interest** — 37% of Visitors 'General Look Around'		**Specifically Interested in the Relationship between Design and Ergonomics** — 38% of Visitors 'Interested in specific exhibition'		**Purely Interested in Ergonomics** — 21% of Visitors 'Professional Interest'
Specific Target Persona	Overseas Tourist	Construction Worker	Medical Professional	Retired Person	Young Creative Professional / Businessman
Visitor's Current Skill Level — Dreyfus and Dreyfus Skill Acquisition Model (Dreyfus, 2004)	**Novice** — "The instruction process begins with the instructor decomposing the task environment into context-free features that the beginner can recognize without the desired skill" (p.177)	**Advanced Beginner** — "As the novice gains experience... and begins to develop an understanding of the relevant context...an instructor points out, perspicuous examples of meaningful additional aspects of the situation or domain." (p.177)	**Competence** — "With more experience, the number of potentially relevant elements and procedures that the learner is able to recognize [increases]...to avoid mistakes, the competent performer seeks situational rules [or cases]. (p.178)	**Proficiency** — "As the competent performer becomes more and more emotionally involved in a task, it becomes increasingly difficult for him or her to draw back and adopt the detached, rule-following stance of the beginner." (p.178)	**Expertise** — "The expert not only sees what needs to be achieved; thanks to his or her vast repertoire of situational discriminations, he or she also sees immediately how to achieve this goal." (p.179)
Motivational Stages of Change Model — Prochaska and Di Clemente (1986)	**Pre-Contemplation** — Not considering changing one's view of Ergonomics	**Contemplation** — Thinking about changing one's view of Ergonomics	**Preparation** — Making definite plans to change one's view of Ergonomics	**Action** — Actually engaged in changing view of Ergonomics	**Maintenance** — Working to consolidate one's perception of human factors
SRK Framework — Rasmussen (1990)	**Rule** — 37% of Visitors 'General Look Around'		**Knowledge** — 38% of Visitors 'Interested in specific exhibition' i.e. relationship of design and ergonomics		**Skill** — 21% of Visitors 'Professional Interest' i.e. human factors
Aristotelian Framework — Prior Analytics	**Deductive** — 'Context Sensitive' Principles / process by which Ergonomics operates - an Ergonomic world view		**Abductive** — 'Context Sensitive' How Ergonomics made these specific products better in context.		**Inductive** — 'Context Independent'

FIG. 33 AN EXAMPLE OF THE PERSONAS FRAMEWORK DEVELOPED TO SUPPORT THE DESIGN TEAM EMPHASISE THE SKILL AND MOTIVATIONAL DEVELOPMENT THAT THE PUBLIC ENGAGEMENT EXPERIENCE NEEDED TO AFFORD EACH OF THE IDENTIFIED STAKEHOLDERS

4.4.3 STAKEHOLDER PERSONAS

The stakeholder personas documented in this section exemplify those that might in other projects allow designers to constantly remind themselves of the vast array of differences of opinion and perspective that individual humans and users of products, systems and services possess and exhibit, particularly with respect to regulating their underlying motivational engagement. In designing the exhibition stakeholder personas were used to bring end users to life.

Figure 30 represents facets of human behaviour and skill development that, according to the literature reviewed in the investigation of this thesis, influence and impact upon human engagement in general and an individual's motivation to engage with, in this case, the exhibition and its subject matter specifically. Personas, whilst highly generalised, enabled the design team to see at a glance several possible combinations of experience and perception, and reminded them of their end users. This approach was taken to tie together the multiple perspectives of the project team members, to build a united perception of who the audience was needed engaging and motivating.

This visualised framework also served as a reminder to the project team of some insights previously gathered during the interviews about perceptions of ergonomics. Stakeholder personas were linked with models of skill development and motivational engagement, to support and remind designers of the best way to stagger and deconceptualise the process of designing to support motivation.

The personas were designed and introduced to the project team by the designers who had focused on developing intrinsic, or increasingly introjected and internalised representations of motivation within design of the exhibition. As mentioned previously, promoting affinity within the exhibition space and design of the exhibition, to highlight the close relationship intrinsic motivation has with the process of skill

Functional Purpose

Highlight that Ergonomics is making *things* better

Ergonomics provides scientific methods, processes and frameworks for better understanding human capability and designing systems, products and services that increase control and add value for those that use and implement them.

Abstract Function / Values and Priorities

Increases Control

Increases Value

Generalised Function / User Defined Values

Safer

Comfier

User Friendly

Efficient

Appealing

Physical Function / Ergonomist Defined Values

Anthropometry   Biomechanics   Haptic Perception   Auditory Perception   Visual Perception   Cognition

Real World Contexts

Physical Form / Physical Objects

Tape Measure   DBO Chairs   Sky Remote   02 Cocoon   E-books   Medical Packaging

Passport Desk   Bloodhound SSC   Footlite   Rail Simulator   Control Room

FIG. 34 SNAPSHOT OF AN EARLY ITERATION OF THE ABSTRACTION HIERARCHY USED TO DEVELOP & ARTICULATE THE MULTIPLE LAYERS OF INTERPRETATION OF THE EXHIBITION AS WELL AS THE CONTEXTUAL 'CHUNKING' OF THE EXHIBITION.

acquisition and learning, was a way in which designers could consciously influence the motivational state of visitors to the exhibition as they navigated the exhibition environment.

FIG. 35 RENDERING OF EARLY CONCEPT FOR THE INTERACTIVE EXHIBIT DETAILING AND ENGAGING VISITORS WITH THE CONCEPT OF ANTHROPOMETRY – A SUBSET OF PHYSICAL ERGONOMICS, INCLUDING DETAIL DESIGN & CAPTIONS FOR THE EXHIBITS.

4.4.4 ABSTRACTION HIERARCHY

In contrast to other design approaches that enabled consideration and discussion of physical and spatial design factors in the design of the exhibition, the Abstraction Hierarchy (AH) presented the exhibition as a one page summary to articulate the value of ergonomics to new stakeholders and to support the design team to explore and rationalise the justifications for design decisions against the overriding aims and purposes of the exhibition. It does this by mapping the layers of abstraction or engagement and energy flows, or motivational energisation of behaviour required of users to transition between them.

In a traditional context of application an abstraction hierarchy would map energy in the physical sense, of electrical cabling or heat transfer. In this context the energy visualised is the motivational energisation, signifying the behavioural demands of the user physically or cognitively moving between the different levels of abstraction contained within the scope and context of the sociotechnical system in question, the exhibition. By ensuring a consistency of recursion between the layers of abstraction of the exhibition the AH was a tool, or methodological approach, that supported the designers to design for the consistency and authenticity of a user's interaction with the exhibition.

The AH ensured a focus on authenticity in the design of the exhibition which supported a focus on reducing discrepancies in the aims and values of the exhibition and how these were physically manifest within the exhibition space and through and adopted contexts and physically exhibited artefacts. The aims and values of the exhibition, and the public engagement with science project as a whole could then be designed or manifest at lower levels of abstraction, or more tangible representation. Such discrepancies whether recorded descriptively within the AH, or prescribed idealistically, could either be designed out or intentionally constructed to ensure

discrepancy free interaction of users or discrepancy creation to elicit higher levels of motivational engagement and interaction. The AH also allowed the design team to consider the subsequent forms of behaviour and motivational self-regulation users might elicit in these contexts.

The AH provided a means to benchmark why decisions at the top level of abstraction, through to the how decisions of the design team at the bottom as it does in all its applications. In this instance it supported, and would in future support designers, to communicate effectively with each other and with other stakeholders within the design process, contributing to enhanced social interaction and generative and democratic approaches to design.

4.5 CONCEPT EVALUATION

With the earlier results sections documenting the empirical assessment of this thesis in addressing research questions one and two, the final series of empirical assessments recorded in this thesis, those concerned with evaluating the motivational impact and levels of engagement elicited of users by the *Ergonomics Real Design Exhibition*, are addressed in an attempt to answer research question three of this thesis.
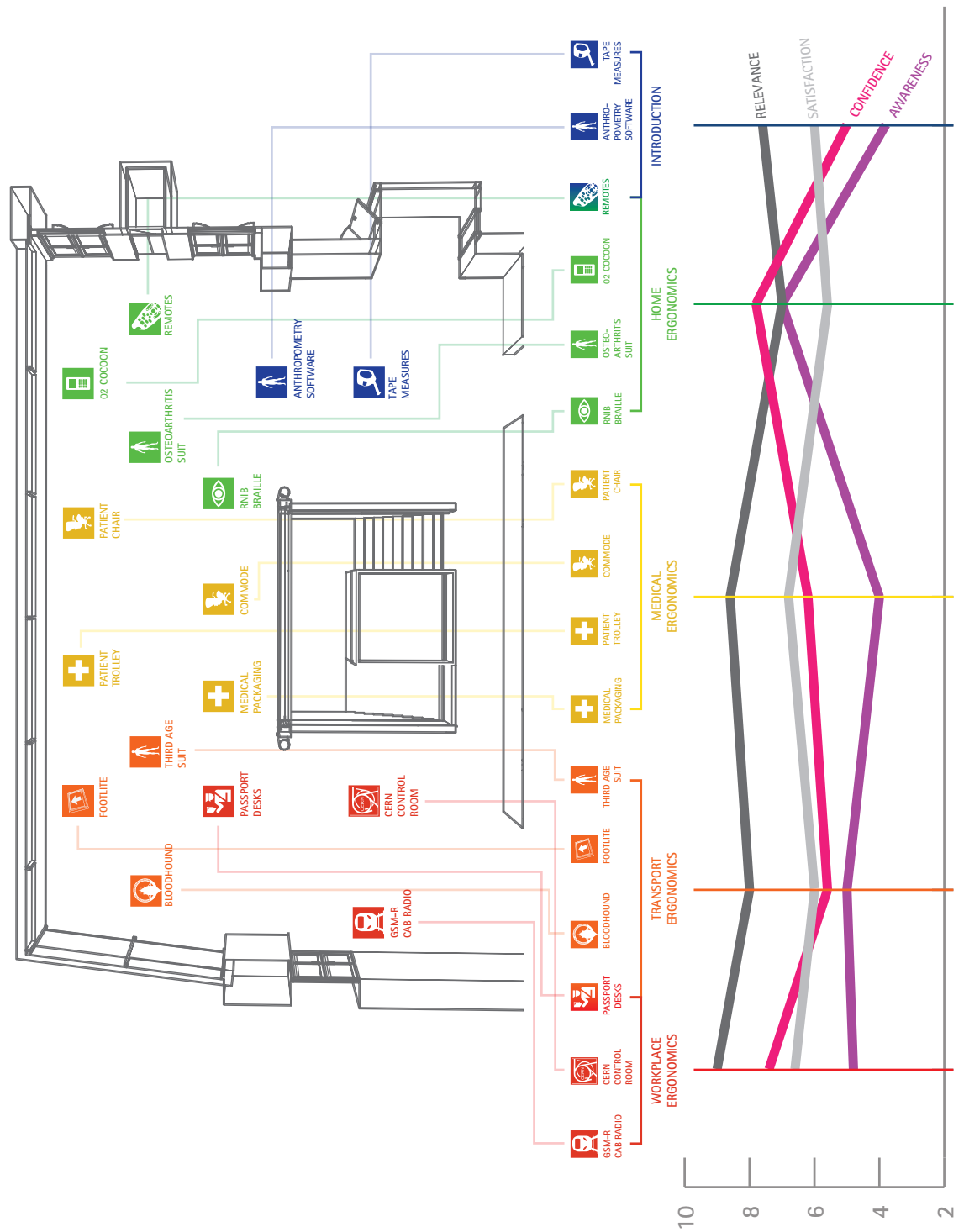
FIG. 36 EXPERT META-MOTIVATIONAL INTERPRETATION OF THE ERGONOMICS REAL DESIGN EXHIBITION

4.5.1 SELF-REPORT QUESTIONNAIRES

Self-report questionnaires were given to two groups, expert ergonomists and design students; the results of each group are provided below.

4.5.1.1   EXPERT ERGONOMIST DATA

This process uses the two-dimensional physical-spatio synthesis approach outlined earlier, and applies it to the finalised exhibition exhibits and physical orientation. This utilises the articulated levels of awareness, relevance, confidence and satisfaction (from Keller's 1983 ARCS Motivational Design Framework) and maps them to the part of the exhibition the respondents were referring to.

This visualisation allows the viewer to assess how respondents' levels of motivated engagement fluctuated as they navigated the museum environment. This enables a judgement about how the design of the exhibition affected these expert respondents' motivational engagement and motivational self-regulation.

Means Levels of:	WORKPLACE	TRANSPORT	MEDICAL	HOME	INTRO
EXPERT SATISFACTION	6.6	6	6.8	5.6	6
EXPERT CONFIDENCE	7.4	5.6	6.2	7.8	5
EXPERT RELEVANCE	9	8	8.6	7	7.6
EXPERT AWARENESS	4.8	5	4	7	3.8

TABLE 6: DATA FROM THE ARCS META–MOTIVATIONAL EVALUATION OF THE ERGONOMICS REAL DESIGN EXHIBITION, EXPERT SAMPLE

Whilst acknowledging the small sample size, these results demonstrate interesting trends of engagement as respondents made their way around the *Ergonomics Real Design Exhibition*. Engagement was composed of four facets of perceived prior awareness, perceived personal relevance, perceived confidence of in ability to remember the message and learning from the exhibit, and finally, their overall satisfaction of the experience.
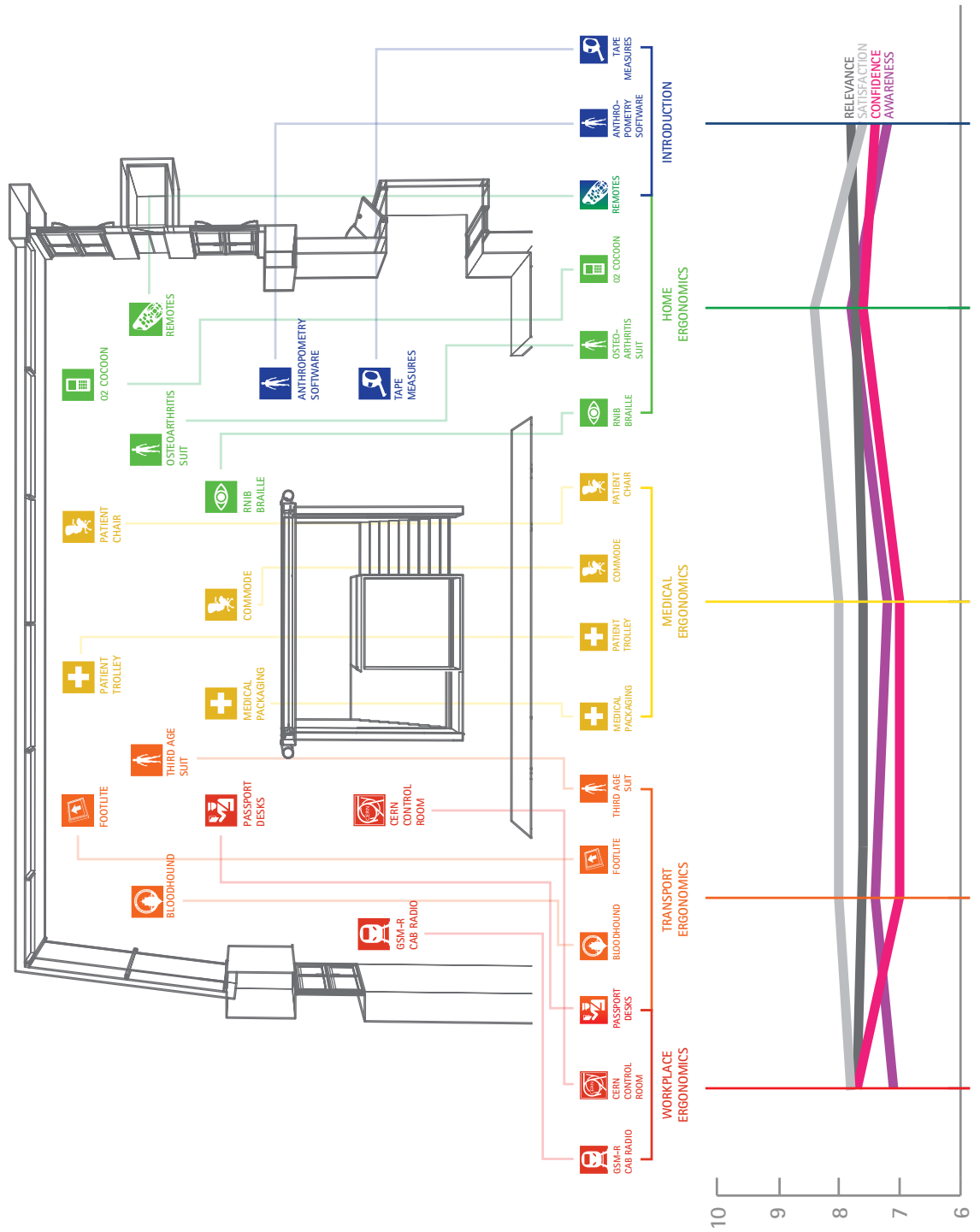
FIG. 37 STUDENT META-MOTIVATIONAL INTERPRETATION OF THE ERGONOMICS REAL DESIGN EXHIBITION

The relationship between the average values of relevance and satisfaction is clear (covariance = 0.36, p=0.01), indicating that as relevance increases so do the expert perceptions of relevance. High measures of relevance throughout the expert ergonomist data suggest that the majority of contexts featured in the exhibition were representative of and relevant to their schema of ergonomics as a discipline. From a design and curatorial perspective perception relevance is integral to the degree of motivational engagement that each respondent exhibited as they interacted with sections of the exhibition.

The only exception in relevance responses from expert ergonomists was in the Home Ergonomics context, which they perceived as less relevant. Despite the low relevance score, respondents indicated higher levels of awareness and confidence about what they had learned in this context, relative to other exhibits that they scored as more relevant. It could be hypothesised, therefore, that despite being perceived as less relevant and less consistent with the ergonomist's self-schema of the contexts that constitute ergonomics as a discipline, these exhibits were actually more engaging to them as result.

This finding is reinforced by the qualitative feedback gathered in section 3.5.2, the outcomes of which are detailed in 4.5.2. Comparing these two sets of data demonstrates that experts had more to say about the Home Ergonomics exhibit, whether positive or negative, demonstrating a higher degree of engagement and motivational energisation in engaging with the exhibit, even though it was considered less or not at all representative of the discipline.

This observation is a clear indication of the power of discrepancy as a motivator or energiser of behaviour. Despite Home Ergonomics being a contentious inclusion within the final exhibition, it proved to be an energising and engaging exhibit for non-expert participants. This could be because it was more consistent with their

existing expectations of ergonomics. It also proved an engaging exhibit for the professional ergonomists because it was discrepant with their prior perceptions.

Gathering rich user insights early in the design process enabled the design team to frame the series of exhibits that constituted Home Ergonomics as a motivating experience for professional and public participants. This exemplifies the differences identified in the literature review, of the industrial-era conception of public communication of science as a process of broadcasting 'an epistemological truth' versus the more recent process of 'engagement with science' which privileges the conception of the public as an empowered participant within the process of engagement and designs the intervention in a manner that acknowledges this.

There are also clear relationships between the expert values of awareness and confidence. In contexts where expert respondents declared that their awareness of ergonomics had been increased as a result of engaging with exhibits of a given context, they also recorded a correlated measure of confidence in their ability to remember and pass on this new awareness to another person. Whilst undoubtedly a basic measure of learning, this observation seems to support the hypothesis fundamental to the motivational design perspective, that sustaining motivation requires the opportunity for learning. The observation of Confidence in this respect could be considered a measure of the degree to which an individual has internalised the value of ergonomics.
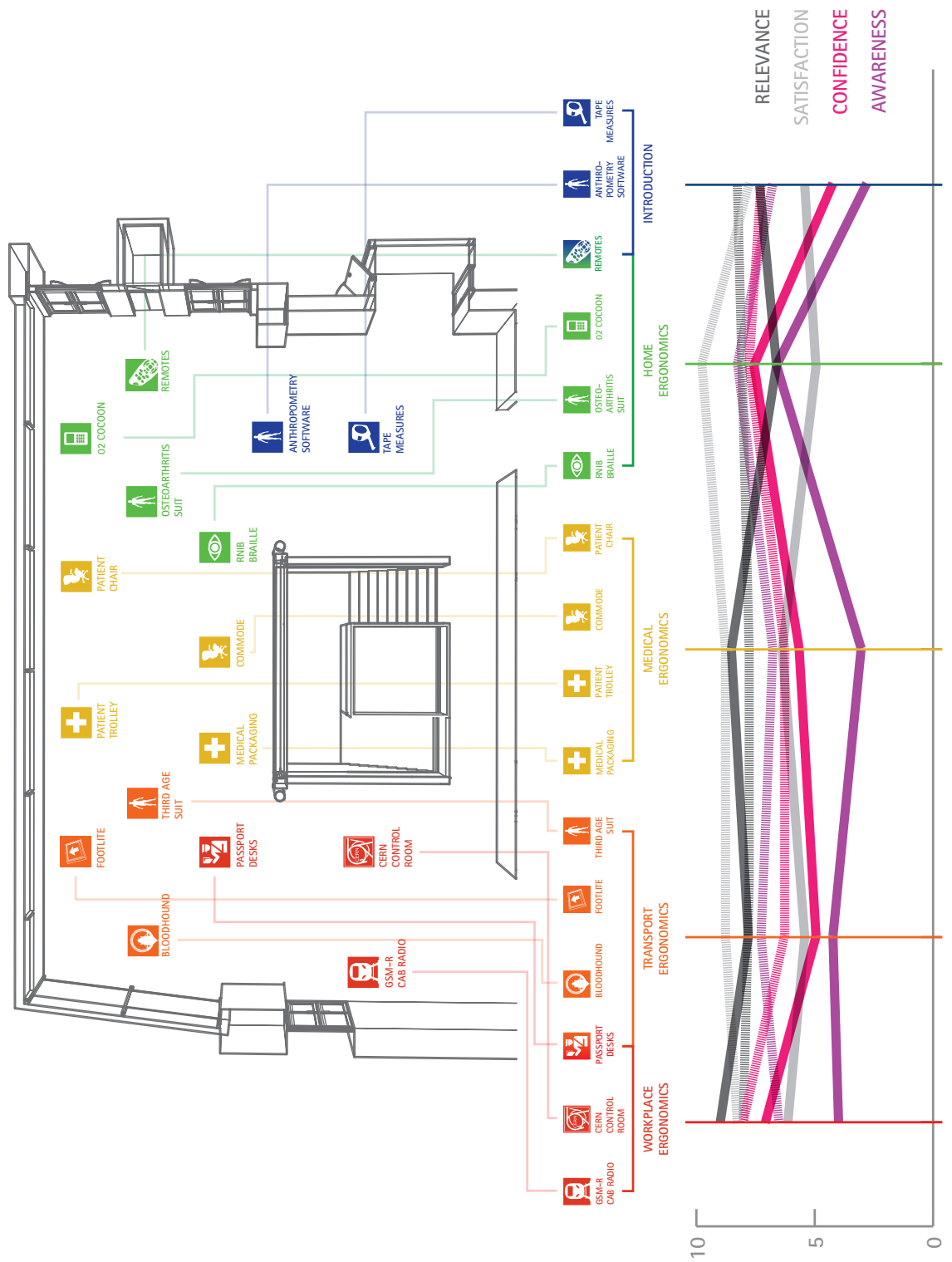
FIG. 38 COMBINED STUDENT & EXPERT META–MOTIVATIONAL INTERPRETATION OF THE ERGONOMICS REAL DESIGN EXHIBITION

4.5.1.2 DESIGN STUDENT DATA

Ave. Levels of:	WORKPLACE	TRANSPORT	MEDICAL	HOME	INTRO	GENERAL
STUDENT SATISFACTION	7.8	8.0	8.0	8.4	7.6	8.5
STUDENT CONFIDENCE	7.7	7.0	7.0	7.6	7.4	8.2
STUDENT RELEVANCE	7.7	7.6	7.6	7.7	7.8	8.4
STUDENT AWARENESS	7.1	7.4	7.2	7.8	7.2	7.9

TABLE 7   DATA FROM THE ARCS META–MOTIVATIONAL EVALUATION OF THE ERGONOMICS REAL DESIGN EXHIBITION, STUDENT SAMPLE

Data were collected from twenty design students, a larger sample than experts, and responses were closely grouped. The Home Ergonomics context resulted in the highest levels of awareness and satisfaction, as predicted by the public engagement with science literature reviewed earlier that suggested engaging non-experts with a context they are familiar with, or have least discrepancy with, will result in higher levels of engagement.

Student responses on perceptions of relevance are lower than the expert ergonomist respondents. They considered the Introduction section most relevant, followed by Home Ergonomics. The recorded measures of relevance were very similar throughout the exhibition (ranging from 7.6 – 7.8). This pattern was replicated with most of the other meta-measures of motivation with small ranges recorded.

Figure 35 illustrates the relationships calculated to determine which contexts of ergonomics had the greatest relationship to the students' perceived motivation and general perception of the public engagement experience overall. This analysis enables identification of the contexts of ergonomics most discrepant with existing public perceptions of the discipline, and the assessment of whether future approaches to

public engagement with ergonomics should adopt an approach-oriented or avoidance-oriented philosophy of engagement.

Respondents scored the Introduction section highest on the overall perception and engagement with the exhibition. All reported measures of awareness, relevance, confidence and satisfaction showed clear relationships with overall average reported engagement with the exhibition, as one might expect from the primacy-recency effect (Petty et al, 2001) and motivational and behavioural psychology (Asch, 1956).

The strongest correlation was Awareness of Home context and Awareness of exhibition as a whole (r=0.92, p=0.01). This indicates a stronger relationship between these two factors than any other two factors investigated. These results underline the design consideration expressed earlier in the literature review, of the importance of the primary point of interaction in a designed user experience, and the need to manage users' expectations in influencing overall perceptions of a user's engagement with the rest of the exhibition.

4.5.3 STUDENT STAKEHOLDER STRUCTURAL ATTRIBUTION OF META-MOTIVATIONAL FACTORS

Following the recording and contextualisation of the results of the student and expert motivational engagement data in the previous section Figure 37 explores the structural relationships between the various elements of the student data. The student data is explored here because the student engagement data also recorded a 'general perception' question asking them to record their generalised perception of how the exhibition had impacted upon their awareness, relevance, confidence and satisfaction of ergonomics. This, as explored in this diagram (fig. 37) allows the relationships between the student engagement with individual exhibit areas, and their perceptions of the exhibition as a whole to be profiled.

The implications of these findings for designers considering design for motivation are discussed in the next chapter.

4.5.1.3 COMBINED DATA

This analysis combines the data from experts and students in one visualisation; student data are indicated by a dotted line and experts by a solid line. It is clear that the Introduction as the primary context had a significant impact on overall perceptions of the *Ergonomics Real Design Exhibition*, although this was found to be less so in the case of the expert ergonomists.

Only one other context showed such a strong relationship with the overall perceptions of the exhibition, Transport. This is surprising when viewed in relation to the qualitative feedback from the expert ergonomists detailed in 4.5.2 and fig. 36 that suggest Transport generated least discussion and qualitative engagement.
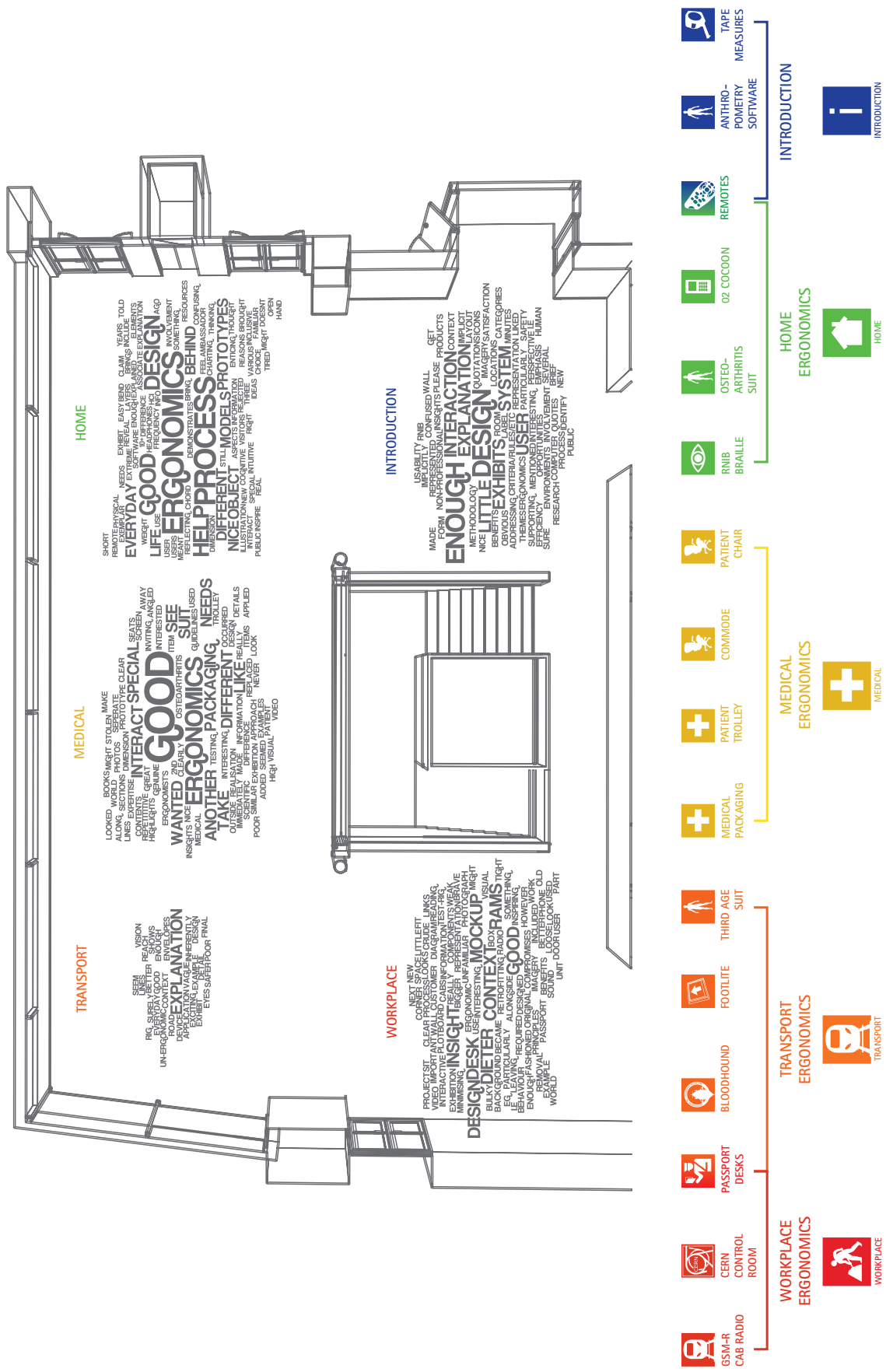
FIG. 39 EXPERT QUALITATIVE FEEDBACK ON EACH EXHIBIT CONTEXT

4.5.2 EXPERT STAKEHOLDER QUALITATIVE FEEDBACK

Figure 39 indicates, using the word clouds methodology as detailed in 3.1.4, the comments that the expert ergonomists made in relation to each context of the exhibition. This exemplifies an approach that could be used by designers to understand more subjectively how the contexts or facets of the multi-touchpoint user experiences that they design could be further refined.

This diagram also indicates which exhibits are the most engaging in terms of the degree of reflection, internalisation and opinion they provoked from expert practitioners interviewed. It is apparent that Home Ergonomics, followed by Introduction and Medical Ergonomics were the most engaging, with Transport being considerably less engaging. This analysis also reflects the earlier engagement analysis.

The implications of these findings for designers considering design for motivation are discussed in the next chapter.
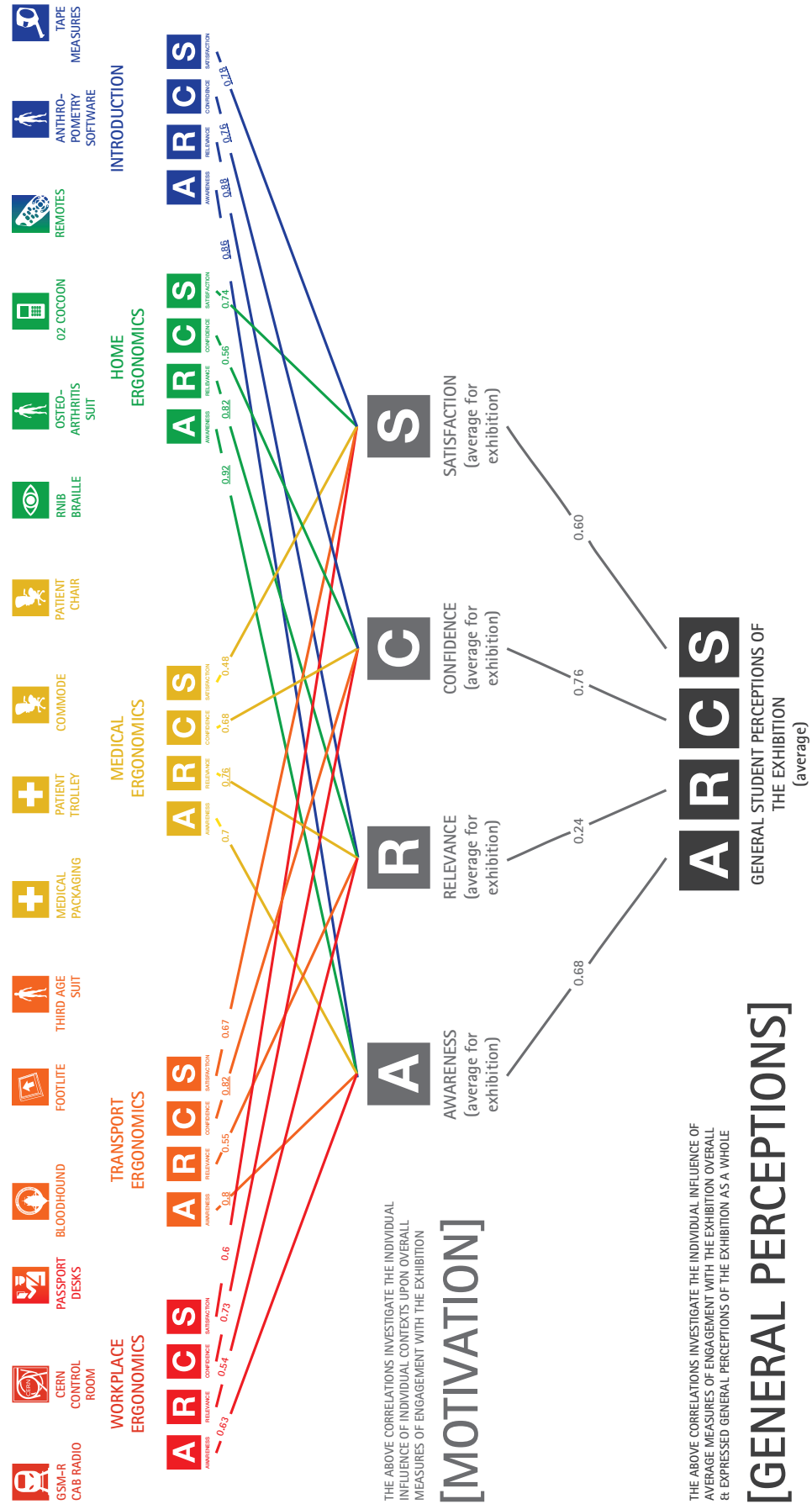
FIG. 40 DIAGRAM OF CORRELATING FACTORS FROM THE META–MOTIVATIONAL ANALYSIS OF THE ERGONOMIC REAL DESIGN EXHIBITION

5. DISCUSSION

This thesis has researched, defined and explored from the perspective of designers and design researchers the concept of adopting a motivational approach to their research and practice. It has synthesised and proposed a motivational design philosophy heavily informed by literature and previous research. Seeking to clarify and expand upon this philosophy, and address its primary research question which is to say synthesise the factors impacting upon the motivational engagement and self-regulation of users as they interact with designed products, systems and services, a conceptual synthesis of the role of motivation in design is presented, the Motivational Design Framework. The Motivational Design Framework contains a number of motivational concepts and precedents that designers and design researchers could adopt as design concepts, constructs or lenses through which to view a their existing practice and the behavioural impact of their work. This Motivational Design Framework could also provide a structure to further evaluate the role of motivation within the field of design research or evaluate the impact of design more generally, both contentions and points for exploration that formed the second and third research objectives of this thesis.

Ostensibly, the philosophy of motivational design explored in the course of this thesis represents a contribution to the field of Design Research, elucidating, examining

and visualising what Krippendorff (2004) described as the prevailing social norm of extrinsic motivation within the fields of Industrial Design and Human Factors. This thesis has constructed its synthesis through a broad analysis and interpretation of the role of motivation within these fields, and through reflection upon the implications of this perspective for design practitioners and researchers, particularly those interested in supporting public engagement or supporting practitioners who work in exhibition or museum design.

Designers need to transition from their narrow concern for the aesthetic and functional aspects of design to address the wider social space of designing systems and designing for society (Butler, 2010 cited in Berno, 2011). The methodology and results reported in chapters three and four of this thesis seek to provide support, and model and evaluate an approach, that designers and design researchers could adopt to respond to this challenge of designing to engage both the individual and engage society. The epistemology identified would allow designers to consciously influence motivation at an individual behavioural level and at a broader social behavioural level of abstraction as part of their design practice and research. Reflections upon the use of a number of well established tools and methods, and some more novel tools and approaches that designers can use to articulate, visualise and evaluate the motivational energisation of stakeholders within the design process are presented. These tools and their results are discussed in specific relation to the design of a public engagement with science museum exhibition *Ergonomics Real Design* and their impact on supporting design for motivational engagement.

The key findings from the literature, the case-based reflections upon this design and research process, the presented methods and the results of the evaluation of this design process are now discussed. Suggestions for the role that these methods and this philosophical approach can play in supporting designers and design researchers to

converse about, visualise and evaluate the role of motivation within the development of the products, systems and services that they design, are explored.

INTRINSIC
FACTORS

EXTRINSIC
FACTORS

INDIVIDUAL

AUTONOMY

PHYSICAL

RELATEDNESS

COGNITIVE

COMPETENCE

ORGANISATIONAL

SOCIAL
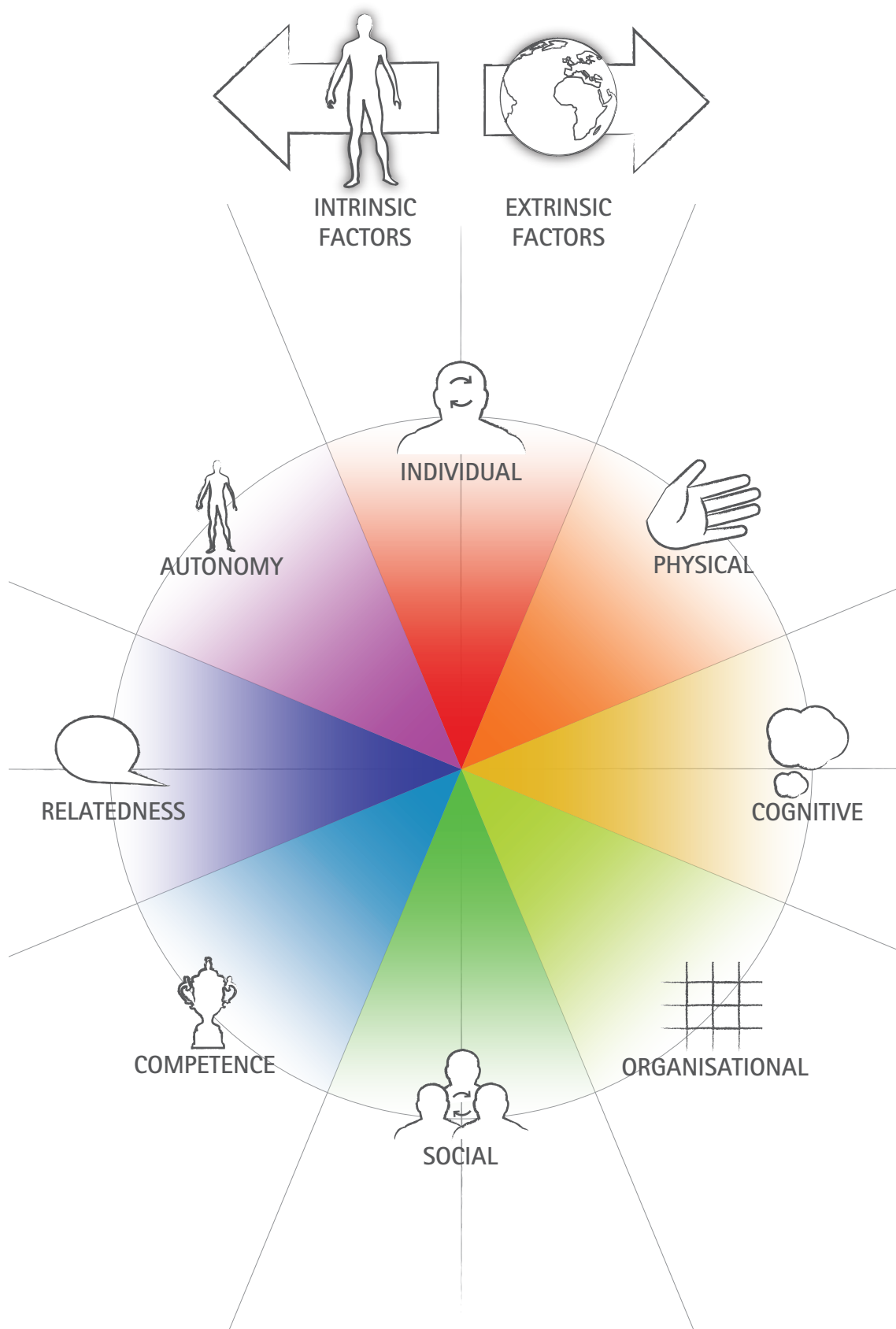
FIG. 41 THE MOTIVATIONAL DESIGN FRAMEWORK

5.1. THE DEVELOPMENT OF A MOTIVATIONAL DESIGN FRAMEWORK

Reviewing the motivational psychology literature and summarising key facets of motivational psychology as they relate to design practice and design research, has identified a three-tiered conception of how designers can interpret, verbalise, visualise and direct motivation as a result of, and within, the design process. Such synthesis also identifies how design practitioners or design researchers can consciously articulate, visualise and evaluate the broader individual and social impact of design. This framework, and the philosophy of motivational design that underpins it, encourages and supports designers to think of the motivational impact of the products, systems and services they design and thereby consciously consider the role of motivation and the motivated behaviour of end users throughout both the development and use of products, systems and services that they design. The Motivational Design Framework provides support to designers in further exploring and understanding human behaviour and in identifying tools, methods and design approaches for consciously influencing, monitoring or quantifying motivational engagement within and as a result of the products, systems and services they design, and for evaluating the impact of such engagement.

The broad theoretical and conceptual review of the public engagement with science, museal engagement and motivational psychology literature synthesised in chapter two of this thesis enabled a praxeological exploration and empirical assessment of the most pertinent facets of the role of motivation within design. These were assessed and selected as representatively as possible from the entire breadth of the design process from ideation, through concept and design development, to evaluation of the complete designed system. The case study intentionally excluded reflections or empirical assessment of the role of motivation within the manufacturing phase of the design process, as high quality first-hand practitioner reflections on this aspect of the design process were not available. Future research specifically focusing on the role of motivation in design throughout the manufacture or assembly phase of the design process would complement and expand those elements of the design process evaluated and discussed from a motivational perspective in this thesis.

5.1.1 DISCUSSION OF RESEARCH OBJECTIVE ONE; RESEARCH INTO, AND SYNTHESIS OF, THE FACTORS IMPACTING UPON THE MOTIVATIONAL ENGAGEMENT AND SELF-REGULATION OF USERS AS THEY INTERACT WITH DESIGNED PRODUCTS, SYSTEMS AND SERVICES

The literature review and this thesis as a whole was underpinned by three broad objectives, the first of which was research into, and synthesis of, the factors impacting upon the motivational self-regulation of users of designed products, systems and services. This resulted in the synthesis of a Motivational Design Framework, that brought together a heuristic of a number of the key facets identified throughout the course of this research as those affecting an end-user's motivational engagement and self-regulation which designers can or do influence in the design of products, complex systems or services. This synthesis was followed by a thorough review of these factors highlighted by the Motivational Design Framework in relation to concepts explored and recorded in the literature from the fields of Public Engagement with Science, Museum and Exhibition Design, Motivational Psychology and Instructional and Educational Design as these were deemed pertinent to the particular specific application of this research in developing a public engagement museum, and deriving user engagement in an educational museum and exhibition design setting.

The Motivational Design Framework was used in the course of the case-based reflections of this thesis, to aid the design team's reflections and consideration about how to demonstrate and communicate the breadth of value of ergonomics, and successfully motivate and engage members of the public, design and ergonomics practitioners and design students with the concept and application of Ergonomics. As a generative tool the Motivational Design Framework thereby enables design practitioners and researchers to consider the three core areas of human factors of ergonomics (physical, cognitive and organisational) and how theses elements relate and interface with other fields of design practice and research, such as the phenomenological, the rational and the pragmatic dimensions of experience asserted by Jones and Dubberly (2010)

or the design paradigm of industrial design, interaction design and social design, or participatory design.

Further exploration of the models, spectrums and continuums often used to summarise the impact or aims of design disciplines or theories of design, and which are useful in concept mapping the philosophy and validity of design as a tool to energise and direct human behaviour, may represent a fruitful area of design research building on that initiated within this work particularly with a view to further synergising the fields of motivational psychology with those of design research. It is further hypothesised that by way of example of such synthesis, human factors and ergonomics can play a foundational role in underpinning, influencing and informing design practice and research, particularly in supporting the development of autonomous human behaviour in relation to the design and use of complex systems or technology. Building on the secondary role of this framework in this thesis, the Motivational Design Framework is also potentially a valuable tool for the promotion of ergonomics and human factors more generally. Being, as it was, synthesised in conjunction with the development of the Ergonomics Real Design Exhibition, it could support promotion of the discipline by enabling individuals to more accurately map the dimensions or categorisations of ergonomics and human factors that it contains with those of the intrinsic needs and energisation of human behaviour that it also summarises, such causal mapping or cause-effect hypothesis and attribution of the impact or benefits of ergonomics. Mapping the impact of ergonomics in such basal behavioural motivational terms, enabled by the Motivational Design Framework may also be valuable in supporting the future public engagement with the work of ergonomists and human factors specialists by allowing the discipline to measure or describe its purpose and impact in more 'need-oriented' terms.

In the case of the *Ergonomics Real Design Exhibition*, and in the research recorded in this thesis the use of the Motivational Design Framework represented an exploratory

approach to identifying artefacts considered ergonomic, from across the spectrum of design practice and research, suitable for inclusion in the exhibition, whether they were a physical ergonomic intervention or initiative or indicative or representative of cognitive and/or organisational ergonomics. As was the case with products chosen as the result of an Inclusive Design research and development process (see section 2.6.1), the ability to rationalise the motivation behind their design as ergonomic resulted in the inclusion of these Inclusive Design exhibits in the exhibition. The validation of this approach and the use of conceptual synthesis and this so-called 'forced juxtaposition' of ergonomic interventions as an interpretive or curatorial approach within a museum context - so called systematic curation - would benefit from further investigation and research and validation in comparison with other comparable approaches to the design and definition of museum or exhibition exhibits.

Such an approach to rationalising or systemising the design and curation of exhibitions, as that supported by the Motivational Design Framework, represents one of its key contributions and as a tool for design practitioners the Motivational Design Framework arguably offers the possibility for design professionals more generally to justify their choice of design or, more specifically justify the orientation of designed services or multi-user, multi-touchpoint user experiences in the same motivational terms as those contained in the framework. Within the context of the case-based reflections from the *Ergonomics Real Design* project, also recorded in this thesis, the utility and potential of the Motivational Design Framework for supporting such reflective and rational purposes is highlighted, alongside the potential of using concept maps and conceptual syntheses such as the Motivational Design Framework as a generative tool to support future design practice and design research. Concept mapping within the field of design research has been pioneered, by amongst others, Hugh Dubberly (2010) and whilst the Motivational Design Framework lacks a lot of the grammar and syntactic rules that Dubberly tends to apply as the basis for such concept mapping, such as the use of noun and verb groupings of concepts and

relationships respectively within a concept map (Dubberly, 2000), there would be potential to explore development of the Motivational Design Framework to become compatible with similar formal logics, or other structured approaches to visualisation and comprehension of human behaviour and understanding.

As it stands at present, and to utilise Buchanan's (2005) notion of a 'basic' framework, or 'mode of enquiry', the Motivational Design Framework is exactly that, basic, and would require further practice use and research evaluation to develop it through the various stages of maturity that Buchanan outlines, namely the phases of applied and clinical maturity. This process however, if developed as a programme of empirical design research might enable the Motivational Design Framework to assume either an applied or clinical validity in supporting designers to conceptualise or interpret the motivated behaviour of their users, as either autonomy-seeking, social-relatedness oriented or competence-seeking for example. A process of further refinement or design research building on that contained in this thesis in addressing research objective one might also support or identify user behaviour as physically, cognitively or organisationally mediated, where at present it only offers designers an outline or 'lense' on those broad, complex and often overlapping concepts.

In conclusion, more conscious and deliberate consideration of the role of motivation and motivational self-regulation within the design process, and across the life span of the design process is possible as a result of the synthesis of the Motivational Design Framework in this thesis. Utilising the Motivational Design framework as tool within the design process, whether at the conceptual ideation phase of design development or in evaluating or refining the 'use' phase of the design process, does not necessarily demand designers to physically do much different in how they phenomenologically approach and enact their role and responsibilities within the design process. It does however demand and support designers to adapt the way they view and conceptualise the capabilities of the user as an actor or active participant

within this process. The Motivational Design Framework provides them eight 'lenses' through which to alternatively visualise and conceptualise human behaviour. An initial enquiry into how design as a discipline and designers specifically can view or conceptualise this generative 'Motivational' approach to engagement, and therefore support or encourage designers to adapt their design processes to better motivate and engage participants and their latent or intrinsic capabilities, or specifically as in this research, better motivate and engage their participants in the course the design process of a public engagement museum exhibition. Discussion of the results of this empirical component of this thesis forms a response to the second research objective of this thesis.

5.1.2 DISCUSSION OF RESEARCH OBJECTIVE TWO; IDENTIFICATION AND REFLECTION UPON THE MOTIVATIONAL DESIGN FRAMEWORK AND A PROTOTYPE MOTIVATIONAL DESIGN PROCESS.

The second research objective sought to build on the earlier exploration of the processes through which a museum or exhibition experience might be made more motivating with reference to the synthesis of the Motivational Design Framework, and the reciprocal demands this places, and opportunities that this creates, for designers. By exploring in more detail the concept of human motivation, through synthesis and evaluation of the Motivational Design Framework, and the role motivation plays in design, it was possible to synthesise both the fundamental tenets of extrinsic and intrinsic motivation within design. Presenting, in the process, a heuristic of motivation within the process of design, and thereby enabling a hypothesis of a design process that sought to specifically address these facets of human behaviour within its users and wider stakeholders. Having provided a framework to support such a changed perspective and support designers to embody a motivational design approach to their work in the Motivational Design Framework synthesised to address research objective one, this secondary research objective in this thesis focused on how designers might tangibly influence, direct and regulate the motivational energisation of their users as they interact with designed products, systems and services. The review of the literature that followed and which is recorded in chapter two of this thesis resulted in the topic of motivation being broken into six component parts: autonomy, relatedness, competence, organisational human factors, cognitive human factors and physical human factors, as exemplified in the Motivational Design Framework detailed in fig. 41.

As it has been suggested in the previous section, the synthesis of the key considerations from the motivational psychology literature, in the form of Motivational Design Framework, makes it easier for designers and design researchers to further their understanding of the components of motivated behaviour and consider how existing

design tools, processes and outputs support or limit the development of motivated behaviour in general or this specific segments or facets of it. The framework enables them to consider motivation as a product of the human need concepts of autonomy, relatedness and competence and consider how fulfilment of these 'human needs' or modes of human experience and interaction might be enabled or regulated by the industrial design and human factors based constructs of physical, cognitive and organisational design and, in particular, the rich repository of tools, methods and expertise that can already be attributed to, or identified from within the field of design research or from design practice as suitable in addressing each of these constructs. The physical, cognitive and organisational mechanisms, processes and affordances available to designers as part of the process of design, or that individuals can shape through, or contribute to, the process of design to regulate or exacerbate such human need fulfilment are inherently extrinsic in their manifestation. However, as explored in this thesis, and outlined in relation to this and the discussion of the previous research objective, engagement processes such as conversation and designers adopting a conversational approach to their work, with a focus on creating and diminishing discrepancy through such processes of conversation, make the traditional tools of industrial-era design and human factors less extrinsically deterministic and mediatory and allow more intrinsic elements of experience instead to be incorporated as part of a deliberate design process to elicit intrinsically derived and mediated behaviour by users of such products, systems and services.

Designers can manipulate and construct physical, psychological and organisational constructs in order to satisfy or exacerbate the human need constructs of autonomy, relatedness and competence. In doing so they can impact upon the motivational energisation required of, or exerted by, the users of the products, systems and services that they design. Each of these facets of human motivation, or as it has been termed in this thesis, facets of meta-motivational design research, can further help designers

to theoretically and pragmatically understand the motivational influence of their work by viewing motivation consciously at these fundamental levels of abstraction.

In addition to presenting these six segments of Autonomy, Relatedness, Competence, Physical, Cognitive and Organisational as a visualised conceptual framework or research synthesis and in addition to considering how such a synthesis might underpin and enable the development of a motivational approach to design, the Motivational Design Framework could be further developed and validated as a tool to aid designers' self-reflection and understanding of their position of motivational influence. The conceptualisation or proposed heuristic of the manifestation of motivation in design articulated by the Motivational Design Framework can, this thesis continues to argue, help increase designers' awareness or broad conceptual understanding of their ability to influence and support the motivational self-regulation of their users and stakeholders as they co-create, use and 'language into being' products, systems and services designers with or for, their users.

The conclusions from this objective of the thesis of synthesising the 'basic' components and dimensions of motivated human behaviour are that for design practitioners or design researchers, particularly those working in a museum or exhibition context, in order to consciously address the role of motivation within the design process, there is no explicit requirement for a praxeological shift in how they approach their work. In the first instance, all that is required is simply an awareness or change in how designers conceptualise and interpret the active capabilities, latent capabilities and potential for motivational energisation of their users. This thesis has drawn attention to this fact. Such an awareness of or attention to, the motivational capabilities, or underlying motivational needs of all humans can be achieved by design practitioners using the Motivational Design Framework, although that is by no means the exclusive tool available to designers to such an end. Illustrated within the Motivational Design Framework through each of the segments it contains, the process, for design

practitioners of deliberately motivating or engaging individuals would hypothetically and illustratively see designers choose to focus on motivating or demotivating users as a result of supporting or diminishing users autonomy seeking needs for example, or for another example seeking to ensure seamless and satisfying physical or cognitive interaction between users and the product or system in question. Just as a mobile phone, for example, might become more motivating if users find it the right physical shape and physical orientation for them, or if they are able to cognitively interpret the functionality afforded to them by the phone, the motivational design framework through having identified, and articulated these two components of human experience as integral to human motivation is capable of supporting designers to address these elements of user experience and engagement discretely and as part of a concerted process of enhancing user motivation and engagement. Designers, in pursuing a process of deliberate motivational engagement, could then choose to measure or evaluate their designs based on users perception of physical 'ease-of-interaction' or in terms of utility or in terms of how much more autonomously users are able to interact with the product or system to utilise just two examples of the eight components of user motivation that the Motivational Design Framework identifies. As users interact with designed experiences and sociotechnical systems, a change in the way designers conceptualise this interaction has the potential to facilitate the design of more motivating and more motivationally engaging interaction with and through the use of accordingly designed products, systems and services. This shift in perspective would require designers to alter their focus from concern with the manner by which users functionally or phenomenologically interact with products, systems and services, to one concerned with such functional or phenomenological aspects of user experience support users to motivationally and autonomously self-regulate their engagement with those same products, systems and services, or to use other examples, enhance a user's self competence or social relatedness in interacting with products, systems or services.

It is proposed that by enabling designers to explore the concept of motivation in terms of the base principles of human behaviour which ordinarily the term 'motivation' encapsulates, the Motivational Design Framework can support designers to address more complex social problems. The Motivational Design Framework can also support design professionals and design researchers through assisting them to conceptualise and measure the impact of design in motivational terms, whether that motivation is discrepancy-reduction oriented or more probably, discrepancy-creation oriented. The work of this thesis also enables design practitioners and researchers to ascertain whether the motivational energisation achieved through or by design is preoccupied with regulating the autonomy, competence or social-relatedness of the users of the product, system or service, or conversely, whether the designer is intent on extrinsically determining or regulating the physical, cognitive and organisational constraints of the design solution on human behaviour and its impact, such as is commonly the case in safety-critical applications.

The framework also aids the mapping of a variety of models of design, to demonstrate whether they address extrinsic or intrinsic sources of motivation, or indeed a combination of both. The Motivational Design Framework enables the concept of motivation to be introduced visually in a descriptive, analytic, or generative sense as part of an applied design process or as part of an investigation of design research, 'through design' (Cross, 1999). The process of designers and design researchers adopting and developing the Motivational Design Framework is intended to assist a discussion or support a series of conversations amongst the design team and other project stakeholders about the motivational influences and implications for motivational engagement provoked by the subject matter or context in question. Such a process or philosophy of motivational design, identifying motivational discrepancy from a series of conversations with users, was also exemplified by the work recorded and analysed in this research.

The notions of design for behaviour and persuasive design have throughout the course of the period whence this research has taken place, become far more established terms within the contemporary design practitioners' and design researchers' lexicon. A systematic review of the design research literature that seeks to further explore and identify the areas of design research already established in designing to support the behavioural constructs of increased autonomy, relatedness and competence would be beneficial in supporting designers to greater understand, influence and support the role of motivation within design. Another avenue of future research could be the systematic reflection upon the existing body of ergonomics and human factors literature that deals with physical, cognitive and organisational human factors and the relationship of these to understanding and conceptualising motivation.

The Motivational Design Framework may be of less use to designers who have implicitly designed in a manner consistent with motivating their users, through seeking, for example implicitly working to increase the autonomy, relatedness or sense of competence of their users throughout their design interventions and design practice, assuming that, they have adopted the same means of doing, namely, through manipulation of physical, cognitive or organisational structures. That said, the literature review confirmed that few designers or design researchers have publicly made the ambition of consciously or explicitly influencing the motivation of their end users the central objective of their design intent. Whilst there are doubtless ethical and financial reasons for this, still fewer designers have reflected on their attempt to consciously motivate and engage users and thus, the notion of designing for motivation or adopted the philosophy of Motivational Design is a less clearly articulated concept and in need of further development and exploration. This thesis has, through its case based reflections on the process of researching and developing a museum exhibition which was designed to consciously and deliberately engage its participants, also set a new precedent, building on that of Ingemann (2010) in the field of Design Research for documenting such reflective practice in a reciprocal

and conversant manner. More reflective exercises such as this would significantly benefit the field of design research and if such exercised continued to focus on the reflection upon the role of motivation within design, they would significantly help address the second research objective of this thesis of identifying and elucidating the characteristics and suitable tools for a motivational approach to design.

Despite the apparent utility of the Motivational Design Framework in supporting designers to conceptualise and visualise the role of motivation within and throughout their design process, the real crux of the second research objective of this thesis; to synthesise a motivational approach to design or Motivational Design Process, is addressed in this thesis through the case based reflections and conversations outlined in section 3.2 and detailed throughout the extensive literature review. Whilst highly specific and contextualised these, combined with the design process recorded in sections 3.3 and 3.4 which detail a motivational approach to design taken in the course of a public engagement with science exhibition *Ergonomics Real Design*, demonstrate the possibilities and precedent for designers in adopting a motivational design process. Future research could perhaps attempt to either record similar case-based reflections on the process of consciously influencing the motivational engagement of users within another designed context of multi-user, multi-stakeholder service experience to see whether it is possible to derive any similarities or discrepancies between that approach and the one recorded in this thesis. Alternatively and additionally future research might also attempt to adopt a similar design process to than adopted in this thesis in an attempt to observe any similarities in the engagement that was elicited as part, or as a result of that process amongst the users, designers or wider stakeholders of that process. As it stands however, both the process recorded and detailed in this thesis and the case-based reflections that accompany and discuss it represent a novel record of an attempt within the field of design research to consciously and specifically influence the engagement of users or participants of a designed multi-user, multi-touchpoint public engagement exhibition, and as such answer the

secondary objective of this thesis based on a thorough an extensive review of the design research literature.

This research has considered the implicit assumption that motivational energisation occurs in any user's interaction with a designed product, system or service. It considers the role of motivation, where possible by reflecting upon largely established approaches to design rather than in the development of novel methods. This builds an understanding, as far as possible within the limits of a single case study and one based within a 'real world' applied design project of the identifiable characteristics of motivation and of a motivational design process, and how those can be addressed within established design practice and research, particularly through the use of conversations with stakeholders and a subsequent conceptual synthesis of the ideas and concepts exchanged in these conversations. Whilst the Motivational Design Framework represents a novel approach to conceptualising motivation within design, it was felt more appropriate to begin to address the third research objective of this thesis, that of evaluating the motivational impact of design, by resorting to more established models of motivational design or motivation within an instructional setting. As was outlined in chapter three and four of this thesis, the identified model for the empirical evaluative aspect of the motivational impact of the *Ergonomics Real Design Exhibition* was Keller's (1983) ARCS Model, recorded in section 3.5 and 4.5. This was adopted to ensure that the validity of the Motivational Design Framework as a tool for designers and conceptual synthesis it offers designers was not inherently linked to or limited by the public engagement context of this research and was representative of alternative conceptions of Motivation in Design. Future design research exploring the role of motivation within design might therefore consider adoption of the Motivational Design Framework as the framework through which to measure and evaluate such motivational impact across the product development lifecycle or to evaluate users' motivational fluctuations or engagement within the

course of their interaction with products, systems and services. This thesis will discuss the results of the evaluation, as it was in fact conducted, in due course.

5.1.3 DISCUSSION OF RESEARCH OBJECTIVE THREE; TO IDENTIFY FACTORS TO BE CONSIDERED BY DESIGNERS INTENDING TO CONSCIOUSLY INFLUENCE THE MOTIVATION OF THEIR USERS, AND TO IDENTIFY AN APPROACH TO MEASURING MOTIVATION.

The visual synthesis, exemplified by the Motivational Design Framework which synthesised to address the initial research objective of this thesis, also helps address its third research objective. The third objective of this thesis focused on identifying from the literature the factors that designers need to consider when intending to consciously influence the motivation of their users, and explored the question of how these can be measured. The measurement and evaluation of 'influential motivational factors' within the locus of control of designers as part of a Motivational Design Process was addressed in the case based reflections outlined in section 3.2 of this thesis and in more empirical detail through evaluation of the motivational engagement derived by users in interacting with the resultant exhibition developed in parallel to those case-based reflections. This empirical approach to evaluating the motivational engagement of users in interacting with a museum exhibition, is detailed section 3.5. This latter empirical aspect of the research contained in this thesis utilised 'meta-motivational' in-situ analysis and self-reflection by expert and non-expert participants as they navigated the *Ergonomics Real Design Exhibition* and as such, is presented in this thesis as a novel approach for designers in measuring the motivational engagement of users interacting with a multi-user, multi-touchpoint user experience such as in this case, the *Ergonomics Real Design* public engagement exhibition.

The research in this thesis culminates by identifying consensus from a review of the literature that the museum and exhibition design, and interpretative process within these contexts is, like much of the result or outputs from design practice, becoming increasingly socially mediated. This recent awareness or conscious deviation of focus within the field of design research from a prior concern with artefact-mediated approaches demands more of designers' abilities to develop social engagement and

promote stakeholder participation in the design process, rather than relying purely upon an artefact-mediated approach to engagement.

In the terms of the Motivation Design Framework, this philosophical shift within museal and exhibition design processes represents a shift from a design intent directed solely and deterministically by designers, to a situation where the design intent of museum design generally, and the process of public engagement with science specifically, is increasingly focussed on developing visitors' sense of relatedness with the subject matter through increasingly performative and participatory modes of engagement and interaction. Correspondingly with this insight, a number of design methods were adopted, developed or reflected upon throughout the empirical enquiry of this research with the aim of evaluating and supporting the social, conversational and therefore participatory design of a public engagement exhibition. Using a case-based approach, the implications of these specific methods, namely that of structuring conversation with users as part of the design approach or design philosophy was considered in sections 3.3 and 4.3. The utility of these conversations, underpinned by conversational and cybernetic theory was, significantly, also synthesised into a series of performative contexts, or 'chunks' that this research, and the design process it records, hypothesised would result in both more participatory, but also more motivationally engaging interaction with visitors to the resulting exhibition.

These social approaches, to consulting users as part of the development process, whilst not novel within the context of design research, are considered as part of this research and in addressing this final research objective, as a novel attempt to integrate user-centred approaches to design with those potentially more Machiavellian and intended to enable designers to consciously and specifically influence the motivational engagement of their participants. As this 'Motivational Design Process' related to the case study of this thesis, the *Ergonomics Real Design Exhibition*, the design process exuded a particular focus on determining the points of discrepancy

within users' interaction with the topic of Ergonomics, prior to their engagement with an exhibition that both attempted to reconcile such discrepancies, but that also attempted to consciously create additional discrepancies in the perception of visitors participating in the experience. By implication, the notions of creating discrepancy and diminishing it relative to the prior conceptions in the user's minds before they visited the exhibition would illicit both social motivation and engagement and behavioural self-regulation of users as they interacted with the designed experience.

Conversation between designers and users is thereby suggested as a means by which designers can identify critical interactive "hot-spots", otherwise referred to as critical service moments in the discipline of service design, to consider or reconsider user-motivation, engagement and motivational energisation. These critical-moments of motivational regulation of user behaviour enable designers to more efficiently identify where motivational breakdowns occur within users' interaction with their designed experience, and therefore where their energies might best be invested in ensuring more engaging or gratifying designed products, systems and services. Further validation of the identification of such motivational hotspots within the design and use of products, systems or services is identified as an area of future research for greater reflection and empirical validation.

Evaluation of the role of these motivational "hot-spots" within the *Ergonomics Real Design Exhibition* was addressed as part of this thesis in an attempt to introduce consistency to reflections and evaluations upon human motivation within design research and practice, but clearly in this instance was only addressing an attempt to measure and evaluate end-user motivational engagement in the context of a public engagement exhibition in a museum context. The case study reported in this work deliberately intervened in the course of users' interaction with a designed public engagement exhibition in an attempt to empirically assess the tendency for human motivation to fluctuate across different domains or conceptual contexts of application,

and also assess motivational changes and users regulation of motivation temporally within the same application domain. From this exercise, detailed in sections 3.5 and 4.5 of this thesis, it is possible to discern a number of key implications of both a socially mediated, conversational and participatory approach to engaging users in the design of a public engagement exhibition, but also demonstrate some interesting and potentially generalisable implications for the structuring of public engagement exhibitions in future and the design of multi-touchpoint designed service experiences more generally.

Designers and design researchers could also attempt to reconcile understanding of how human behaviour adapts, self-regulates and evolves in response to the sort of phenomenological stimuli that designers typically shape and manipulate. This is a challenge faced by designers addressing inclusive design problems or design products that target elderly, physically or cognitively impaired users. Equipping designers with a greater understanding of the development of human capability and behaviour over time, and attempting to measure the motivational energy humans exert in response to such dynamic events and experience, will ensure the evaluation of adaptable, scalable and engaging products, systems and services (for more on this theoretical perspective see Bisset, 2010).

The case study research utilised the ARCS Framework as a means of assessing the meta-motivational impact of the exhibition design. Future design research could adopt a similar approach, using the categorisation of the Motivational Design Framework in the same manner as those from the ARCS Framework that were recorded in this research. This research established the validity and precedent for conceptual frameworks such as the ARCS Model and the Motivational Design Framework, as tools to aid designers evaluate the role of motivation within, and as part of users' interaction with the products, systems and services they design. This research also establishes this approach as a means by which designers might evaluate the

motivational engagement of their work. For the validity of these claims however to be ascertained, future research should seek to confirm the validity of this approach in both similar contexts and in those outside of the museum and exhibition domain as well as compare this approach to other established or alternative modes of measuring user engagement and motivational energisation qualitatively and quantitatively.

5.2 DISCUSSION OF THE CASE BASED REFLECTIONS

A series of design practice oriented reflections were recorded in the research. These reflected upon the challenges and opportunities in adopting a motivational approach to design through action-reflection upon a single case-based practice oriented design project. This case study approach utilised a range of methodological approaches including data gathered from the implementation of a number of tools, such as user personas, two and three dimensional visualisations and abstraction hierarchies. These tools were introduced for multiple purposes in the course of the *Ergonomics Real Design Exhibition* Project, and they could be adopted as tools to support designers conceptualise motivation and support social motivational energisation within the design development process of products, systems and services in future work.

5.2.1 PRESENTATION OF THE CASE BASED REFLECTIONS

Case-based reflections on the literature reviewed throughout this research, highlighted in yellow, represent an approach to integrating design research with first hand reflections on design practice. This, as an approach to design research, represents a prototype for future studies structured to record designers, or a design team's, reflections upon their design decision making in general but also specifically their design decision making in relation to consciously influencing the behaviour and motivation of the stakeholders in the products, systems and services they design. This epistemological or philosophical shift for designers and design research integrates and enables designers to add value to the processes they may currently use to define functionally and aesthetically, the products, systems and services they are designing.

5.2.2 LIMITATIONS OF THE CASE BASED REFLECTIONS

The limitations of the reflections contained in this study are that they grew organically from practice based challenges faced by the researcher, arising from his experience as a design practitioner as a member of the design team on the *Ergonomics Real Design Exhibition* project and from the literature synthesised during his design research. As such the case based reflections contained in this thesis represent ad-hoc observations based on those experiences rather than more focussed or structured dialogic, investigative approaches to case-based reflection, such as those typical in the domains of aviation, law and medicine (O'Hare et al, 2010) or as in the pioneering, and more intrinsically mediated case-based reflections of Schon (1983), architecture. The introspective, ad-hoc reflections reported here are relevant as a method of research into design practice, in that they afford researchers to introspectively analyse design practitioners' efforts to consciously converse about, model and influence user behaviour.

5.3 THE ROLE OF CONVERSATION IN SUPPORTING MOTIVATIONAL DESIGN (RQ1)

Conversation was used in this research, and could be utilised in future research, to inform the design process and to assist the design team to consciously anticipate the motivational impact of the design process.

5.3.1 THE ROLE OF CONVERSATION IN SUPPORTING MOTIVATIONAL DESIGN (RQ1) – EMBODIMENT

Conversations with the public were fundamentally phenomenological, dealing with uncovering users' conscious experience of ergonomics and the meaning they derived from that. There appeared to be a distinct lack of confidence in the members of the public interviewed to provide a phenomenological vocabulary of ergonomics. This does not mean individuals were not conscious of ergonomics, rather, they struggled to articulate that consciousness. People resorted to analogy and metaphor relevant to their everyday lives, and yet there is a distinct lack of personal reference or embodiment in the results of this study (Grant and Williams, 2010).

5.3.2 THE ROLE OF CONVERSATION IN SUPPORTING MOTIVATIONAL DESIGN (RQ1) – THE ROLE OF METAPHOR, ANALOGY AND NARRATIVE IN SUPPORTING ENGAGEMENT AND EMBODIMENT

Respondents' use of metaphor, analogy and narrative demonstrates the standard way people attempt to personalise and define meaning from 'languaging into being' their experiences (Krippendorff, 2004; Krippendorff and Butter, 2007). The rather disembodied phenomenological response identifiable in the responses gathered correlates with the assertion from the *Ergonomics Real Design* Project Team at the onset of that project that people only tend to notice or adopt an embodied intrinsically motivated response to ergonomics, when it is absent. By implication this often tends be as part of an anti-motivated attempt to avoid the negative implications of such a situation or potentially serious event. Ergonomics is the science responsible for reducing the friction between people and sociotechnical systems and it appears it is only noticed where the friction has not been reduced sufficiently. One can infer from this analysis that when ergonomics is at its most effective or most valuable, the lack of phenomenological friction it creates, or the conscious experience it provokes, results in people failing to infer its presence in the environment or correspondingly its influence as a scientific discipline or as a motivational influence upon their use of the products or services they are engaging with. This insight, developed though the research recorded in this thesis, affords designers some key insights into the level of engagement and internalisation of their users as they design for them.

The first research question (RQ1) sought to explore the role of conversation in supporting designers to consciously articulate the role of motivation in their design. The data collected indicated that many users express views and a relationship with ergonomics that can be observed as typifying an extrinsically mediated response. They describe a utilitarian and extrinsically benchmarked relationship and level of prior engagement with ergonomics, rather than an embodied assessment or reflective personal experience. This could be analysed further as a future course of research and

structured reflection, in conjunction with further reference to Deci and Ryan's (2000) Cognitive Evaluation Theory (CET) Framework, to guide and structure future public engagement with science. The CET Framework represents an interesting and pertinent framework against which the notion of moving the public upstream from awareness to full engagement might be evaluated.

5.3.3 CONVERSATION THEORY AS A FRAMEWORK TO ELUCIDATE AND MEDIATE INTRINSIC AND EXTRINSIC PERCEPTION OF EXPERIENCE

Such observations as those recorded in conversations with members of the public (detailed in section 3.3 and 4.3), are usually in contrast to what a designer might expect of as an intrinsically mediated or intrinsically motivated response in assessing baseline and existing measures of motivational engagement. In such an instance where by contrast, users were intrinsically motivated, designers might expect individuals to exhibit the sort of embodied phenomenological response discussed earlier (Krippendorff and Butter, 2007). The observable tendency, in the case of the members of the public interviewed for this research, is to exhibit more extrinsically mediated and disembodied behavioural responses. When viewed in juxtaposition to the Motivational Design Framework, this suggests that designers should seek to provide their users with a more physically salient experience of the context or concept they are seeking to engage users with, if they are to be successfully intrinsically motivated by it.

The more embodied a perception, or physically salient an experience, the more intrinsically motivating, either positively or negatively it is likely to be. When considering such an implication in terms of how it relates to designing for motivation generally, if their users are exhibiting disembodied attitudes and behaviours towards a given concept, product, systems or service, as exemplified by largely resorting in conversation to metaphorical, analogous or extrinsically mediated levels of reflection and description, designers might wish to make users' experience of the context, concept or product in question towards the more physical and tangible. In other words, making the experience more visceral. In many senses this same approach can be seen in the evolution of the fields of critical design over the past ten years.

The interview data suggest that conversation is useful for designers to pinpoint the embodiment users exhibit in describing their existing understanding of a concept,

product, system or service. There are alternative ways of elucidating these user insights and reflections, such as asking visitors to draw or model their current perceptions. These are challenges for designers who may themselves have a more embodied sense of the context of a given concept, product or service proposition or who may, as a result of using more kinaesthetic approaches to concept and design development such as drawing, modelling or manufacture have a more embodied approach to the concept, product or service in question themselves.

There is significant potential for designers and design researchers in continually monitoring the levels of integration, internalisation and embodiment exhibited or perceived by all stakeholders engaged in the process of designing or developing products, systems and services and throughout the design process or product-service lifecycle. Such monitoring of the level of embodiment warrants further investigation.

5.4 THE ROLE OF CONVERSATION IN SUPPORTING MOTIVATIONAL DESIGN (RQ1)

Few of the conversations with the public occurred at a praxeological level (see sections 3.3 and 4.3). Respondents were not generally confident in articulating either how or why they perceived certain things to be ergonomic or indeed why these artefacts were more valuable to them as a result.

5.4.1 THE ROLE OF CONVERSATION IN SUPPORTING MOTIVATIONAL DESIGN (RQ1) – FIRST AND SECOND ORDER CONCEPTIONS OF CONVERSATION & WHAT THEY REVEAL ABOUT THE MOTIVATION OF THE PARTICIPANTS

As Krippendorff and Butter express "...ordinary people are not expected to have a second-order understanding, or to consider large numbers of contexts, as designers need to do, [however] meanings that are narrated [by the public] create future contexts of use [and] occupy much of everyday life" (2007, p.18). Implicit in this assertion, and following the rationale outlined in the review of the literature, the process of allowing people to narrate their everyday experiences through the conversations conducted with design researchers, allowed individuals to develop their second-order understanding and levels of interpretation of ergonomics, the so-called bigger picture that fuels assessment of whether individuals are successfully motivating or regulating their behaviour or otherwise.

As the research sought to understand, an interpretation such as this, and the insight it provides about user behaviour, underlines the importance of conversation for designers seeking to motivate and greater engage their end users. In this instance, conversation acts as the mechanism by which it becomes possible to furnish users with a bigger picture view, or through which designers might better inform their understanding of the bigger picture, or context of which their users perceive themselves to be a part as they interact with products, systems and services. The conversation designers might have with users to understand their motives early in the design process, becomes the praxis and the first hand experience through which both parties can develop an embodied sense of where the other is coming from, and through which they can co-create a shared understanding of definition of the product, system or service in question and the value it creates.

5.4.2 THE ROLE OF CONVERSATION IN SUPPORTING MOTIVATIONAL DESIGN (RQ1) – THE DESIGNER AS A COACH TO THE USER

The apparent lack of praxeological understanding or confidence in performance, elucidated by the conversations with users, in this research and in the development of the *Ergonomics Real Design Exhibition*, also underlines one of the earlier contentions that initiated this research, that a process of motivational design might offer more in terms of enhancing user motivation if it is developed in conjunction with, or as part of, a process of instructional design. The process of skill acquisition, the conscious and deliberate acquisition of skill or praxeological understanding, might afford a way of designers conceptualising and consciously directing and developing users' skilled behaviour, and by implication, their motivational engagement and self-regulation of behaviour. The designer in this instance becomes the tutor, or the coach, as they share in the process of developed understanding and engagement with and of their users.

Deliberate skill development is conceptually similar to the process of deliberately motivating individuals. Given that Keller's (1983) ARCS Model of Motivational Design was developed to support instructional design and skill development this observation is not without precedent in the field of Motivational Psychology and the field of Design Research. There is potential for further studies to examine the implications for motivational engagement if they are considered as part of a structured process of praxeological or professional development. Such notions relate closely to the idea expressed in this thesis of a public engagement exhibition with Ergonomics, such as *Ergonomics Real Design* being more a process of empowering individuals to embody and develop the skills and practices used by professional ergonomists, a participatory and performative, socially-mediated approach to engagement, rather than the converse, traditional legislative or interpretive process of public engagement that is more, aesthetic, static and artefact-led. Such participatory and performative ideas for future public engagement initiatives represent a significant area for future design

development and should be of interest to other designers and design researchers interested in designing to support public engagement with science.

5.4.3 THE ROLE OF CONVERSATION IN SUPPORTING MOTIVATIONAL DESIGN (RQ1) – RECIPROCITY IN ENERGISING & EMPOWERING THE RELATIONSHIP BETWEEN DESIGNER AND USER

Respondents shared their ideas and assumptions about the context of the designed system, specifically in revealing what contexts they perceive ergonomics to be of particular value. As the conversations progressed interviewees seemed more content or energised and motivated as a result of the conversation. This could be a result of the fact that many of the participants found their perceptions were to some extent shared with others, or at least understood by the researchers as being typical responses. It became clear through conducting the conversations with members of the public that the conversational process itself had the potential to be motivating for participants. One might speculate that this was due to it being energising and inspiring for the designers to begin to embody, inform and constrain their own idea of what, in this instance, the *Ergonomics Real Design Exhibition* might become. It could also be suggested that from the perspective of the interviewee, one might speculate that the conversations were engaging and motivating for participants, as it was empowering for them to feel that in some way they were influencing or informing the design of an exhibition at a prestigious venue such as, in this context, The Design Museum, London. Whilst this phenomenon of conversations as an inherently motivating feature of the design process will require further, more controlled, research, it is possible to frame and discuss such perceptions in conjunction with the Motivational Design Framework to evidence their utility and to help structure inspections of why this observed phenomena, of conversation being an inherently motivational aspect of a successful design process, might occur.

It could be argued that these conversations, in seeking to understand more about members of the public's perceptions of ergonomics, were motivating to participants because they helped the design team to conceptualise, organise and begin to contextualise the concept of ergonomics in terms of how users cognitively, and to

a lesser extent physically, reflect on their experiences with it and within it. This, as a process of autonomic and social relatedness highlights, with reference to Deci and Ryan's Self Determination Theory, one explanation for conversations being motivating, as by definition of the Motivational Design Framework and the literature reviewed such social relatedness is an intrinsically motivating need possessed by all individuals. These insights gathered from the conversations with the public might also have been for the way they began to inform the design of how the designers might more autonomously begin the process of defining the exhibition.

The insights gathered from the conversation data enabled the design team, through the process of conceptual synthesis detailed in section 3.6, to consider and inform how they might begin to assemble the public engagement exhibition. The conversations conducted empowered interviewees to define what ergonomics meant to them, serving as an example of these conversations being useful to the process of motivational design, in assisting the designer in reducing the discrepancy they were tasked with addressing themselves, namely of defining the exhibition and engaging the public with it. This notion of conversations as a tool for sharing the responsibility and managing risk within the design process, is one greater explored by Rickinson, Sebba and Edwards (2011).

With reference again to the Motivational Design Framework, it is possible to suggest that being interviewed was motivating and energising for the users because it enhanced their sense of competence and relatedness, as the responses they gave were going to help define an exhibition in a prestigious venue.

Creating an environment that challenged or stimulated people's second order beliefs and ideas about ergonomics, in the same manner as these conversations did, is a design approach that the ARCS meta-motivational analysis detailed in section 4.5.1 and 4.5.2 highlights. In relation to the *Ergonomics Real Design Exhibition*, a process

of energising positive and negative motivation was used; in the terminology of ARCS, moving individuals from awareness, through relevance to confidence and satisfaction. This balancing of positive and negative motivational energisation, through a recursive process of discrepancy creation and discrepancy reduction is conceptually similar to that of conversation theory. The preliminary conversations with the public were to adopt conversational theory terminology, conversations for consensus on what the public perceived of ergonomics. The next stage in the process was converting this consensus, as documented in section 3.3, into action and thereby implicitly into an active designed experience of the sort discussed previously in this section as imperative to engaged behaviour. A participatory approach to design would take this further and continue to involve users in the action phase of the exhibition development.

As synthesised in the data in section 4.6.2, the conceptual synthesis constructed from these conversations helped to highlight at a basic level the aspects of ergonomics users interviewed were most aware of, or considered most relevant to them. In adherence with the principles of the ARCS Model, such fundamentals help designers interested in developing motivational and engaging design to identify the aspects of ergonomics that interviewees perceive they are already aware of or that are relevant to them personally. Such insights afford designers a starting point from which to identify how best to engage individuals with the subject matter, context, or use-case of the product, system or service they are designing. In the case of the *Ergonomics Real Design Exhibition*, these interviews resulted in the development and inclusion of the Home Ergonomics section, the one most closely informed by the interviews with users, being identified as the entry point to the exhibition.

Following in the design research tradition of iterative participatory design (Simonsen and Hertzum, 2010), this research, and this particular reflection from the *Ergonomics Real Design Exhibition* case study, represents a tangible and practical demonstration

of how conversation and conversational theory can be embedded in design practice or adopted as part of a motivational design process as a means of conceptualising and supporting the iterative design and user interaction and embodiment of a multi-touchpoint user experience.

5.4.4 THE ROLE OF CONVERSATION IN SUPPORTING MOTIVATIONAL DESIGN (RQ1) – DISCUSSION OF THE METHODS OF CONDUCTING THE PUBLIC INTERVIEWS

The preliminary interviews were, in the human-centred spirit with which the *Ergonomics Real Design Exhibition* project was instigated, intended to give visitors to the venue and the general public the opportunity, to paraphrase Krippendorff (2004), to 'language the experience of the public engagement exhibition into being'. Conversations were transcribed and manually analysed for statements in which users either positively or negatively referenced contexts of ergonomics, definitions of ergonomics or what they perceived as the purpose of ergonomics. Considering Simon's suggestion for increasing engagement by presenting "objects in juxtaposition, conflict or conversation with each other" (2010, p.138) several juxtapositions, or discrepancies, as they might be considered from a motivational psychological perspective, came up in the course of the conversations with members of the public. In addition to the vague semantic and contextual groupings of the artefacts or systems that interviewees perceived to be of relevance to ergonomics.

Some of the more confident assertions from interviewees about what they perceived constituted ergonomics were also noted. These statements varied in their confidence and their assertiveness, and from a motivational psychology perspective, it can be argued, with reference to the schema theory discussed in section 2.4, that such confidence was a measure of how well the interviewees felt that their self-schema of ergonomics mapped onto the real world or socially-mediated definition of ergonomics developed in the course of the conversation.

Confidence, as a metric of successful engagement and internalisation, emerged throughout the investigation of this research as fundamental in terms of addressing this research question, both as an outcome from a conversational approach to engaging

users and as a factor determining the likelihood of that individual to reengage with the concept, with ergonomics in the future.

Confidence was also measured empirically as part of the design process in Section 4.5.2 and represents a valuable metric for the relative success of any engagement initiative. Assessing and designing to directly influence the confidence of one's users represents a potentially valuable metric of the success of designers' efforts to influence engagement and energisation of motivation within the design process.

The resounding reflection upon the process of attempting to address this research question was the difficulty associated with defining and implementing an interpretive approach to the communication of the information mediated by the artefacts contained in the exhibition. Despite the obvious value of the conversations in benchmarking the confidence and early conceptual engagement of potential visitors to the *Ergonomics Real Design Exhibition*, as the design development of the exhibition progressed it became increasingly hard for the design team to hold and advocate for the user voice and perspective gathered through these conversations.

Much of the resources allocated to designing and developing the exhibition were spent on developing content, rather than defining and designing the informative and interactive processes that enable users to interact and interpret meaning and relevance from these artefacts. This affirms the precedent within industrial-era influenced design practice of privileging the aesthetic and functional aspects of design, over the broader behavioural and social impact of that design. For whilst this thesis has argued for an emphasis on the tangible aspects of design, given their significance in motivating user behaviour, it argues that in light of the research recorded in this thesis that these should not represent the extent of the design and that any tangible artefacts should be designed in anticipation, by the designer, of the social and behavioural response they may elicit.

Future public engagement with science initiatives, or design initiatives in general, should consider these reflections in their attempts to evaluate the role and value of conversation within the design of a motivating and engaging experience. It is also suggested that future public engagement initiatives should allocate funds and priorities within their initiatives accordingly in order that the value of the engagement be assessed where possible in terms of the behavioural and social interaction it elicits, rather than in terms of how such concepts or constructs are physically represented and how individuals react to this.

Designers interested in consciously influencing motivational engagement could build on the work of this thesis by embedding social interaction, conversational processes and forced juxtaposition within the design of physical artefacts, using for example social media or other emerging networked technologies. In an era of social media and intelligent devices there are myriad possibilities for designers in terms of how they facilitate such conversational engagement or in terms of how they seek to elicit ongoing conversation and participatory interaction with their audience and stakeholders throughout the design development phases and use phases of the product or service lifecycle (Casey, 2003).

The Design Museum has an Interpreting Museum Approach, if it had been possible to move away from that towards privileging or supporting a Legislating or Performing Approach (Casey, 2003) then such as in the case of the Home Ergonomics exhibit, conversation and social interaction may have been able to play a greater role in the end user social motivational interaction within the *Ergonomics Real Design Exhibition.*

The design research recorded in this thesis has indicated a variety of approaches designers can adopt to capture conversational data and user insights, to serve as a continued point of reference or inspiration in informing the motivational design of the exhibition. These have included the use of user personas (3.4.3), abstraction hierarchies

(section 3.4.4) and broader visual syntheses (section 3.7). Such visualisation processes can support designers to consciously conceptualise and influence the motivational engagement of their users and provide a focal point for continued reflection upon motivational energisation throughout the design process.

5.4.5 ASSESSING THE IMPACT OF CONVERSATION ON USERS' MOTIVATIONAL ENGAGEMENT WITH THE EXHIBITION (RQ1) – THE ROLE OF EMBODIMENT IN SUPPORTING MOTIVATIONAL DESIGN

The metric of confidence recorded also represents an attempt to quantify a self assessed measure of the degree to which visitors felt they had embodied a new perspective as a result of engaging with the exhibition. It serves as a metric of the visualised sense users were left with, of a given context, after they had left the museum environment. The measures of awareness and relevance served as a form of feedback to designers upon how new or divergent the visitors' experience was, in comparison with their envisioned sense of expectation or personal relevance possessed prior to visiting the museum exhibition and interacting with it.

The measures of confidence were ascertained by participants stating how confident they were to explain the context of the exhibition to others. This measure reflectively empowers the visitor to imagine and assess their confidence in becoming an advocate for the exhibition, or building on the notions of conversation, social motivation and engagement discussed above how they might socially mediate the content of the exhibition. It is perhaps unsurprising therefore that the exhibit that individuals stated they would be most confident about explaining to someone else, and thus by implication it could be argued they had the strongest visualised sense of, was that of Home Ergonomics. This was of course the exhibit designed to be most relevant, and was the one exhibit most closely informed by the interview data expressing respondents' everyday experiences of ergonomics.

For designers interested in designing to support the motivation of their users, particularly in this case for designers interested in supporting their stakeholders to socially engage and advocate for a product, service or system they have designed, the findings reported in this thesis justifiably indicate that using conversation with users as a process or tool for ensuring that there are parts of that end-user experience that

resonate with users' existing experience of, in this case ergonomics, can result in an overall experience that is more motivating for individuals.

There are a number of further questions provoked by the insights generated from this particular research question, namely at what point, and how frequently throughout the design process should designers converse with end users and what particular aspects of the design decision making process should users be specifically consulted on? In relation to the motivational impact and implications of the design of a product, system of service, this is undoubtedly an area requiring further research and development. The decision of the exhibition design team in this case, when interpreted through a motivational psychology lens, was that it would be beneficial for visitors to experience such an exhibit of high perceived relevance and personal resonance early in their experience of the exhibition environment, in order to ensure their heightened motivational engagement throughout the exhibition.

From a motivational design perspective, engagement is best promoted and sustained by designers addressing users' initial awareness, in this case of ergonomics. This is supported by the work of Keller (1983) and Arnone (2005) focused on implementing the ARCS Model in practice. These models, ARCS and the Motivational Design Framework, can assist designers in conceptualising and supporting their users' perceptions of the relevance to them personally of the context, concept or system in question. If end users' understanding and continued skill development and engagement with the experience was to be sustainably and consciously engaged, it is suggested that designers would also need to introduce an approach to confirming or reassuring visitors of their progression. To develop the role of conversation in supporting motivational design, this could involve the integration of social media components to the product, service or system, to support users to continue to interact with, and feedback to the designers or service providers, throughout the use phase of the product, system or service.

These methods of visualisation and evaluation enable and empower design practitioners and design researchers to understand their abilities to consciously influence the motivational engagement of their end users. They also enable them to identify where and when in the users' interaction and temporal engagement with the product or service experience, designers might be best placed to identify or address the motivational requirements of their users.

5.4.6 THE ROLE OF CONVERSATION IN SUPPORTING MOTIVATIONAL DESIGN (RQ1) – DISCUSSION OF THE EXPERT PRACTITIONER INTERVIEWS

The interview data clearly indicated that it is difficult to define the essence of ergonomics, or indeed, even define one archetype example of ergonomics. Most of the expert ergonomists interviewed admitted they found it difficult to communicate their work, some saying they even avoided mentioning the word ergonomics in conversation, as it tended to complicate the process. The examples given in these conversations were useful to illustrate the work of ergonomists, while also painting a somewhat limited view of the field; this is a finding consistent with Dempsey et al's own interviews with ergonomics practitioners (2000).

The interview examples failed to tangibly expand the definition or purpose of ergonomics, much beyond the subjective opinion of the individual who volunteered it. They lacked a reference point, or way of benchmarking the volunteered examples or artefact deemed ergonomic by the respondent. Several respondents mentioned companies such as Apple as exemplars of good ergonomics, but there was nothing within the interview data that made it possible to separate the elements of Apple's design practice that were specifically ergonomic. In motivational psychology terms, these conversations provided little evidence of a clear descriptive model of ergonomics.

This may of course have been in part due to research limitations, such as the nature of the questions, or limitations imposed by the context or time constraints. The subjective interpretations interviewees offered did have use and many were engaging interactions; however, the pertinent observation for designers interested in the role of conversation as part of a process of motivational design, is that the results of these interviews were difficult to synthesise and consequently did not lead to generalisable conclusions.

Designers benefit from working with stereotypes for clear graphical or tangible communication (Ingemann, 2010). In the case study, when trying to synthesise a tangible concept from an epistemological or praxeological one, the interview data from expert ergonomists failed to yield conceptual synthesis or stereotypical generalisation. This was the case even though the interviews were conducted in a similar fashion to those with non-expert practitioners, detailed previously, that did support this.

One implication for future public engagement with ergonomics work would be building on this research and further developing the *Ergonomics Real Design* project contribution to the public engagement with science agenda, to succinctly reference the benefits of ergonomics and the values of the discipline visually and tangibly across a range of different contexts of application, and with reference to a number of specific ergonomic artefacts. This approach would highlight the benefits of ergonomics and the relevance of it as a scientific discipline to visitors personally.

Motivationally, the lack of stereotype as a means of motivational engagement and construct from which motivation can either be energised towards understanding or against which the individual's current understanding can be juxtaposed, could be a result of ergonomics being a matter of design epistemology and praxeology rather than a more tangible concept or construct. This may also offer some explanation of a common grievance aired by the expert ergonomists around concerns they have with the use of the term ergonomic as a marketing term, applied to products often without heed, reference or validation of the processes whereby such a term should, in their opinion be validated. This cheapening and commodification of the term ergonomic was something that the exhibition sought to address by highlighting that ergonomics, as an applied scientific discipline, is more expansive than this common adjective in product marketing literature often implies.

The expert ergonomist interview data contains many personal and subjective responses, which may allude to a discipline where in light of the highly internalised and engaged nature of many of its practitioners, very often the means of the ergonomics process justifies, to its participants, its own end. To paraphrase Heckhausen to engage people in the same manner as these ergonomists, "[we should] not ask to what end an action goal is pursued, but [rather] how a goal adequate action sequence is possible..." (Heckhausen, 1980, p.9). That is, designers attempting to engage people through public engagement with science, should not in the course of such informative conversation focus on end results of the ergonomic process, or what artefacts or systems are ergonomic. They should focus on the process by which an ergonomist addresses the task of making them ergonomic.

This, like the public conversations discussed previously, highlights the role of practice or praxeological enquiry in mediating an engaging, or motivating experience. Instead of attempting to benchmark and engage the public with ergonomics by promoting it as a discipline against qualitative, quantitative or aesthetic measures of its value, a more motivating form of engagement would be one that empowered the public to absorb themselves within, and participate of, the processes that appear to absorb the expert ergonomists so implicitly and intrinsically. In conclusion, in the terms of Cross (1999) this would constitute engagement through the practice of ergonomics rather than into the practice of ergonomics.

5.5 TO WHAT EXTENT IS THE DESIGN PROCESS CONDUCIVE TO ENSURING MOTIVATIONAL ENGAGEMENT? (RQ2)

This research, through synthesising motivational psychology literature in relation to the practice of design, and the process of designing for public engagement, together with the insights gathered through interviews, highlights some important distinctions for designers interested in consciously influencing motivation. These correlate to what Krippendorff heralds as a philosophical shift in the way designers conceptualise engaging with users as the shift from object-centred to human-centred research and design. He states, "It is the less tangible artefacts that are now legitimizing concerns [that] defy explanations in terms of objective or observer-independent accounts, externally imposed tasks or goals and measurable performance criteria" (2004, p.44).

Krippendorff (2004) categorises that "the three most important pillars of this emerging epistemology are: respect for the internal validity of different world constructions [autonomy], acknowledgment of the social or cultural role of language in accounting for what people feel, think, see, do or design [social relatedness and self reflection] and the recognition of the reality of embodied human experiences". These directly map to the wider motivational psychology research synthesised within the Motivational

Design Framework and neatly synthesise the contribution of this thesis in documenting a design process that sought to reconcile and incorporate these facets of experience.

5.5.1 TO WHAT EXTENT IS THE DESIGN PROCESS CONDUCIVE TO ENSURING MOTIVATIONAL ENGAGEMENT (RQ2) – IMPLICATIONS FOR DESIGNERS WISHING TO CONSCIOUSLY INFLUENCE MOTIVATION

Based on the conversations conducted with practitioners, and the challenges evident in being able to summarise and synthesise a definition of ergonomics with which to then engage individuals in the form of a public engagement with science exhibition, there are a number of further challenges and opportunities for designers interested in consciously influencing the role of motivation within design. These challenges may not so much be articulated in terms of how individuals interact with designed artefacts that exemplify ergonomics and the work of ergonomists, but rather in terms of the processes through which it is possible for designers to encourage, empower and support individuals to embody the process and practice of being an ergonomist that will have the biggest significant bearing upon their engagement with ergonomics.

Designers must consider their interaction with users as part of an on-going process or relationship mediated by the designed artefacts or service touchpoints, rather than as a by-product or end result of users' interaction with these products. Designers interested in understanding what already motivates expert users of such products, systems or services may need to adopt a participatory and embodied approach to user engagement and observation, of which conversation might form a part, but does not represent the extent.

5.5.2 TO WHAT EXTENT IS THE DESIGN PROCESS CONDUCIVE TO ENSURING MOTIVATIONAL ENGAGEMENT (RQ2) – MOTIVATION VISUALISED AS A PROCESS OF SKILL DEVELOPMENT

A varied approach to engagement could involve designers becoming more accomplished at monitoring and evaluating users' interaction with products and making adaptations as a result, as well as mediating dialogue or conversation through artefacts in the manipulation and orientation of these through the functionality they offer. The work of educational theorists and researchers, such as Edelson (2002) highlighted in the literature review, detailed the role of influencing and developing physical and cognitive literacy. This can be harnessed by designers to better understand the question of how phenomenologically designers can shape and influence behaviour. This reference to design for motivation as analogous to that of design for skill development reiterates a recurrent finding throughout this research, that of the parallels between the paradigms of instructional and motivational design.

There is a recurrent reference throughout this chapter to the different means by which the role of motivation can be conceptualised, such as in the above case, by analogy with the role of skill acquisition and the development of physical literacy within design. This challenge to conceptualise motivation is not a new one, when attempting to understand motivation "The challenge is to find ways of conceptualising it, which help [people] to understand... [their own] progress and behaviour" (Galloway et al., 1998 p.42). This notion of the importance of progress, monitoring embodiment, physical and cognitive engagement represents a means for designers to actively engage users' motivational energisation, by understanding and addressing their competence-oriented needs and ambitions.

In this sense the interview data from expert ergonomists were valuable in discerning a very real and personal sense of what had energised these individuals' career choices and their resultant engagement with ergonomics. Designers interested in

understanding users' motivation and engagement, should focus their research on understanding how users enact and conceptualise their relationship with the given context, product or service (ergonomics) rather than seek to inquire as to the artefacts that exemplify or represent tokens of such experience. In order for designers to empower and facilitate a broad range of motivational engagement, that of both experts and novices, it is important that they do not limit the focus of that interaction to physical artefacts and tangible representations of that engagement. They must also consider the psychological and social drivers of motivation and engagement that individuals possess and that, in this context with many of the expert ergonomists interviewed, implicitly energised their motivation for a career as an ergonomist.

Fogg (2010) offers a useful framing of the progress, spectrum or continuum of behaviour and motivational engagement as a combination of simplicity and ability. Adopting Fogg's conceptualisation in relation to motivational design as a process of skill acquisition requires the reconciliation of simple explanations of ergonomics from these interviews with expert ergonomists. Simplicity can be considered the extrinsic specification, that is the process of reducing the prevalence of affordances that cause behavioural friction in the environment (the right side of the Motivational Design Framework), ability can be considered the intrinsic specification (the left side of the Motivational Design Framework), that is the capability or quality of self schema and skill inherent in the behaviour of the human user. It would appear, given the difficulties associated with elucidating meaningful examples of ergonomics from the expert ergonomist interview data, that the focus of the interviews was too intent on the extrinsic simplicity end of Fogg's conceptual spectrum. They would have benefited from attempts to elucidate aspects of exemplar characteristics or anecdotes of the interviewee's expert performance or abilities.

Designers and design researchers interested in using conversation to support design for greater motivational engagement should seek to explore expert users' abilities as

the focal point for conversation from which to generate motivational engagement with the products, systems and services they design. Wharton et al's (2004) Cognitive Walkthrough methodology may offer designers potential guidance in structuring such ability-oriented conversations, in addition to that of Klein's Expert Decision Making (1989) and Cognitive Work Analysis (Vicente, 1999).

5.5.3 TO WHAT EXTENT IS THE DESIGN PROCESS CONDUCIVE TO ENSURING MOTIVATIONAL ENGAGEMENT (RQ2) – THE CONSTRUCTION OF RELEVANT AND FAMILIAR CONTEXT TO PROMOTE GOAL SEEKING BEHAVIOUR

The contexts identified as suitable for the engagement of the public with the values of ergonomics were informed by interview data. This approach was taken because the project team believed that for motivational design to occur and be most effective, some form of progression and conceptual abstraction would be required to structure visitors' interaction and energise their goal identification and goal seeking behaviour. This section discusses the second research question, exploring the role of the design process, and designers as stewards of that process in determining or influencing users' goal seeking behaviour and motivation. This section will thus discuss how design approaches and processes can support users to energise their behaviour and engagement and empower individual users' capabilities to feed-forward or visualise goal-action sequences (Heckhausen, 1980) that the process of design can then bring alive and into fruition. In other words, this section explores the question of how visible or apparent, in case of the meta-motivational evaluation of the *Ergonomics Real Design Exhibition*, a broader conceptual abstraction was to users and how valuable such visualisation was to the designers.

The notions of goal-action sequences were tangibly represented by Keller's (1983) ARCS Model. The ARCS Model implies that for individuals to engage, construct and fulfil a goal-action sequence of behaviour, they need to have at first awareness of, and subsequently perceive the relevance of, a particular task or concept demanded of them or presented to them. The interview data collected during the design of the exhibition helped the design team to begin to elucidate a baseline assessment of awareness and personal relevance from experts and novice potential participants. Their responses were synthesised in the conceptual synthesis outlined in section 3.6 to support the exhibition designers to greater engage and motivate members of the public; that is, to support members of the public to construct their own goal-action

sequences of behaviour and motivational engagement towards the scientific discipline of ergonomics and its work.

Artefacts to furnish these identified contexts were subsequently sourced from a wide range of ergonomics consultancies. The visualised notion of the 'contexts of use' of ergonomics presented a flexible and adaptable construct, from which and through which to collate and curate the sourced ergonomic artefacts. It is hoped that this research, and the visualised models and reflections discussed herein will provide an exemplar process of conceptual synthesis for future public engagement exhibitions.

5.5.4 TO WHAT EXTENT IS THE DESIGN PROCESS CONDUCIVE TO ENSURING MOTIVATIONAL ENGAGEMENT (RQ2) – COMPARISON OF THE VISUALISED MODEL OF ERGONOMICS WITH THAT OF ESTABLISHED MODELS OF ERGONOMICS

There are a number of commonly cited definitions of ergonomics within the literature and there was much discussion within the development process of the *Ergonomics Real Design Exhibition* as to whether, in terms of aiding users abilities to engage with the discipline and acquire an accurate perception or visualised sense of the discipline of ergonomics, it would be better in designing the exhibition or through the design process of the exhibition to defer to one of the established definitions of ergonomics or persist with the definition co-created together with prospective visitors to the exhibition in the interviews detailed above.

In motivational terms this constitutes a delineation between the extrinsically mediated definitions afforded by the literature, constructed without input or reference to the personal or intrinsic representation of ergonomics, as advocated by the prospective visitors to the exhibition we interviewed and the highly intrinsically valid, but arguably not broadly representative definition of ergonomics established together with members of the public and expert ergonomists. This question of what conceptual schema underpins the design of a product, system or service is one that affects every design process or design project. Any design is constructed as an extension of the designers' frame of reference, the design team's frame of reference or the users' frame of reference or a combination of these equally valid but sometimes contradictory cognitive constructs.

Clearly, user-centred and human-centred approaches to design have sought to address the precarious nature of a design process that adopts purely a designer's intrinsically mediated definition of the solution or conceptual schema of a particular design process. Given the subject matter of ergonomics, an applied scientific discipline

that promotes user-centred approaches to design itself, there was perhaps increased pressure to adopt one of the established models from the literature such as that of the International Ergonomics Association or others identified in the course of the development of the exhibition such as that of Pheasant (1986) or Wickens (2004).

Adopting the premise of Vargo and Lusch (2004), that all value is co-created with users, the recommendation from this research would be to defer to a co-created definition of ergonomics. The sense of relevance, personal ownership and empowerment that such a shared mental model of the concept would create, would represent a positive environment or platform from which designers could energise the motivational engagement of their users. This recommendation does however present designers and design researchers with a dilemma, as the literature review discussed, and the results of the ARCS meta-motivational analysis recorded in section 4.5 reveal, in an expert discipline such as ergonomics it is of significance that the definition of ergonomics the public are being engaged with, is authentic to the professional heritage and literature that backs the work of the ergonomists themselves.

Further research is required to understand how the full range of motivational engagement, including intrinsic motivation and introjected regulation of understanding and conceptual engagement, can occur whilst still ensuring that the product, system, service or concept with which individuals are engaging remains authentic and consistent with the established, evidence informed and expert-led knowledge and approaches exemplified by ergonomists and ergonomics as a professional discipline. In this sense, successful engagement may represent an authentic and successful balancing of all parties' intrinsic drivers of behaviour in a manner resulting in an introjected or identified regulation of a combined understanding of the subject matter or task in question.

5.5.5 TO WHAT EXTENT IS THE DESIGN PROCESS CONDUCIVE TO ENSURING MOTIVATIONAL ENGAGEMENT (RQ2) – DISCUSSION OF AN ALTERNATIVE MODEL FOR THE VISUALISATION & STRUCTURING OF PUBLIC ENGAGEMENT – THE DREYFUS AND DREYFUS SKILL ACQUISITION MODEL

This research has established that engagement demands a variety of implicit or explicit physical and cognitive skills and basic physical literacies and capabilities. The Dreyfus and Dreyfus Model represents one such way of structuring designed systems to support the development of increasingly identified and intrinsic motivation as an implicit behavioural process.

In the case of the *Ergonomics Real Design Exhibition*, a praxeological approach to engagement could have been taken, visualising or developing the exhibition as a designed experience through a process of decomposing tasks or skills of ergonomists into context-independent features and processes that "the user can recognise without the desired skill [of being themselves an Ergonomist]" (Dreyfus, 2004, p.177). The user would subsequently be afforded progression from novice through to an expert level of awareness by gradually assembling and, where possible, imitating the skills and behaviours of the ergonomists so that they engage and embody fully the processes of ergonomics.

In this context, with reference to the earlier cited work of Rust et al (2000), the artefacts in question should support process-oriented knowledge transfer and would facilitate social interaction and interpretation (Simon, 2010). Such an implicitly participatory approach to task deconstruction and re-conceptualisation is, by the implication of this research, effective and successful in engaging people with skilled behaviour or performance of psychomotor tasks and arguably represents a more concerted and explicit attempt to engage participants than the approach adopted by the *Ergonomics Real Design Exhibition*. This can be best evidenced by the fact that the context that

elicited the greatest amount of engagement was that which the users had most closely informed and socially constructed.

The validity of the Dreyfus and Dreyfus Model in its ability to measurably direct the energisation and motivational engagement of users in a museum context requires further exploration; however, the high levels of engagement recorded in the ARCS meta-motivational analysis gathered in the first two sections of the exhibition suggests that designers need to work to sustain early initial engagement, in the manner that Dreyfus Model asserts as theoretically possible.

Considering the principles of museal engagement (Simon, 2010; Casey, 2003) referenced earlier in this thesis, the physical venue or context of engagement activity needs to be designed to support a participatory and action-oriented approach, beneficial to the greater motivational energisation of the users who interact with it and participate of the process of public engagement within it. In practical terms, a number of role models or instructors would be required, or alternatively some expert practitioners to facilitate participatory engagement. These people would need to be willing and able to deconstruct their own processes and approach to their work, to enable it to be re-synthesised within the designed environment or context of the product or service proposition being developed.

This approach to engagement would lend itself well to forms of user interaction where a strong participatory, theatrical or performative approach was possible and appropriate. When viewed from a broad level of abstraction, this could be considered analogous within the field of design to organisations and manufacturers offering training and product support as part of a service proposition to accompany or add value to a physical product. This approach to the use of human interactive and performative functions and capabilities within the design of product service

propositions is increasingly commonplace in the modern service-dominant economies of the developed world (Vargo and Lusch, 2004; Young, 2008).

In the case of the *Ergonomics Real Design Exhibition*, a skill development, designing as coaching, active learning approach to engagement was not deemed appropriate for the hosting venue. The exhibition's chosen interpretive approach, as discussed previously, involved object-centric approaches and reflection upon a series of contexts of application of ergonomics. An even greater focus on direct reflection by users, of the acts or performance of the ergonomists in these contexts may have been more engaging.

The benefits to motivation of adopting an active learning approach, visualisation or conceptualisation of the role of design and the designer in influencing and directing the motivation of their users, makes a strong case and offers additional possibilities for designers to add value to their design proposition in situations where role play and performative approaches to design development or product and service interaction are required or might be considered beneficial. Implementation of the Dreyfus Model as part of future public engagement with science would potentially require designers to focus on just one specific context of engagement, rather than the six that made up the *Ergonomics Real Design Exhibition*. This would facilitate the engagement of participants with specific tasks or applications, rather than with the breadth of an entire professional discipline.

This approach to transitioning the user from their existing level of understanding, at the initiation of their interaction, through to a heightened level of appreciation, knowledge and experience by the time they had reached the end of it, is central to the Dreyfus Skill Acquisition Model and its applicability in supporting designers to consciously motivate their users. In this light it bears much relation to the process of

public engagement itself, as articulated by the EPSRC of moving individuals upstream from awareness to full engagement.

5.5.6 TO WHAT EXTENT IS THE DESIGN PROCESS CONDUCIVE TO ENSURING MOTIVATIONAL ENGAGEMENT (RQ2) – A MODEL OF ENGAGEMENT AND SELF–DETERMINATION THEORY AND FLOW

The work of Deci and Ryan (1985; 2000) was pivotal to the thinking behind this research, particularly around the importance of individual autonomy and social or competence oriented approaches to evaluating the motivational impact of a design intervention. These are critical to the self-deterministic, organismic view of behaviour that underpins the conceptualisation of motivation, and the role of motivation within design, asserted throughout this thesis.

Deci and Ryan's work supports the assertion of this thesis that designers can play a more prominent role in defining and influencing the motivational engagement of their users and that they additionally have a responsibility to evidence the impact of their design thinking in these terms. Their Cognitive Evaluation Theory approach to modelling motivation provides a framework of utility to designers, and one worthy of greater research and practical evaluation in terms of how it could be integrated within the design process.

Public engagement with science and the design required to support this is explicitly linked to public motivation and the public's motivation to learn about science. Therefore, designers focussed on designing for public engagement, such as the *Ergonomics Real Design Exhibition* design team, can learn much from motivational psychology literature, that supports the development of a schema of what individuals might reasonably be expected to learn or take away from such an engagement experience and their levels of motivation towards or away from this goal, or series of goal-action sequences of behaviour, as and when they do so.

The models of design, behavioural change and skill development discussed in this section, present ideas for future evaluation and reflection on the part of designers and

design researchers about the role of skill development and motivational progression as users interact with designed products, systems and services. Such frameworks build on the approach within this research that created the Motivational Design Framework and utilised the ARCS Model as a framework to visualise and evaluate the motivational engagement and psychological conceptual development undertaken by users in interacting with a designed experience.

These frameworks can support designers in addressing the challenge that the Engineering and Physical Science Research Council (EPSRC) warn those participating in Public Engagement with Science projects to be particularly mindful of, to '...not assume that your public wish to learn about what you have to tell them...'.

Designers should not assume that motivation is inherent as an outcome of a particular designed intervention, but as has been argued elsewhere throughout, it should be consciously considered, visualised and articulated within the design process. Motivation, according to the literature reviewed, is something most designers do not consciously seek to influence, or if they did so they utilising an industrial–era 'carrot and stick' (Pink, 2010) approach to conceptualising, visualising and evaluating, which is to say 'designing', motivation.

A number of frameworks through which designers can consciously visualise motivation as a process of skill development or behaviour progression are suggested in response to the second research question. These frameworks can, like those constructed in the course of the *Ergonomics Real Design Exhibition* design development, be used to articulate the conceptual schema within the design of the exhibition. As such, these schema or frameworks support greater understanding and design development of the experience in question, by consistently providing a framework from which designers can reflect upon the behaviour and conceptual map or mental model that they are asking users to engage with.

5.5.7 TO WHAT EXTENT IS THE DESIGN PROCESS CONDUCIVE TO ENSURING MOTIVATIONAL ENGAGEMENT (RQ2) – THE ROLE OF VISUALISATION, AS A CORE SKILL OF DESIGNERS, IN SYNTHESISING THE RESULTS OF THE MOTIVATIONAL ENGAGEMENT

The process by which the data collected in this research were visualised, and consequently aided communication and collaboration amongst the exhibition project team, is summarised in section 3.6. As discussed above, the ARCS Model presents a straightforward way to conceptualise cognitive engagement, its progress and processes and its resultant behaviour. It was therefore chosen as the framework to support this analysis of data collected in this study and to address the third research question about the visualisation and evaluation of users' motivational engagement with a designed interactive multi-touchpoint user experience.

The ARCS data were visualised as a series of graphs indicating the fluctuating levels of awareness, relevance, confidence and satisfaction of visitors as they interacted with the exhibition. This was essential to its utility as a framework to support designers understanding of these factors and how these in turn impact upon or reflect a users' motivational energisation and self regulation as they interact with a designed product, system or service such as the *Ergonomics Real Design Exhibition.*

It is suggested that the ARCS meta-motivational factors represent an elaboration, at a closer level of abstraction, of the conversational theory constructs of consensus and action.

A further area of investigation and research could consider exploring how else these sort of motivational data might be visualised to aid greater understanding by designers. This could include integration of analysed data with other frameworks and tools employed in the course of the development of the *Ergonomics Real Design Exhibition*, such as the stakeholder personas (section 4.4.3) or the Abstraction Hierarchy (section 4.4.4). This would present a further means of aiding reflection upon the motivational energisation by designers tasked with future public engagement or tasked with consciously influencing the motivational engagement of their stakeholders, users or colleagues in the design of more motivating products, systems and services.

5.5.8 TO WHAT EXTENT IS THE DESIGN PROCESS CONDUCIVE TO ENSURING MOTIVATIONAL ENGAGEMENT (RQ2) – DETERMINING AND ASSISTING PERCEPTIONS OF AUTHENTICITY, RELEVANCE AND COGNITIVE DISSONANCE

This research explored the role of conversation in informing designers' efforts to motivate and engage their users. It has further sought to explore how designers and design researchers might visualise users' responses to these conversations to ensure that they play a significant role in informing the design of the product, systems or service in question, given the clear steer in the motivational psychology literature that individuals' perception of personal relevance and resonance is key to their ability to motivationally engage with that product, system or service. These two enquiries, in addition to broader reflections upon the role of visualisation, sought to explore how, having generated a range of insights through the process of conversing with stakeholders in the design process, those insights might be visualised and subsequently evaluated to ensure the design and development of a motivationally engaging, cognitively coherent and authentic experience. Authenticity and conceptual coherence were identified in the review of the literature as fundamental attributes to prevent the growth or prevalence of cognitive dissonance and task discrepancy amongst users, and the impact that this will inevitably have on users' motivation to engage with a designed product, system or service.

As the literature explored in thesis highlighted, specifically the museum literature, adoption of a clear interpretive approach to ensure learning, and knowledge transfer in a manner that "ensures a high degree of personal relevance" is fundamental to successful museal engagement and to the effective intrinsic motivation and knowledge transfer (social relatedness and motivational energisation) of users or participants.

The approach to envisioning or visualising future scenarios, as detailed in section 3.4.1, is a well-established design technique that, as the results of the conversational engagement detailed in section 3.3 also indicate, is powerful and pertinent in enabling

designers to support greater motivational engagement of users through enabling them to 'language into being' (Krippendorff, 2004), that is, to feed-forward an embodied and imagined sense of their future engagement and interaction and empower them in the process of defining how such engagement might manifest itself.

5.6 DISCUSSION AND CONCLUSIONS FROM THE META–MOTIVATIONAL APPROACH TO EVALUATING MOTIVATIONAL ENGAGEMENT (RQ3) – THE ROLE OF MOTIVATION IN EXPERT AND STUDENT ENGAGEMENT WITH THE ERGONOMICS REAL DESIGN EXHIBITION.

The ARCS meta-motivational analysis serves as a prototype or exploratory design research approach to support designers in measuring perceived motivational engagement and self-regulation of motivation of their stakeholders, in this case as they interacted with the *Ergonomics Real Design Exhibition.* The ARCS meta-motivational analysis represents a novel methodology in the field of design research and presents some interesting results for designers concerned with understanding what components of user behaviour they can directly influence, or support users to more autonomously regulate themselves. This approach could be replicated in future public engagement initiatives or in other contexts, in order to support designers to consciously influence the motivation of their users as the user interacts with a wide variety of products, systems or services. As such this approach specifically built on the work recorded throughout this thesis in addressing the earlier research questions and seeks itself to address the final research question of how designers might better evaluate the motivational engagement and self-regulation of motivation of users as they interact with the products, systems and services they design.

The case study data include a number of interesting results that might help inform the design of future public engagement with ergonomics, and that support Keller's (1983) assertion that contexts most relevant to users would be the most motivating and engaging for users to interact with. The data collected support the earlier assertion that, if framed in terms of the motivational principle of discrepancy, it is simultaneously possible to design an artefact-led or service-led experience, such as a museum exhibit, that can be both familiar and positively engaging to non-experts, and cognitively discrepant, but therefore also negatively engaging to experts or individuals who possess a more established understanding of the subject matter at hand.

In essence it is possible to accommodate a range of prior abilities and levels of motivational engagement within the design of products, services and systems through coherence with a number of key principles. This research examined the underlying behavioural and motivational energisation implicated in Simon's (2010) assertion that framing objects or concepts in juxtaposition to each other within a museum environment represents one way to energise engagement of the visitors who interact with them, and implicitly therefore the motivation such engagement will demand.

5.6.1 DISCUSSION AND CONCLUSIONS FROM THE META–MOTIVATIONAL APPROACH TO EVALUATING MOTIVATIONAL ENGAGEMENT (RQ3) – THE ROLE OF POSITIVE MOTIVATIONAL ENGAGEMENT IN DESIGN RESEARCH AND PRACTICE

This observation and the exploration of positive and negative engagement toward a museum exhibit and the facets of motivational engagement that it elicits highlights the motivational concepts of approach and avoidance motivation in support of the argument of this thesis that approach avoidance constructs and the concept of discrepancy are beneficial to the design and evaluation of a public engagement with science exhibition and to design research more generally.

The motivational psychology literature reviewed throughout this thesis has further delineated the notion of discrepancy or juxtaposition in terms of how as a construct it can be utilised by designers to impact upon the motivational engagement of their users. Thus, related to the results profiled in section 4.5, the notion of discrepancy can be further evaluated in terms of discrepancy-reduction, in this case ensuring that the context was more familiar to, and less discrepant with, visitors' prior experience or alternatively in terms of discrepancy-creation, namely ensuring, in this instance, that expert ergonomists could reasonably be empowered to respond to any perceived discrepancy in a constructive, creative manner.

Referencing the motivational psychology literature synthesised in chapter two, and the results of the meta-motivational analysis, suggests that failure on the part of designers to allow users to respond creatively and pro-actively to perceived discrepancy results in a disempowered and demotivated response. This research developed an approach from which designers can evaluate users' motivational self-regulation of their experience of a multi-touchpoint or multi-context user experience. This framework enables the identification of areas where users may appreciate or benefit from being

empowered to creatively or co-creatively input or respond to the product or service development and delivery process.

5.6.2 DISCUSSION AND CONCLUSIONS FROM THE META–MOTIVATIONAL APPROACH TO EVALUATING MOTIVATIONAL ENGAGEMENT (RQ3) – UTILISING MOTIVATIONAL ENERGISATION AND ENGAGEMENT AS

In the *Ergonomics Real Design Exhibition* context, Home Ergonomics generated the most engagement from expert and non-expert users and could therefore be considered the subject for further conceptual development and co-creation, perhaps in the form of a co-creative workshop of the sort detailed in section 3.5.3, but involving both groups of participants or a range of experiences amongst the same group of participants.

The results of the meta-motivational analysis could also be used by designers to inform the ongoing development or redesign of a product, system or service. In the case of *Ergonomics Real Design*, this could have involved using the meta-motivational analysis to identify the exhibit that participants identified as having least awareness of prior to the exhibition, medical ergonomics in the case of the experts and workplace in the case of the students interviewed. Making this context the focal point or central feature of any future engagement, as the one that this motivational analysis has identified as the most discrepant with users' existing levels of awareness, should result in an increase in positive motivational energisation from users. The thesis would also argue however, that in order to harness this discrepancy reduction energisation most effectively, designers may need to provision the means of supporting users to more autonomously interact with this context or, alternatively, provision a greater degree of social interaction around this subject matter in order that individuals are capable of successfully internalising the message of this context and the task and conceptual demands it places on users.

Design practitioners are increasingly supporting organisational cultures of value co-creation and perpetual-beta (Vargo and Lusch, 2004; O'Reilly, 2005), adopting an ARCS Motivational Design Framework in the evaluation of the motivational impact

of the designed experience an organisation offers its users, in the manner adopted in this research, represents an interesting and exciting means by which to explore users' engagement and interaction with a product, system or service an organisation offers. This approach also provides a unique insight into the manner in which users have internalised the value that the given product, system, context or service has offered them. This evaluation of motivation can provide designers with a much clearer insight into how then to engage or re-engage users with aspects of the experience they may have perceived as ones they are disengaged with or vice-versa.

This research sought to translate the findings of motivational psychology about aspects of human behaviour in a way conducive to supporting designers and design researchers to understand them and adopt them within their practice, as areas of additional research investigation or designed enquiry. Designers and design researchers can make use of the identified motivational constructs of Awareness, Relevance, Confidence and Satisfaction to enable designers to address discrepancy creation and discrepancy reduction in different areas of a multi-touchpoint, multi-user systems or service experience.

5.6.3 DISCUSSION AND CONCLUSIONS FROM THE META–MOTIVATIONAL APPROACH TO EVALUATING MOTIVATIONAL ENGAGEMENT (RQ3) – THE ROLE OF NEGATIVE MOTIVATIONAL ENGAGEMENT WITHIN DESIGN RESEARCH AND PRACTICE

The negative role of motivation, a concept not evidenced or explored within the context of design research, was clear in this research, in the expert-ergonomists' behaviour. Despite being in disagreement, or being negatively engaged with the interpretative choice and inclusion of the exhibits in the Home Ergonomics context, they were still more energised with the Home Ergonomics context according to the ARCS meta-motivational data recorded in 4.5.1 and the qualitative measures of motivation recorded in 4.5.2 in comparison to the same measures of motivational engagement in the other less contentious exhibition contexts.

This energisation highlights the occurrence of engaged behaviour, even though negative, a concept that particularly may be of value to designers in safety critical domains and in the design of complex systems. Such a construct may also be of great value to designers looking to prolong engagement or delay gratification amongst their users. One such example being a situation where it may be advantageous to the smooth operation of the system to ensure that in certain places users are strategically left feeling demotivated or negatively motivated, either to prevent them doing something disruptive or to encourage them to subsequently self-regulate by exercising positive motivation.

The concept of designing for negative motivation throws up some interesting ethical questions about the abilities and appropriateness of designers in influencing the motivational engagement of users in this arguably Machiavellian way. These latter questions again represent areas for further investigation and analysis within the fields of Design Research and Human Factors and Ergonomics.

The visualised indications of negative motivation, detailed elsewhere in this thesis as anti-goals and avoidance seeking behaviour, contrast with the alleged more conventional view within design of motivational engagement that assumed that rather than exhibit negative motivational engagement in this manner, when users were faced with a disagreeable situation, such as that faced by the expert ergonomists in the Home Ergonomics context of this study, they might instead have demonstrated amotivated or apathetic engagement with the situation. This more traditional view of user behaviour would imply that users when not engaged with a given product, system or service, would exhibit no energisation of behaviour or response to the situation at all.

It is easy to see how this apathy hypothesis of the role of motivation in design, explicitly, that users are either motivated or not, in this case to engage with an exhibition, might propagate itself in the museum or exhibition engagement environment where it is often hard to determine signifiers of engaged user behaviour or cognitive engagement. This is particularly true for designers attempting to interpret user behaviour in the museum context, being as it is, largely a psychological process of internal reflection.

This research proposes an approach for design practitioners and researchers to elicit and evidence the underlying energisation of human behaviour and motivational engagement within a designed multi-touchpoint user experience, that supports a broader conception of user capability than might have more typically been the case, within the field of design research.

5.6.4 DISCUSSION AND CONCLUSIONS FROM THE META–MOTIVATIONAL APPROACH TO EVALUATING MOTIVATIONAL ENGAGEMENT (RQ3) – THE EXPERT AND STUDENT META–MOTIVATIONAL EVALUATION OF THE ERGONOMICS REAL DESIGN EXHIBITION

Discussions about the role and capabilities of users to motivate and self-regulate their behaviour lead to questions about some of the presumptions at the heart of public engagement with science, and more recent moves in the public engagement with science agenda in the UK, to move away from a model of the public as apathetic or amotivated. This research highlights the value to public engagement of users being considered as capable and empowered, which is to say, self-regulatory and self-determined in their motivational energisation in terms of their ability to both positively and negatively respond to a given situation or interaction within a designed product, system or service.

The conclusions for public engagement from the work of this thesis are clear. It is of increasing significance and consensus to view public engagement with science as an ongoing conversational process between scientists and the public, which as exemplified by the results of the meta-motivational analysis of this thesis that found the most engaging exhibits to be those most directly informed by the earlier engagement and conversations with users. Should this conversational process, or the message that it seeks to communicate, not be effectively translated into a representative physical or reciprocal designed process, there will be limits to the ability of the designers and organisers of the public engagement initiative to consciously influence the views and behaviour of the public.

Reliance on static and artefact-led approaches that are not sufficiently informed or empowered by conversation, and early active and embodied engagement with members of the public, will inhibit the opportunity for public engagement exercises such as that developed in the case of the *Ergonomics Real Design Exhibition* to build

meaningful social relationships with such stakeholders and motivate sustainable engaged behaviour and understanding with and amongst its audience.

5.6.5 DISCUSSION AND CONCLUSIONS FROM THE META-MOTIVATIONAL APPROACH TO EVALUATING MOTIVATIONAL ENGAGEMENT (RQ3) – THE STRUCTURING OF THE ENGAGEMENT PROCESS AND ITS IMPLICATIONS FOR THE EXPERT AND STUDENT MOTIVATIONAL ENGAGEMENT WITH THE ERGONOMICS REAL DESIGN EXHIBITION (RQ3).

The meta-motivational analysis results suggest that when it comes to engaging non-experts, the area or concept that they are most familiar with will be the most engaging, or the area they experience first will be the most engaging. This primacy-relevance effect and its influence upon motivation has been explored by Petty et al (2001) with their observations that: "Under chunked conditions, [i.e. where experience has been compartmentalised, as was the case with the exhibition being chunked into individual contexts] participants who were highly motivated to think were more susceptible to primacy effects than were those low in motivation to think. Under unchunked conditions, this pattern was reversed – those highly motivated to think were more susceptible to recency effects than those low in motivation to think" (p.332).

It can be inferred that by asking participants to consider the exhibition in chunks, or in terms of the contexts that constitute it, there may have been increased likelihood of their susceptibility to primacy effects on engagement. The meta-motivational analysis together with the work of Petty et al (2001) offers an avenue to explore further the identification of the most engaged participants of public engagement amongst those interacting with this designed experience. This second-order analysis, and attempts such as these to understand the reciprocal, organismic nature of motivational engagement exhibited by visitors to the *Ergonomics Real Design Exhibition*, clearly require a tighter, more controlled approach to measuring signifiers of engagement and motivation if the factors determining such engagement are to be more clearly understood.

For the sake of this discussion, however, such a line of supposition as this primacy recency analysis and explanation for the results outlined above, would infer that all but two of the twenty students interviewed were motivated to engage with ergonomics when they set foot in the exhibition space, and all but one of the expert ergonomists. Thus, as a potential means of systematically assessing the motivational engagement of participants within a designed experience, this hypothesised means of assessing individuals' potential for motivational engagement is yet another area of further investigation that can be drawn out from the work of this thesis as beneficial and of interest to designers and design researchers interested in influencing motivational engagement or measuring it.

The approach proposed in this thesis of attempting to ascertain motivational engagement of visitors to the exhibition and observe the manner of their self-regulation of engagement as they navigate the exhibition, presents a number of methodological challenges such as those in being able to identify the parallel multiplicity of influences upon motivation (Dornyei, 2001). Such parallel multiplicity is inherent even within the already reductive ARCS Framework, which supposes that the four measures it contains are, at a broad level of abstraction, representative of the myriad competing influences on motivated behaviour and engagement.

Dornyei (2001) also identifies a number of issues around ascertaining the cognitive and the affective influences upon motivation, which is to say specific to this study, the impact of the aesthetic design of the exhibits as opposed to the information or conceptual schema they symbolise. These factors can be approximated to the awareness and relevance factors being indicative of the cognitive and organisational elements of the design, whereas the confidence and satisfaction factors can be considered as more representative of the aesthetic elements of the design. However, this claim would benefit from further research and controlled study. That said, this delineation strikes at the heart of the traditional, industrial-era conception of designers as form

givers versus the information era conception of designers and design researchers as simplifiers of complexity and mappers of relationships, behaviour and user-experience within the design of complex systems (Martin, 2009).

As devices and sensors become ever more discrete and measures of stress, workload and sensory engagement become possible for longer periods of time in increasingly less invasive and more pervasive forms, these sensors and the data they yield offer designers and design researchers a huge array of possible ways to measure motivation and engagement at a more basal unconscious physiological level instead or in addition to the sort of self report methods utilised in this research. Fields such as psychophysiology and cognitive neuroscience, whilst still developing, may in the future present more accurate methods through which designers might gauge and measure engagement and changes in motivational state and self-regulation as users interact with their products, systems and services.

5.7 DISCUSSION FROM THE META–MOTIVATIONAL APPROACH TO EVALUATING MOTIVATIONAL ENGAGEMENT (RQ3) – RECONCILING INTRINSIC AND EXTRINSIC MOTIVATION WITHIN THE DESIGN PROCESS

The Self Determination Theories of motivation underpinning a lot of this thesis' philosophic and conceptual premises contain a presumption that a designer's ability to tap into the motivational energy innate within each human to learn, to grow and to develop the individual user's sense of autonomy, relatedness and competence, is critical to their ability to engage users with the use and ownership of their products, systems and services. However, as Krippendorff (2004), claims:

"In our lingering modernist tradition, extrinsic motivation is the pervasive cultural norm. Deviations from that norm are easily dismissed as aberrant, unworthy of attention, and in [many cases go] unnoticed" (p.3).

The work conducted and recorded in this thesis has sought to remedy this stated status quo within the field of design. It has done this by inquiring of the role of motivation within design in a theoretical and literature-informed manner, and through reflection upon an applied design project or case study, the *Ergonomics Real Design* public engagement with science exhibition.

5.7.1 DISCUSSION AND CONCLUSIONS FROM THE META-MOTIVATIONAL APPROACH TO EVALUATING MOTIVATIONAL ENGAGEMENT (RQ3) – THE DISCREPANCY CREATION AND DISCREPANCY REDUCTION MOTIVATIONAL DESIGN APPROACH

If it is valid that humans are all born with a tendency for organismic growth as the self-determinist motivation research tradition maintains (Deci and Ryan, 1985; 2000; Reeve, Deci and Ryan, 2004) then the extent to which such patterns of growth and personal fulfilment have been disrupted or supported by a user's interaction with a designed artefact or experience should continue to be explored or sought to be understood by designers.

It is possible that the most intuitive engaging design is simply that which most closely aligns with our predisposed and innate tendencies for physical, sensory and psychological skill development. If the rules, norms and values that govern organisations and society are now, and arguably always have been, predominantly extrinsic, then the question of how designers can conceptualise, visualise, apply structure and form, and evaluate the intrinsic and extrinsically introjected drivers of motivation in designing and successfully accommodating human engagement is key. This is particularly true as designers seek to address ever-broader social issues and develop products and services that appeal to ever broader markets. This research represents a contribution in attempting to theorise, conceptualise and measure such motivational impact.

In terms of design research, the design process adopted and reported charts the clear attempts by a researcher and design practitioner to document early interactions with key stakeholders and audience members, and highlights a number of methods and approaches that could be used by designers and design researchers to translate and evaluate the insights generated in terms of the potential they offer for supporting and inspiring the motivational energisation of product, system or service users.

Building on these tools, this thesis also proposes an approach to evaluating levels of motivational engagement, as self recorded measures of awareness, relatedness, confidence and satisfaction. It is proposed that this meta-motivational analysis achieved two things, it drew participants' conscious attention to their levels of awareness, perceived relevance, confidence and satisfaction, and it enabled the consideration of these hitherto implicit factors within the design and future development of public engagement with ergonomics. More generally, the research also illustrated the possibilities to designers of engaging in a participatory and co-creative approach to addressing some of the discrepant factors affecting motivational engagement within the design of any product, system or service. This iterative approach to development exemplified how this increasingly commonplace workshop based approach to co-creation and participatory design can be inspired by the motivational evaluation of the designed system. This approach also empowers users, in this case visitors to a museum, to a greater level of participation and motivational energisation within the design and development process of products, systems, services and exhibitions.

The process of making explicit motivational affordances previously implicit within design processes is integral to the continued development of designers' abilities to consciously influence a user's motivational state and resultant behaviour. As suggested previously, the factors highlighted in the ARCS methodology, and proposed by the Motivational Design Framework, would benefit from further testing, in more controlled conditions, if they are to become established areas of design research investigation.

However, as a generative tool for designers interested in exploring and evaluating the motivational impact of their design decision making, or for structuring or focussing participatory and co-creative design activity, the methods adopted in this research and

the components of motivation identified throughout this thesis, represent compelling areas for design experimentation.

One possible explanation for the absence of conscious evaluation of the role of motivation within design previously, is that industrial-era and modernist-era design, and the design research that underpinned it has been, and in some cases still is, preoccupied by the process of creating value through aesthetic or functional refinement of products and services within the design development process. Therefore the prevailing means of assessing value with the design process resort to cost and utility models of user and organisational behaviour and motivation. Whilst these models are still important and at least socially relevant, they are this thesis has argued, less appropriate to the process of public engagement with science.

5.7.2 DISCUSSION AND CONCLUSIONS FROM THE META–MOTIVATIONAL APPROACH TO EVALUATING MOTIVATIONAL ENGAGEMENT (RQ3) – THE EXPECTANCY VALUE MOTIVATIONAL DESIGN APPROACH

The design process, and in the case of ergonomics, the role of ergonomics within it, was thus focused on the manufacturing value, the industrialised process of refining physical resources, whether natural or synthetic to increase their value, or configuring such refined resources in unique value-propositions (Young, 2008; Gilmore and Pine, 2007; Morelli, 2002). Motivating users in this situation additionally focused on the process of adding value to physical resources, alongside the marketing process of building expectation about the resultant value this would create for consumers if and when they purchased the product. In such an expectancy value generation process, as Eccles and Wigfield (1995, p.24) point out:

"[the] focus is on the expectancy component, while... ...little attention [is paid] to defining or measuring [or in the terms of this particular research question (RQ3), evaluate] the value component".

To remedy this, from a motivational psychology perspective, they propose a comprehensive model of values that more clearly delineates the drivers of motivation than the dual dichotomy of intrinsic versus extrinsic allows. This range of values is akin to that provided by the Motivational Design Framework. It should be possible and, from a motivational design perspective, of greater value to measure the impact of a designer's input into the product development process in terms of how they support the greater autonomy of the users of the product, or how they contributed to rewarding the competence of users. As Dubberly (2011) notes:

"Design doesn't have feedback loops ...feedback loops ensure quality. Without them, design will remain stuck... Drawing and form-giving (the traditional modes of design)

are not the essence of design. Seeing patterns, making connections, and understanding relationships are".

This delineation helps provide explanation for why after years of acting as form-givers, or more latterly in some cases product marketers, designers' conceptions of human motivation do not equate to much more than that of the so called 'juicer carrot' approach to considering motivation within the design process, by for example, designers making something more aesthetically pleasing or adding another function or two.

5.8 DISCUSSION OF THE META–MOTIVATIONAL APPROACH TO EVALUATING MOTIVATIONAL ENGAGEMENT (RQ3) – THE COMPETENCE ORIENTED MOTIVATIONAL DESIGN APPROACH

This thesis and the methods proposed within it have presented a model of motivation within design that with the further development outlined in this discussion and conclusion, affords designers the ability to measure a number of motivational feedback-loops to ensure the continued quality of their design, particularly with respect to energising human behaviour and motivational engagement.

This model is proposed at a time when many designers are transitioning towards more user-centric and use-focused forms of design that present them with new opportunities for more sustainable, social and competence focused approaches to motivating users, than the extrinsically mediated and utility-value models of human behaviour that have predominated within the field of design until now (Vargo and Lusch 2004, 2010).

The motivational feedback or evaluative loop considered in this thesis could be adopted by designers as a means of measuring or assessing the personal importance of demonstrating one's participation within the engagement process. In the case of an

exhibition such as the *Ergonomics Real Design Exhibition*, this would mean providing the visitor to a museum with a number of means by which to advertise and promote the fact that they had participated in the engagement activity, to help ensure that for those for whom signals of attainment are important in galvanising or rewarding their engagement, or in sustaining their motivational energisation, opportunity was created by the designer for their need to be fulfilled.

The Motivational Design Framework constitutes a competence or relatedness oriented perspective to motivational design, as it involves providing evaluation and feedback on users' participation, a social act, as well as providing feedback on their performance, a competence measure. The data gathered throughout this research, through interviews with potential users prior to the design of the exhibition, and the evaluation conducted afterwards, represent data gathered and evaluated independently to the use-phase and visitors interacting with the exhibition. A value in use perspective such as that proposed by Vargo and Lusch (2004) might involve such data being gathered or recorded in real time in an attempt to make it more adaptable as a form of feedback or measure of competence or relatedness motivation.

The methods used in this research might, as evaluative processes intent on supporting designers design for motivation, be considered with respect to the Extrinsic Utility Value of the data:

"That is, awareness of how well a task relates to current and future goals and what role learning plays in improving the quality of life or making one a better person" (Eccles and Wigfield, 1995, p.24).

In designing a museum experience, this approach would constitute an evaluation of how the subject of the museum exhibit made things better or more efficient as a result of its integration or influence upon the design of a sociotechnical system. Effectively

this might include capacity within the design of the engagement environment to benchmark the utility of the exhibit against a number of familiar, predominant or personally significant and relevant utilitarian values.

Similarly, and with the specific intent of presenting a balanced and reciprocal impression of the value of an experience, where balance and reciprocity might be conceptualised as the outcome of an attempt to persistently evaluate and regulate a user's experience and interaction with a design, a designer might provide visitors to the environment the chance to balance the perceived benefits of the exhibit or artefact against the costs and alternatives to the artefact. Such a real-time, customisable information approach seems important to ensure the integrity and honesty of the initiative, an approach somewhat limited in the case of the *Ergonomics Real Design Exhibition* for the fact that the exhibits tended to be static in their information content and presentation. Simon (2010) indicates that such real-time feedback and interaction is integral to the process of exhibits becoming sociable and by implication, the engagement process becoming more socially mediated and socially motivating. This feedback does not require dynamic display of real-time information, other more low technology and cost efficient approaches are prevalent, such as the nutritional information on most foodstuffs in the UK, or flight tickets that enable you to visualise the environmental impact of your journey. In relation to design, it is important to note that cost in this context does not purely refer to financial cost, it could also refer to the bio-cost, social-cost and ecological impact of a designed intervention (Dubberly and Jones, 2010). The provision of cost-based feedback to users as a result of their interaction with products, systems and services represents an exciting area for future design research and practice based enquiry and exploration.

Conceptualising the values that motivate people to engage with a museum exhibit poses significant questions for designers who seek to design exhibitions. The most notable is the question of how these various factors can be conceptualised and how they

can be measured. The research reported in this thesis makes a significant contribution to attempting to answer the questions of how motivation can be conceptualised in relation to design, and how it can be measured for the benefit and utility of designers. It is hoped that the work of this thesis can serve as the basis for further design research and design practice that formalises the ability and credibility of designers in being able to conceptualise, understand and consciously and methodically influence levels of motivation within the design of products, systems and services.

5.9 HOW DESIGN PRACTITIONERS MIGHT USE OR ACCESS THE FINDINGS AND CONCLUSIONS OF THIS RESEARCH

Finally however, in concluding the discussion of the findings and contribution of this thesis, a further range of ways that the Motivational Design Framework and wider findings of this thesis can support design practitioners and design researchers in their work will be expounded. It has already been argued that greater understanding of the role of motivation in design represents a critical and important area of research to ensure an evidence-based and ethical approach to design. Design research bridges many disciplines and consequently there is potential for its impact to be measured or integrated with the philosophies, processes and empirical findings of many others, most specifically in the case of this research the field of motivational psychology. As design as a discipline seeks to further explore and address ever broader and more complex social problems, the ability to continually view design at broad level of abstraction, in terms of its philosophical intent and in terms of its basal individual and social behavioural impact is important.

The implications of this 'conceptual shift' within design research and design practice could also be extended to incorporate perspectives on how designers theorise, visualise and reflect upon the role of users and designers own involvement, or the role of all as

stakeholders in the design, use and reuse phases of the products, systems and services they develop. Such a shift, as that proposed and prototyped in the research recorded in this thesis and supported tangibly by the 'lenses' or conceptual framework afforded by the Motivational Design Framework, is of value to the field of design and can, as a potential research area within the field of design, also be observed in the parallel development and growth of research areas such as service-dominant logic and the growing emphasis on "value co-creation' and "value in use" (Vargo and Lusch, 2004) and that of open innovation (Chesborough, 2003). Further investigation into the utility of conceptualising the 'value' of these two distinct theoretical approaches in terms of the respective impact they have on the motivational engagement of their stakeholders may be a useful way to further integrate the findings of this thesis with more established research areas within, or pertaining to, the field of design research. Put another way, being able to use the Motivational Design Framework to support and measure the 'creation of value' or 'value co-creation' within the field of design or throughout the design process, may represent a really interesting way of making more tangible the concept of 'value' within the design of complex service systems or within the design of technology enabled and networked products. This suggestion is effectively proposing the concept of value within the design of complex sociotechnical systems be considered in terms of the behavioural and motivational energisation and the direction of that energisation.

In conclusion, it is contended that the synthesis and hypothesis of these facets of motivation articulated through the Motivational Design Framework represent a key contribution to the field of design research and to paraphrase Martin (2009) provides a platform for future design research and design practice based enquiry by having developed a heuristic of motivation within design, a concept that despite being a fundamental facet of human behaviour was previously mysterious, or complex within the field of design and design research.

This thesis also argues with respect addressing the second research objective of this thesis that the focus of a designers design intent, and the behaviour designers consciously seek to elicit from the products, systems and services they design can be improved by viewing human behaviour, within the design process, from a level of abstraction such as that afforded by the Motivational Design Framework. Validation of such claims and validation of the utility of the Motivational Design Framework in informing design practice has been expressed already, as an area for further study. However, with tools such as IDEO's Method Cards and Lockton's (2010) Design with Intent Toolkit established within the field of design research and within design practice as tools that can similarly support designers in appropriating their work at a high level of abstraction from the detail of the design and the intricacies of the design process, and design approaches. These method card approaches allow designers to consciously influence and generatively direct human behaviour and the act of design itself and thus a series of motivational method cards to support designers to conceptualise the motivational impact of their work and identify suitable methods and case studies through which to explore better ways of motivationally engaging users with their work represent a way that design practitioners and design researchers can utilise the findings of this thesis and the body of insights from empirical study and review of the literature it contains. As such, there is cause for much optimism about the value of motivational approaches to future design or practice based research in this area. It is also considered that the positive impact of a broader awareness and subsequent attention to and integration of, the behavioural sciences within the practice and design process of designers, such as that achieved by the Motivational Design Framework will be of benefit to ensuring the continued growth and wider validity of design research and design practice itself, particularly, as Brown (2009) maintains, whilst design as a discipline increasingly finds itself addressing ever more social and complex problems.

To the above end of supporting designers to address ever more complex social problems, it is hoped that the key messages from this research will soon be synthesised in an online and mobile device accessible database, that will be open to other design practitioners to submit their own examples and case-based reflections to and will be conducive to supporting the practice-based reflections and recording further case-based reflections on the role of motivation within design.

6.   CONCLUSIONS

This thesis was undertaken to address the fact that motivation was not formally or systematically understood or documented within the field of design research. This was particularly the case with respect to exhibition design, where the role of motivation and motivational engagement was not understood in a manner conducive to its application by the design team of the *Ergonomics Real Design* public engagement with science exhibition.

In the first instance and in pursuit of its initial research objective this thesis has formalised and syntactically articulated a concept and framework of motivation within the field of design research. This thesis therefore outlines a number of constructs that can be used to support the design and development of engaging and motivating museum exhibition experiences by formalising the underlying dimensions of human behaviour that derive and exemplify human motivation. Building on recent work in the field of museum and exhibition design, this thesis has further reviewed the museal curation research literature and synthesised some key dimensions of this literature together with key findings within the motivational psychology literature and literature from the field of design research, to articulate what it considers to be a model of motivation of utility for designers and researchers in both the museum context and more generally of utility to designers in the design of multi-touchpoint,

multi-user service experiences, particularly where educational outcomes and learning are desired. Further to this synthesis of motivation in the form of a Motivational Design Framework, this thesis, in pursuit of its secondary research objective has reviewed, prototyped, tested and discussed the notion of a motivational approach to design which leverages both the definitions of motivation established in the Motivational Design Framework and which leverages established approaches to design and museum curation, providing a clear design process to support the emerging 'participatory perspective' within the design profession and within the curation and design of museum exhibitions more specifically.

As part of its contribution to the so-called participatory approach to design practice and to support future participatory design and curation of museums and exhibitions this thesis has also developed and contributed a novel conversational approach or methodology of design synthesis as part of the design and development process of the *Ergonomics Real Design Exhibition* it records. These conversational and motivational approaches to design synthesis were recorded in this thesis as products of attempts to facilitate more participatory, systematic and rational approaches to museal curation and, in direct response to the first and second research objectives of this thesis, to greater support and enable designers to identify and consciously and specifically influence the motivational engagement of their users through the design of more motivating products, systems, services. This Motivational Design Approach is discussed in this thesis as consistent with other motivational approaches to design prevalent in the fields of interaction design and instructional design and, this thesis argues, such a philosophic approach to the design of sociotechnical systems would also support designers interested or engaged in the emerging practice and design specialism of Design for Behaviour or Persuasive Design.

The approach to museum and exhibition design outlined in and contributed by this thesis, incorporates and leverages from the design literature concepts and tools from

the physical product, interactive, social and instructional fields of design, identified in the thesis as individually and collectively integral to motivating and engaging human behaviour. Specifically, in addressing the first research objective of this thesis, it has been argued that design for motivational engagement, within the museum environment, and indeed within design practice more generally, designers should consider the 'extrinsic' physical, cognitive and organisational subsets of design and human factors research together with the 'intrinsic' autonomy, competence and social-relatedness seeking dimension of human experience in order to ensure that they design products that are both extrinsically and intrinsically motivating. These motivational factors are synthesised in the form of a Motivational Design Framework in this work to support design practitioners to more readily engage with them and explore the inter-relationships between these dimensions of human behaviour and experience, this synthesis is a direct response to, and validation of, the claims of Krippendorff (2004) of the need for Human Factors and Ergonomics and Industrial Design as professions to be more conscious of the intrinsic motivators of human behaviour. In fulfilling to its first and second research objectives this thesis supports design and human factors professionals to have awareness of, and better respond to the motivational engagement of their users in both an exhibition context and in the design process more generally.

In addition to conversational approaches and synthesis outlined above, discrepancy reduction and discrepancy creation have been identified, in the course of the research of this thesis as fundamental concepts for designers interested in deliberately supporting the motivational engagement of their users and stakeholders, whilst these as concepts have not been expanded fully in relation to design practice within this thesis, this thesis provides a platform for future design research in this area. Such further design research exploration is of clear utility for design practitioners and researchers interested in developing more engaging and motivating design. This discrepancy based approach to museal curation and motivational design from

the Cognitive Psychology research literature is contrasted with more need based constructs prevalent and recorded within the Motivational Psychology literature, the reconciliation and synthesis of such systematic and organismic approaches respectively, to conceptualising human motivation would itself be a fruitful area of investigation building on the work of this thesis.

The Motivational Design Framework, as a key contribution of this thesis is further complemented by a series of case based reflections from design practice, reflecting upon an approach adopted by designers attempting to consciously motivate and engage users within a museum exhibition context as part of a process of public engagement with science. The documentation of this approach in this thesis sets a precedent and provides a reference point for future museum and exhibition design and future public engagement with science endeavours. The Motivational Design philosophy espoused herein, and discussed in detail in these case-based reflections has the potential to support designers working on future public engagement with science initiatives, as well as other design practitioner and researchers seeking to engage and motivate their users.

This thesis in pursuit of its third and final research objective, to measure the motivational engagement of users within a museum exhibition context, presents the field of design research with a prototyped and validated approach to measuring and evaluating the motivational engagement of users as they interact with designed multi-touchpoint user experiences, and the products, systems and services that constitute and sustain such experiences. The articulated approach within this thesis to measuring and evaluating the motivational engagement of users as they interact with a multi-touchpoint, designed user experience is based upon models of motivation identified through the motivational psychology and instructional design literature reviewed in this thesis. This evaluative approach represents the early basis of, and foundation for, a more formalised and clinical process of measuring and assessing the motivational

energisation, self-regulation and engagement of users as they interact with designed experiences in particular designed museum experiences.

This thesis articulates ideas, methods, synthesis and evidence of practice oriented empirical enquiry together with evidence from theoretical and empirical scientific inquiry that together support the validity of motivation as an established concept within the fields of design practice and design research.

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